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Bone marrow sparing Intensity modulated radiotherapy vs Three-Dimensional Conformal Radiation Therapy in carcinoma of the rectum: A prospective study

Karnika , Shaqul Qamar Wani , Aijaz Ahmad Khan , Talib Khan,
Misba Hamid Baba, Shahida Nasreen, Malik Mohib ul Haq, Zubaida Rasool

Abstract:

Background: Colorectal cancer ranks among the most prevalent cancers affecting the gastrointestinal tract. The conventional treatment for patients with clinically staged T3 or T4 or node-positive illness is preoperative chemoradiation therapy. This study presents a comparison of 3D-CRT and bone IMRT as therapeutic options for colorectal cancer.

Material and Methods: The study consisted of a total of fifty participants who were selected and allocated at random to one of two groups: Group A, where patients underwent radiation therapy with Three-Dimensional Conformal Radiation Therapy (3DCRT), and Group B, where patients got bone marrow-sparing intensity-modulated radiation therapy (IMRT). All patients were administered concurrent capecitabine at a dosage of 825 mg/m2 twice a day on the days of radiation. The patients underwent weekly evaluations for the course of their radiation treatment. To assess toxicity, the researchers employed the Common Toxicity Criteria for Adverse Events (CTCAE) version 5.0. Furthermore, a comparative analysis of the dosimetric aspects was performed for the two radiation therapy approaches.

Results : The incidence of acute skin toxicity of grade 2 or higher was shown to be reduced in the group receiving IMRT. There was no difference in the acute genitourinary toxicity and haematological toxicity during treatment with IMRT or 3DCRT. However, it was shown that the IMRT group had a decreased degree of acute lower gastrointestinal toxicity compared to the 3DCRT group. The IMRT group exhibited lower doses to the organs at risk in comparison to the 3DCRT group.

Conclusion: Our results suggest that IMRT-based Concurrent chemoradiation may minimize normal tissue doses and, in turn, the rates of acute toxicity, leading to fewer treatment interruptions. This is demonstrated by comparing bone marrow-sparing IMRT to 3DCRT. Our findings suggest that bone marrow-sparing IMRT has a positive impact on patient outcomes.

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INTRODUCTION

Colon cancer is a global health burden due to patient suffering and treatment costs. Colorectal cancer is the most frequent gastrointestinal malignancy and the 2nd most prevalent cancer in women and the 3rd in men worldwide [1]. Rectal cancer is more common in men and colonic cancer in women. The rectum accounts for 25% of colorectal cancers in high-incidence nations, 21% in women, and 30% in men [2].

Stage 0 rectal cancer tumours may necessitate local excision or simple polypectomy [3].The conventional therapeutic modalities for stage I rectal cancer comprise surgical intervention, either with or without adjunctive chemoradiotherapy. According to the research findings, it has been observed that patients who have tumours classified as T2 or higher often exhibit lymph node involvement, with an approximate reccurrence rate of 20%. Consequently, these patients may necessitate supplementary therapeutic interventions [4]. The utilization of preoperative chemoradiotherapy has become the established

practice for patients presenting with clinically advanced T3 or T4 or node-positive illness, as supported by findings from the German Rectal Cancer Study [5]. The utilization of neoadjuvant therapy is linked with the down staging of tumours, enhanced resectability, and tolerance, as well as the possibility of providing additional alternatives for sphincter preservation in the distal rectum. Neoadjuvant therapy offers several advantages, including enhanced radiosensitivity resulting from increased oxygenation of cells and a reduction in tumour seeding during surgical procedures.

The typical four-field orthogonal planning method is commonly considered to be an effective approach for preoperative chemoradiotherapy. The impact of conformal planning compared to conventional planning in preoperative chemoradiotherapy for locally advanced rectal cancer was evaluated by researchers, with a focus on the effects on the bladder and small bowel as well as the optimization of target volume coverage [6].

Three-Dimensional Conformal Radiation Therapy (3DCRT) is a radiotherapeutic modality that enables the precise delivery of radiation to a concentrated high-dose region while minimizing radiation exposure to surrounding healthy tissues. This technique has shown promising results in improving the local tumour control rate [7]. By reducing the negative effects of treatment, it is possible to increase the radiation dose to the target volume, leading to a more effective eradication of cancer cells. Technological advancements in the field of radiation oncology, exemplified by intensity-modulated radiation therapy (IMRT), have facilitated enhanced precision in treatment administration and the ability to escalate radiation dosage. IMRT possesses the capability to produce treatment plans that exhibit a high degree of conformity and inhomogeneity, hence resulting in a reduction of radiation dosage to adjacent healthy organs. Furthermore, it has been observed that IMRT offers superior dosimetric outcomes compared to 3D-CRT in many tumour sites across the human body. This advantage is particularly evident in cases of pelvic tumours, where the exposure of the intestine to radiation can be significantly reduced [8].

Prospectively, IMRT has been used to treat pelvic tumours such as anal, cervical, and endometrial tumours [9,10]. IMRT reduced unfavourable gastrointestinal (GI) toxicities relative to 3DCRT in these studies, although rectal cancer IMRT research is scarce and inconsistent.

The neoadjuvant IMRT combined with capecitabine and oxaliplatin, as tested in the Radiotherapy Oncology Group (RTOG) 0822 study [11], did not demonstrate a statistically significant reduction in the incidence of grade ≥ 2 gastrointestinal toxicities when compared to the use of 3DCRT with concurrent capecitabine and oxaliplatin in the Radiation Therapy Oncology Group (RTOG) 0247 study [12]. However, it is important to note that despite this, the rates of the comparable pathological complete response indicate that the improvement in conformance of radiation did not impact tumour coverage.

Given the limited and contradictory findings regarding the use of IMRT and 3DCRT in the treatment of rectal cancer, we conducted a comparative study to assess the efficacy as well as the adverse effects of neoadjuvant chemoradiotherapy. In addition, we compared the outcomes of treatment by using 3DCRT versus IMRT (bone marrow sparing), concurrent with capecitabine. Our analysis focused on evaluating the extent of pathological response rates and the development of toxicities in patients with rectal carcinoma.

MATERIALS AND METHODS

The present study was a prospective comparative study carried out in a tertiary care hospital after obtaining approval from the institutional ethical committee. The study included patients who met the following criteria: Stages II and III, age greater or equal to 15 years, good performance score (ECOG PS 0 to 2) and patients who gave written and informed consent.

A total of fifty participants were enrolled in this study and were allocated randomly to one of two groups: group A, in which patients underwent radiation therapy utilizing 3DCRT, or group B, in which patients received bone marrow-sparing IMRT. All patients received capecitabine concurrently, with a dosage of 825 mg/m2 administered twice daily on the days of radiation. Both groups received a radiation dose of 45 Gy in 25 fractions over 5 weeks. The initial steps in the evaluation process included a baseline history, performing a physical examination, and obtaining a comprehensive set of blood tests, including full blood counts as well as liver and kidney function tests. Additionally, any necessary symptomatic and supportive care measures were taken care of, before the commencement of the Neoadjuvant treatment.

Both treatment groups underwent simulation using the Siemens Somavision CT simulator. The computed tomography (CT) scans of the patients were acquired while they were in a supine position, with a pelvic immobilization device to immobilise the pelvis. The process of contouring involved delineating the gross total volume (GTV), clinical target volume (CTV), and planned target volume (PTV). The organs considered to be at risk, such as the pelvic bone marrow, the intestinal bag, the urinary bladder, and the femoral heads, were delineated based on the consensus criteria for anorectum established by the Radiation Therapy Oncology Group (RTOG) [13].

In group A, 4-field 3DCRT plan was generated for each patient in the group The plans were prepared using Eclipse version 13.2 software. Subsequently, the plans underwent evaluation by a Radiation Oncologist, and treatment was approved for a particular patient if deemed appropriate. The patients had radiation therapy using the Varian Linear

Accelerator (Clinac DHX), which utilised either 6 or 15 MV photons in accordance with the treatment plan. In group B, the patients were treated with the bone marrow-sparing IMRT method and 6 MV photon beam was used for planning on the Eclipse Planning System version 13.2 for the creation of all IMRT plans. The treatment with radiation therapy was again facilitated with the Varian Linear Accelerator. In this study, dynamic IMRT plans were generated, incorporating dose constraints as outlined in Table 1.

Table1: Dose constraints used in Intensity Modulated Radiation Therapy (IMRT)

Organ	Doseconstraints
Bonemarrow	V10<90%
Bowelbag	V45<195cc
Urinary bladder	V65<50%
Femur	V30<85%

The patients underwent weekly evaluations for radiation-related toxicity. To assess toxicity, version 5.0 of the Common Toxicity Criteria for Adverse Events (CTCAE) was used [14].

The clinical and laboratory parameters were assessed every week throughout the chemoradiation treatment. The initial assessments conducted in this study included various laboratory tests, including haemoglobin levels, total leukocyte count, differential leukocyte count, platelet count, serum urea, and creatinine levels. Additionally, the symptoms experienced by the participants were recorded, which included nausea, vomiting, loss of appetite, diarrhoea, pain, malaise, weakness, etc. Furthermore, the necessity for nutritional assistance, such as intravenous fluids, parenteral nutrition, and blood transfusions required during treatment, were also taken care of.

Also, a comparative analysis of dosimetry was performed between the two treatment groups. The plans underwent evaluation in terms of the average percentage volume of the small intestine and urinary bladder that were exposed to radiation doses exceeding 30 and 40 Gy, respectively (referred to as V30 and V40). The mean percentage volume of defined bone marrow receiving more than 10 and 20 Gy (V10 and V20) was also evaluated and compared between the two treatment groups.

At a period of 6-8 weeks following concurrent chemoradiation (CCRT), patients underwent a further assessment involving a range of laboratory investigations and imaging techniques, such as contrast-enhanced computed tomography (CECT) of the neck, chest, abdomen, and pelvis, as well as contrast-enhanced magnetic resonance imaging (CEMRI).

STATISTICAL ANALYSIS OF DATA

The collected data was organized and inputted into a spreadsheet using Microsoft Excel. Subsequently, the data was exported to the data editor of SPSS Version 20.0, developed by SPSS Inc. in Chicago, Illinois, USA. The mean ± standard deviation was used to express continuous variables, while frequencies and percentages were used to summarise categorical variables. The data was visually represented using bar diagrams. The independent t-test was utilized to compare continuous variables in this study. The proper statistical tests, either the chi-square test or Fisher's exact test, were utilized to compare categorical variables. A P-value below the threshold of 0.05 was considered to be statistically significant.

RESULTS

The incidence of lower rectal growth was observed in 50% of patients in the 3DCRT group and 52% of individuals in the IMRT group. In the 3DCRT group, 41.7% of patients exhibited growth in the middle rectum, while 8.5% of patients showed growth in the upper rectum. In the IMRT group, 32% of patients had growth in the middle rectum, and 16% of patients had growth in the upper rectum.

The incidence of acute skin toxicity of grade 2 or higher was found to be reduced in the IMRT group, and this difference was shown to be statistically significant (p=0.032). Table 2 demonstrates that there was no statistically significant distinction observed in the acute genitourinary toxicities (p=0.678) and hematological toxicities (p=0.154) between patients undergoing treatment with either IMRT or 3DCRT. However, it was observed that the severity of acute lower (GI) toxicities was reduced in the IMRT group compared to the 3DCRT group. This difference was found to be statistically significant, as seen in Table 2 (p=0.047). It was worth noting that both techniques had similar clinical responses, and there was no statistically significant difference (p=0.293), as seen in Table 3.

In comparison to 3DCRT, IMRT demonstrated notable variations in the extent of radiation exposure to the bladder and small bowel in patients. These differences were observed specifically in terms of the volume of these organs receiving doses equal to or exceeding 30 and 40 Gy. In the 3DCRT group, the average volume of the bladder that received doses of 30 Gy and 40 Gy or higher was found to be 100% and 94.5%, respectively. In contrast, the IMRT group had average bladder volumes of 66% and 29.5% for doses of 30 Gy and 40 Gy, respectively. This difference between the two groups was statistically significant (P<0.05), as shown in Table 4. As far as the V30 and V40 values for small bowel with the 3DCRT and IMRT were concerned it was 50.85% and 26.15% for 3DCRT and 26.5% and 12.5% for IMRT, respectively, but the observed differences did not reach statistical significance (P>0.05). Also the mean bone marrow exposed to a radiation dose of 10 Gy or higher was found to be 81.2% in the IMRT group, compared to 92.85% in the 3DCRT group. Similarly, the proportion of bone marrow exposed to a radiation dose of 20 Gy or higher was 66.45% in the IMRT group and 74.75% in the 3DCRT group. The statistical significance was observed for V10

(P=0.038), and not for V20 (P=0.523) between the groups as shown in Table 4.

Table2: Various acute toxicities in two treatment techniques

		3DCRT		IMRT		P Value
		Number	Percentage	Number	Percentage	
Acute Skin	0 No toxicity	13	54.2	22	88	0.032
	1 Dull erythema/dry desquamation	7	29.2	2	8	
	2 Bright erythema/moist desquamation/moderate odema	5	16.7	1	4	
	3 Moist desquamation other than skin folds/pitting odema	0	0.0	0	0	
	4 Ulceration/ haemorrhage/necrosis	0	0.0	0	0	
Acute Lower gastrointestinal	0 No toxicity	8	33.3	18	72	0.047
	1 Increased frequency or change in quality of bowel habits/rectal discomfort not requiring drugs	12	50.0	5	20	
	2 Diarrhoea/rectal or abdominal pain requiring drugs/mucous discharge not requiring sanitary pads	4	12.5	2	8	
	3 Diarrhoea requiring parenteral support/severe mucous or blood discharge requiring sanitary pads/Abdominal distension	1	4.2	0	0	
	4 Obstruction/fistula/perforation/GI bleed	0	0.0	0	0	
Acute Genitourinary	0 No toxicity	12	50.0	14	56	0.678
	1 Frequency of urination or nocturia twice pre-treatment habit/dysuria,urgency not requiring drugs.	11	41.7	9	36	
	2 Frequency of urination or nocturia that is less frequent than every hour/Dysuria /urgency/bladder spasm requiring drugs.	1	4.2	2	8	
	3 Frequency with urgency and nocturia hourly or more frequency/dysuria, pelvic pain/bladder spasm/requiring drugs/gross hematuria	1	4.2	0	0	
	4 Haematuria/obstruction/ulceration	0	0.0	0	0	
Acute Hematological	0 No toxicity.	14	54.2	20	80	0.154
	1 WBC3-<4,Platelets75-<100,Neutrophils1.5- <1.9,Hgb11-<9.5	7	29.2	3	12	
	2 WBC2-<3,Platelets50-<75,Neutrophils1- <1.5,Hgb7.5-<9.5	4	16.7	2	8	
	3 WBC1-<2,Platelets25-<50, Neutrophils0.5-<1,Hgb5-<7.5	0	0.0	0	0	
	4 5 WBC<1,Platelets<25,Neutrophils<0.	0	0.0	0	0	

Table 3: Clinical response to treatment in two techniques.

Response to treatment	3DCRT		IMRT		P-value
	No.	%age	No.	%age	
Complete response	7	29.2	7	29.2	0.293
Partial response	9	33.3	12	50.0	
Stable disease	9	37.5	4	16.7	
Progression	0	0.0	1	4.2	
Total	24	100	24	100	

Table 4: Dosimetric differences in the two treatment groups in terms of doses to normal tissue.

Organs	Mean doses (3DCRT)	Mean doses (IMRT)	P value
Bone marrow	V10 =92.85%	V10 =81.2%	0.038
	V20 =74.75%	V20 =66.45%	0.523
Bowel	V30 =50.85%	V30 =26.15%	0.750
	V40 =26.50%	V40 =12.50%	0.216
Urinary bladder	V30 =100.00%	V30 =66.00%	0.0015
	V40 =94.50%	V40 =29.50%	0.001

DISCUSSION

This study aimed to assess the potential clinical and dosimetric advantages of bone marrow-sparing IMRT compared to 3DCRT in patients with rectal cancer. Our study showed that in comparison to 3DCRT, bone marrow-sparing IMRT reduces the radiation doses to the small bowel, bladder, and bone marrow. As is also shown by Milano et al. [15] the mean outcomes in their IMRT treatment group, utilizing a dose of 45 Gy, exhibit similarity to the findings as reported by us, for these significant anatomical regions while employing a prescribed radiation dose of 45 Gy.

Despite utilizing a highly conformal techniques, the iliac bone marrow, which surrounds the rectum, remains a large anatomical structure, posing challenges in minimizing radiation exposure to this region. An increase in haematological toxicity might potentially occur because of the implementation of more complex IMRT fields or the utilization of field reductions as recommended by the Radiation Therapy Oncology Group (RTOG). In phase II studies, it has been observed that patients who undergo concurrent radiotherapy with chemotherapeutic agents consisting of carboplatin and 5-FU may experience a decrease in haematological toxicity when bone marrow-sparing IMRT is employed [16-21].

Our study also demonstrates a decrease in acute skin toxicity when utilizing bone marrow-sparing IMRT as opposed to 3DCRT. However, 8% of patients in the IMRT group and 29.2% in the 3DCRT group exhibited grade 1 acute skin toxicity, characterized by dull erythema and dry desquamation. Also, grade 2 toxicity was experienced by 4% of patients in the IMRT group and 16.7% of patients in the 3DCRT group, which manifested as bright erythema, moist desquamation, and moderate edema. Notably, the difference in the occurrence of grade 2 toxicity between the two groups was statistically significant (p=0.032). The findings of our study are consistent with the study conducted by David JM et al. [22]. In their study, they also observed a decrease in acute skin toxicities among patients who underwent concurrent capecitabine-based chemotherapy and IMRT, as opposed to 3DCRT and capecitabine.

Our study revealed a decrease in acute lower gastrointestinal toxicities with the use of bone marrow-sparing IMRT and the toxicities were grade 1 or 2 as compared to 3DCRT. 20% of patients in the IMRT group and 50% of patients in the 3DCRT group exhibited mild grade 1 acute lower gastrointestinal toxicity, characterized by increased frequency or change in bowel habits, or rectal discomfort that did not necessitate medication. Also, 8% of patients in the IMRT group and 12.5% of patients in the 3DCRT group experienced grade 2 toxicity, which manifested as diarrhoea, mucous discharge, rectal or abdominal pain requiring medication. Notably, none of the patients in the IMRT group had grade 3 toxicity, while 4.2% of patients in the 3DCRT group experienced grade 3 toxicity, which included diarrhoea requiring parenteral support, as well as severe mucous or bloody discharge and abdominal distension. In the IMRT group, 72% of patients did not experience any acute lower gastrointestinal toxicity, as was true about 33.3% of patients in the 3DCRT group. The statistical analysis indicated a significant difference between the two groups (p=0.047). The findings of our study are consistent with the study conducted by David JM et al. [22]. In their study, they also observed a decrease in acute gastrointestinal toxicity among patients who underwent concurrent capecitabine-based chemotherapy and IMRT compared to those who received 3DCRT and capecitabine.

Ferraris et al. [23] conducted a study on comparison between IMRT and 3DCRT in terms of their potential benefits in locoregional control and toxicity management for patients diagnosed with rectal carcinoma. The findings showed that IMRT demonstrated a reduction in acute toxicities of grade 2 or higher, specifically in relation to skin, urinary, and gastrointestinal (GI) complications, when compared to 3DCRT. Consequently, the use of IMRT in rectal cancer treatment was suggested to contribute to a decrease in overall treatment-related morbidity associated with concurrent chemoradiotherapy. The study conducted by the authors also showed a decrease in haematological toxicity with the use of IMRT, which was not observed in our study.

As far as late radiation-induced toxicities are concerned we found the incidence of grade 1 late skin toxicity was seen to be 4.16% in the 3DCRT group, primarily manifesting as pigmentation, and none in the patients of the IMRT group developed grade 1 late skin toxicity.

In the IMRT group, none of the patients showed late grade 3 genitourinary toxicity, but 4% of patients experienced grade 1 late genitourinary toxicity, in the IMRT group characterized by modest impairment of

renal function. About 4.16% of the patients, in the 3DCRT group showed grade 2 late genitourinary toxicity, manifested as a moderate frequency of micturition. Only a small number of studies have been conducted so far that provide data on the late morbidity caused by radiation therapy after highly conformal neoadjuvant therapy. To provide an accurate assessment of the late radiation-induced toxicities, we need to have a long-term follow-up of our treated patients.

CONCLUSION

Our study suggests that bone marrow-sparing IMRT-based CCRT has the potential to decrease the doses received by normal tissues. Consequently, this reduction in radiation exposure may lead to lower rates of acute toxicity and fewer pauses during the treatment. The findings of our study suggest that the use of bone marrow-sparing IMRT shows promising outcomes in terms of treatment efficacy. However, before implementing bone marrow-sparing IMRT as a widely accepted treatment approach in the neoadjuvant setting for rectal cancer, additional prospective studies involving a substantial number of patients are required. These studies would provide conclusive evidence regarding the safety and advantages of bone marrow sparing IMRT compared to 3DCRT.

CONFLICT OF INTEREST
None

Ethical Statement
This study was approved by the Institutional Ethical Committee (Approval No. SIMS 1131/IEC-SKIMS/2019-526) and the copy of the approval can be provided whenever required.

REFERENCES

1. Ferlay J, Shin HR, Bray F, Forman D, Mathers C, Parkin DM: Estimates of worldwide burden of cancer in 2008: GLOBOCAN 2008. Int J Cancer. 2010;15:2893–917.

2. Corman ML, Bergamaschi RCM, Nicholls RJ, Fazio VW: Carcinoma of the rectum. CORMAN'S COLON and RECTAL SURGERY. Philadelphia: Lippincott Williams & Wilkins; 2005. p. 937.

3. Bailey HR, Huval WV, Max E, et al.: Local excision of carcinoma of the rectum for cure. Surgery. 111:555–561.

4. Sitzler PJ, Seow-Choen F, Ho YH, et al.: Lymph node involvement and tumor depth in rectal cancers: an analysis of 805 patients. Dis Colon Rectum. 1997;40:1472–76.

5. Sauer R, Becker H, Hohenberger W, et al.: Preoperative versus postoperative chemoradiotherapy for rectal cancer. N Engl J Med. 2004;351:1731–40.

6. Corner C, Khimji F, Tsang Y: Comparison of conventional and three-dimensional conformal CT planning techniques for preoperative chemoradiotherapy for locally advanced rectal cancer. Br J Radiol. 2011;84:173–78.

7. Wei R, Zhang Y, He J, Shen L, Hong J, Wu H: Three-Dimensional Conformal Radiotherapy for Rectal Cancer and the Changes in Cancer Multi-biomarkers. Dec 2007;4:411–15.

8. Simson DK. Conformal radiotherapy in rectal cancer: a dosimetric review. International Journal of Research in Medical Sciences. 2016;5:8–10.

9. Mitra D, Hong TS, Horick N, et al.: Long-term outcomes and toxicities of a large cohort of anal cancer patients treated with dose-painted IMRT per RTOG 0529. Adv Radiat Oncol. 2:110–117.

10. Klopp AH, Yeung AR, Deshmukh S, et al.: A Phase III Randomized Trial Comparing Patient Reported Toxicity and Quality of Life (QOL) During Pelvic Intensity Modulated Radiation Therapy as Compared to Conventional Radiation Therapy. Int J Radiat Oncol Biol Phys. 2016;96:3.

11. Hong TS, Moughan J, Garofalo MC, et al.: NRG Oncology Radiation Therapy Oncology Group 0822: A Phase 2 Study of Preoperative Chemoradiation Therapy Using Intensity Modulated Radiation Therapy in Combination With Capecitabine and Oxaliplatin for Patients With Locally Advanced Rectal Cancer. Int J Radiat Oncol Biol Phys. 2015;93:2936.

12. Wong SJ, Winter K, Meropol NJ, et al.: Radiation Therapy Oncology Group 0247: a randomized Phase II study of Neoadjuvant capecitabine and irinotecan or capecitabine and oxaliplatin with concurrent radiotherapy for patients with locally advanced rectal cancer. Int J Radiat Oncol Biol Phys. 2012;82:1367–75.

13. Cox JD, Stetz J, Pajak TF: Toxicity criteria of Radiation Therapy Oncology Group and the European Organisation for Research and Treatment of Cancer. Int J Radiat Oncol Biol Phys. 1995 Mar;30:1341–6.

14. Savarese DM: National Cancer Institute. Common terminology criteria for adverse events (CTCAE). Version 5.0. 2013. Accessed November 27, 2017.

15. Milano MT, Jani AB, Farrey KJ, et al.: Intensity-modulated radiation therapy (IMRT) in the treatment of anal cancer: toxicity and clinical outcome. Int J Radiat Oncol Biol Phys. 2005;63:354–61.

16. Martenson JA, Lipsitz SR, Wagner H Jr, et al.: Initial results of a phase II trial of high dose radiation therapy, 5-fluorouracil, and cisplatin for patients with anal cancer (E4292): an Eastern Cooperative Oncology Group study. Int J Radiat Oncol Biol Phys. 1996;35:745–9.

17. Rich TA, Ajani JA, Morrison WH, et al.: Chemoradiation therapy for anal cancer: radiation plus continuous infusion of 5-

fluorouracil with or without cisplatin. Radiother Oncol. 1993;27:209–15.

18. Doci R, Zucali R, La Monica G, et al.: Primary chemoradiation therapy with fluorouracil and cisplatin for cancer of the anus: results in 35 consecutive patients. J Clin Oncol. 1996;14:3121–5.

19. Peiffert D, Giovannini M, Ducreux M, et al.: High-dose radiation therapy and neo-adjuvant plus concomitant chemotherapy with 5-fluorouracil and cisplatin in patients with locally advanced squamous-cell anal canal cancer: final results of a phase II study. Ann Oncol. 2001;12:397–404.

20. Hung A, Crane C, Delclos M, et al.: Cisplatin-based combined modality therapy for anal carcinoma: a wider therapeutic index. Cancer. 2003;97:1195–202.

21. Roeske JC, Bonta D, Mell LK, et al.: A dosimetric analysis of acute gastrointestinal toxicity in women receiving intensity-modulated whole-pelvic radiation therapy. Radiother Oncol. 2003;69:201–7.

22. David J, Jabbour S, Gresham GK, Deek M, Shant T, Robertson JM: Effect of Neoadjuvant IMRT for locally advanced rectal cancer on toxicity and pathologic response. J Clin Oncol. 2017;35:693–93.

23. Ferraris G, Vazquez MFD, Palazzo J, Salenius S, Finkelstein SE, Fernandez E: Clinical outcomes of IMRT versus 3DCRT in preoperative chemoradiotherapy for locally advanced rectal cancer treated in a community setting. J Clin Oncol. 2015;33:17756

Comprehensive dosimetric study of the impact of beamlet width on IMRT plans for cervical cancer patients

Priya Saini, Mary Joan, Anirudh Pradhan

Abstract:

Introduction: Intensity Modulated Radiation Therapy (IMRT) had been widely used in the cervical cancer patient's treatment over last decade due to more conformal compared than three-dimensional conformal radiation therapy (3DCRT). The beamlet width in IMRT plans not only affects the plan quality but also affect treatment efficiency. The aim of this study was to investigate the influence of beamlet width on dose distribution in cervical cancer patients planned with dynamic (IMRT).

Methods: Twenty patients of cervical cancer were selected for this study. For each case, three plans were created with different beamlet width (3, 4 and 5mm). Only the beamlet width in the plans was changed (set to 3, 4, and 5 mm that were named BL03 mm, BL04 mm, and BL05 mm, respectively).

Results: 95% dose to PTV coverage decreased as the beamlet width increased. OARs doses of BL05 mm group was higher than other two groups except $V_{50 Gy}$ for bladder and rectum and D_{max} (Gy) for bowel bag. BL04 mm group had lowest OARs doses among all three groups. In terms of PTV coverage, mean dose, maximum dose, HI and CI value BL03 mm and BL04 mm group plans were better than BL05 mm group. However, BL03 mm group plans had worse delivery accuracy and efficiency than other two groups.

Conclusion: BL04 mm group was the better to obtained a good balance between treatment efficiency, plan quality and execution accuracy. It can be set as optimal value for ca cervix patient in case of IMRT treatment for better clinical outcomes.

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INTRODUCTION

Cervical cancer remains the fourth most prevalent cancer among the female in the world[1,2]. IMRT had been widely used radiation technique in the cervical cancer patient's treatment over last decade. IMRT is more conformal compared with three-dimensional conformal radiation therapy (3DCRT) because of its dosimetric advantage. It could improve dose coverage of target volume and reduce the dose to surrounding normal tissues [3,4]. Non uniform beam intensities are used in IMRT treatment planning optimization. It could also reduce radiation induced toxicity [5,6]. Efficiency and quality of IMRT plan depends on so many different parameters in automatic optimization. Monaco treatment planning for IMRT starts dividing each beam into beamlets (pencil beams). Beamlet width is defined by user. During stage one and stage-two optimization, beamlet width is used. Resolution of the fluence map is defined by beamlet width. In general, the smaller the beamlet width, the finer the fluence grid.

In planning activity, an initial absolute dose distribution is computed from these beamlets. Initially, all beamlets are equally weighted and total dose distribution is weighted sum of the individual beamlet width dose distribution. Contributions of all individual beamlet widths are varied simultaneously by an iterative algorithm to meet prescription requirements. So many authors have been studied the effect of the beamlet width on IMRT treatment plans[8]. In all these studies beamlet width value was normally selected the between 0.1 cm to 1.0 cm in the optimizing window of IMRT parameters in treatment planning system (TPS)[8,9,10]. But,there have been no studies relating the effect of

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different beamlet widths optimization in IMRT plans of cervical cancer. Therefore, the aim of this work was to investigate the effect of the beamlet width on the IMRT treatment efficiency and plan quality for cervical cancer and also set an optimum value of beamlet width for clinical treatment planning.

MATERIALS AND METHODS:

Patients Selection and CT Simulation

Twenty patients of cervical cancer who received IMRT treatment at our hospital between January 2022 and December 2023 were taken for this study. All patients were instructed to follow institute bladder protocol (to void urine 1hr before each treatment and then drink 500ml water). All patients were scanned in most reproducible supine position using four clamp customized thermoplastic mask on acrylic base plate. CT scan was obtained with slice thickness of 2.5mm on Discovery GE 16 slice spiral CT scanner. These CT images were transferred to the Monaco TPS in DICOM format through local area network.

Contouring and dose prescription

Gross tumor volume (GTV),clinical target volume (CTV) and surrounding normal tissues were contoured by experienced radiation oncologist as per institute protocol .10mm margin in all direction to GTV with involved lymph nodes and 5mm margin in all direction to CTV was applied to delineate PTV with dose of 55Gy (PTV55) and 50Gy (PTV50) respectively. Bowel bags, bilateral head of femur, rectum, kidney and bladder were delineated as OARs.

Treatment Planning

Three IMRT plans were designed for each patient using the monte carlo (MC) algorithm with beamlet width of 3mm,4mm and 5mm respectively in Monaco version 6.1.2.0 TPS. They were named BL03 mm, BL04 mm and BL05 mm respectively. Only beamlet width was changed in all plans. Cost functions and remaining parameters were kept fixed with a dose calculation grid size 3mm. Maximum dose rate was used 600 MU/min. Treatment plans were delivered with 6MV X-ray photon beam using elekta versa HD linear accelerator. Seven fields with gantry angles 200º, 250º, 300º, 0º, 50, 100º and 150º were used to design the IMRT plan for each patient.

Plan Evaluation

The different beamlet width plans were analyzed in terms of dosimetric parameters such as median dose $D_{50\%}$,maximum dose $D_{2\%}$, minimum dose $D_{98\%}$ and 95% dose to PTV, MUs, Planning delivery time (PDT) and DVH parameters related to OARs.CI and HI values for target volume were calculated following ICRU 83 report using Eq. (1) and Eq. (2) respectively.

$$HI=(D_{2\%}-D_{98\%}) / D_{50\%} \quad (1)$$
$$CI = (TV_{RI})^2 / (TV * V_{RI}) \quad (2)$$

Where $D_{x\%}$ represent the minimum dose received by x% of PTV, TV represents total target volume, TV_{RI} represents the total target volume receiving the prescription dose and V_{RI} represents the total volume receiving prescription dose. Homogeneity index defines dose uniformity in the target volume. Lesser

HI value represents the better uniformity in the target volume.CI represents the quality of conformation of the plan. Ideally, it should be near to 1. Larger CI value represents the better conformability of the plan. Rectum was evaluated using V_{50} and $D_{50\%}$. Bladder was evaluated using V_{50} and $D_{45\%}$. Bowel was evaluated using 195 cc volume. Femur was evaluated using D_{mean}.

Dosimetric verification

Dosimetric verification of the plan was done using Octavius II system. The criteria for gamma passing rate(GPR) was dose to distance agreement 3%, 3mm. GPR, MU and PDT were noted.

Statistical Analysis

Results were performed as mean ± standard deviation. Primer software was used for statistical analysis. Wilcoxon signed rank test was performed to compared dosimetric parameters related to PTV and OARs between different beamlet groups. Beamlet width 3mm group was selected as the reference and compared with other groups. p value was calculated. p value <.05 represents a statistically significant difference.

RESULTS

Target doses

All the plan met the prescribed doses and limits of each OARs. Target doses, CI and HI values of all three beamlet widths groups for both PTVs were shown in Table2. BL03 mm group was taken as a reference group and other groups were compared with this group. There were no significant statistical difference in terms of 95% dose to PTV coverage and mean dose between BL03 mm and BL04 mm group plans (p>0.05) for both PTVs. There were found significant statistical difference in terms of 95% dose to PTV coverage and mean dose between BL03 mm and BL05 mm group plans (p<0.02) for both PTVs. Maximum dose had no significant statistical difference among all three groups for both PTVs (PTV50 & PTV55). Plans with BL03 mm group had highest value of 95% dose to PTV coverage, mean dose and maximum dose among all three groups. CI values are decreased as the beamlet width value increased for both PTV50 and PTV55. BL03 mm group had highest CI than BL04 mm and BL05 mm group plan. HI values for both PTV50 and PTV55 are increased as the beamlet width value increased and there were no significant statistical difference among all three groups for both PTVs.

OAR Doses

OARs doses of all three group BL03 mm, BL04 mm and BL05 mm were shown in Table 3. OARs doses of BL05 mm group were higher than BL03 mm andBL04 mm group except $V_{50\ Gy}$ for bladder and rectum and D_{max} (Gy) for bowel bag. There was no significant statistical difference for OARs doses among all three groups plans except $V_{50\ Gy}$ for bladder. BL04 mm group had lowest OARs doses among all three groups.

Dosimetric verification, MU and plan delivery time
GPR, PDT and MUs for all three groups were shown in Table 4.Dosimetric plan evaluation was done using a comparison between measured planer dose and calculated dose by TPS studying the gamma passing criteria of a 3% dose difference (DD) and a 3mm distance to agreement (DTA). BL05 mm group plan had highest GPR value and BL03 mm group plan had lowest GPR value. As beamlet width increased, mean number of MUs in the cervical cancer of IMRT plan decreased. The mean number of MUs for the all three groups BL03 mm, BL04 mm and BL05 mm were 845,809 and 775 respectively (Table 3).BL03 mm group plans had highest MU and BL05 mm group plans had lowest MU. PDT for all 20 patients were shown from the beam turned on time to beam turned off time (Table 3). As beamlet width increased, MUs of IMRT plan decreased, as did the plan delivery time.

DISCUSSION
In IMRT optimization, beamlet width plays a crucial role.It is also easily overlooked. In first step of planning optimization, fluence segmentation is directly affected by beamlet width and in second step, segment optimization is indirectly affected by it. Theoretically, it is found that smaller the beamlet width give the finer fluence map. This may lead to more successful dose distribution [11]. The area of segments cannot read directly by TPS.It is not statistically analyzed; it may affect more small area segments [12]. When we design the IMRT plan for a cancer patient, there are so many different settings of optimized parameters including direction of fields, no of fields, no. of segments, area of segments, minimum segment width (MSW) and beamlet width etc. that affect the IMRT plan dose distribution. In this study, we compared the three beamlet width optimization schemes; each was based on different beamlet width value. It was observed that different beamlet width not only affects the PTV dose distribution and OARs, but it also affects the PDT and MU value. BL03mm was taken as reference group. BL03mm group had highest 95% dose to PTV coverage and BL05 mm had lowest. 95% dose to PTV coverage increased as beamlet width decreased. There were not found significant statistical difference in terms of 95% dose to PTV coverage between BL03mm and BL04mm group plan (p>0.05) for both PTVs. This study showed that there were no significant statistical difference for OARs doses among all three groups plan except $V_{50\ Gy}$ for bladder. BL04 mm group had lowest OARs doses among all three groups. As beamlet width increased, MUs, and PDT were decreased and GPR value increased.The range of MUs for each plan group was below 100 MUs and the range of PDT was within 20s. BL03 mm group had highest MUs and PDT value but lowest GPR. BL03 mm group had better dose distribution but treatment efficiency and execution accuracy were worse than BL04 mm and BL05 mm group. BL05 mm group had good treatment efficiency and execution accuracy than other group but lowest plan quality than other groups. The decrease of MUs and PDT could reduce patient displacement during patient treatment and improve the biological effect of treatment and enhance treatment efficiency.

CONCLUSION
From a comprehensive evaluation of all dosimetric parameters including 95% dose to PTV coverage, OARs sparing, HI, CI, maximum dose, mean dose, MUs, PDT and GPR of all three group plans, we concluded that all group were able to meet clinical treatments requirements. But BL04 mm group was the better to obtained a good balance between treatment efficiency, plan quality and execution accuracy. It can be set as optimal value for ca cervix patient in case of IMRT treatment.

Table 1 The optimization cost functions of IMRT plans for Cervical Cancer			
Structure	Cost Function	Parameters	Isoconstraint
PTV 55	Target Penalty	98.80%	55 Gy
	Quadratic Overdose	56 Gy	1.5 Gy
	Target EUD	0.5	55 Gy
PTV 50	Target Penalty	98.90%	50.2 Gy
	Quadratic Overdose	52 Gy	1Gy
	Maximum Dose	53.69 Gy	53.69 Gy
	Target EUD	0.5	50.5 Gy
Bladder	Parallel	46 Gy, K=4, Shrink=0.3 cm	55%
Rectum	Parallel	40 Gy, K=4, Shrink=0.2 cm	55%
	Maximum	47.8 Gy, Shrink=0.3 cm	47.8 Gy
Right head of femur	Serial	38 Gy, K=16, Shrink=0 cm	38 Gy
Left head of femur	Serial	38 Gy, K=17, Shrink=0 cm	38 Gy
Bowel	Parallel	45 Gy, K=4, Shrink=0.3 cm	40%
	Maximum	48 Gy, Shrink=0.5 cm	48 Gy
Body	Quadratic Overdose	49 Gy, Shrink=0cm	0.1 Gy
	Maximum Dose	59 Gy	59.10 Gy
	Quadratic Overdose	30 Gy, Shrink=1.7 cm	1.6Gy
	Quadratic Overdose	25 Gy Shrink= 2cm	1.6 Gy

IMRT: Intensity Modulated Radiation Therapy; PTV: Planning Target Volume; EUD: Equivalent Uniform Dose

Tables2PTV dosimetric results of the IMRT plans used to treat 19 cervical cancer patients using three different beamlet widths.

Structure	Parameter	BL03	BL04	BL05	P[1]	P[2]
PTV 55	PTV Coverage 95% (Gy)	54.75± 0.47	54.71± 0.52	53.78± 0.42	P[1]>0.05	P[2]<0.02
	Mean Dose (Gy)	56.22± 0.25	56.19± 0.43	55.31± 0.30	P[1]>0.05	P[2]<0.02
	Maximum Dose (Gy)	59.52± 0.30	59.43± 0.54	59.27± 0.54	P[1]>0.05	P[2]>0.05
	HI	0.060± 0.03	0.064± 0.02	0.065± 0.01	P[1]>0.05	P[2]>0.05
	CI	0.75± 0.10	0.66± 0.18	0.65± 0.17	P>0.054	P>0.054
PTV 50	PTV Coverage 95% (Gy)	48.76± 0.17	48.73± 0.27	48.47± 0.35	P[1]>0.05	P[2]<0.02
	Mean Dose (Gy)	50.95± 0.45	50.92± 0.35	50.69± 0.41	P[1]>0.05	P[2]<0.02
	Maximum Dose (Gy)	59.51± 0.30	59.27± 0.54	59.14± 0.72	P[1]>0.05	P[2]>0.05
	HI	0.16± 0.01	0.17± 0.01	0.17± 0.01	P[1]>0.05	P[2]>0.05
	CI	0.70± 0.08	0.65± 0.06	0.62± 0.12	P[1]>0.05	P[2]<0.02

p1, p-value of comparison between BL03 and BL04; p2, p-value of comparison between BL03 and BL05; HI: Homogeneity index; CI: Conformity Index

Table 3 Doses to the OARs of the IMRT plans with three different beamlet widths for 20 cervical cancer patients.

OARs	Parameters	BL03	BL04	BL05	P^1	P^2
Rectum	$V_{50\,Gy}$ (%)	20.72± 2.23	20.5± 2.29	20.57± 2.89	P^1>0.05	P^2>0.05
	$D_{50\%}$ (Gy)	47.04± 2.23	46.97± 4.80	47.72± 4.80	P^1>0.05	P^2>0.05
Bladder	$V_{50\,Gy}$ (%)	34.03± 5.90	26.33± 9.70	29.77± 4.42	P^1<0.05	P^2<0.05
	$D_{45\%}$ (Gy)	48.39± 2.80	47.68± 2.33	48.82± 1.80	P^1>0.05	P^2>0.05
Bowel Bag	D_{max} (Gy)	57.07± 2.11	56.54± 2.44	57.04± 1.75	P^1>0.05	P^2>0.05
	$V_{45\,Gy}$ (%)	16.69±4.68	19.5± 3.60	19.57 ± 7.66	P^1>0.05	P^2>0.05
	195 cc (Gy)	43.83 ± 4.95	44.63 ± 4.34	46.69 ± 4.19	P^1>0.05	P^2>0.05
Left Femur	D_{mean}	38.00 ± 2.76	40.73 ± 3.93	40.99 ± 3.53	P^1>0.05	P^2>0.05
Right Femur	D_{mean}	35.01 ± 3.74	36.25 ± 3.38	37.12 ± 3.18	P^1>0.05	P^2>0.05

D_{max}, maximum dose; V_x, percentage volume of region
of interest receiving at least X Gy; $D_{x\%}$, minimum dose received by x% volume of PTV

Table 4 Gamma passing rates, monitors units and plan delivery times for plans with different beamlet widths

Parameter	BL03	BL04	BL05
Mus	845.85±62.37	809.88± 85.08	775.23±62.99
PDT(s)	360.92 ± 22.55	355.29 ± 20.6	351.29 ± 20.6
GPR	95.5±1.35	96.3±1.20	96.5±1.23

REFERENCES:

1. Sung H, Ferlay J, Siegel RL, Laversanne M, Soerjomataram I, Jemal A, et al. Global cancer statistics 2020: GLOBOCAN estimates of incidence and mortality worldwide for 36 cancers in 185 countries. CA: A cancer journal for clinicians. 2021;71:209-49.

2. Verbakel WF, Cuijpers JP, Hoffmans D, Bieker M, Slotman BJ, Senan S. Volumetric intensity-modulated arc therapy vs. conventional IMRT in head-and-neck cancer: a comparative planning and dosimetric study. International Journal of RadiationOncology-Biology-Physics. 2009;74:252-9.

3. Coselmon MM, Moran JM, Radawski JD, Fraass BA. Improving IMRT delivery efficiency using intensity limits during inverse planning. Medical physics. 2005;32:1234-45.

4. Ur Rehman J, Ahmad N, Khalid M, Gilani ZA, Ullah I, Nasar G, et al. Intensity modulated radiation therapy: A review of current practice and future outlooks. Journal of radiation research and applied sciences. 2018;11:361-7.

5. Guowei Z, Ziping J, Shepard D, Earl M, Yu C. Effect of beamlet step-size on IMRT plan quality. Medical Physics. 2005;32 : 3448-54.

6. Sutterley C, Gautier Q, Graves Y, Li N, Jia X, Jiang S. SU-E-T-570: Optimizing Dose Calculation Parameters for GPU-Based Treatment Planning. Medical Physics. 2013;40:336.

7. Sun H, Wang N, Wang X, Huang G, Chang Y, Liu Y. A study of different minimum segment area parameters on automatic IMRT plans for cervical cancer using Pinnacle3 910 TPS. Medicine (Baltimore). 2022; 101:29290.

8. Hong J, Han JH, Luo HL, Song YQ. Optimization of Minimum Segment Width Parameter in the Intensity-Modulated Radiotherapy Plan for Esophageal Cancer. International Journal of General Medicine. 2021; 16:9913-21.

9. Wang Y, Chen L, Zhu F, Guo W, Zhang D, Sun W. A study of minimum segment width parameter on VMAT plan quality, delivery accuracy, and efficiency for cervical cancer using Monaco TPS. Journal of Applied Clinical Medical Physics. 2018;19:609-15.

10. Nguyen D, O'Connor D, Yu VY, Ruan D, Cao M, Low DA, et al. Dose domain regularization of MLC leaf patterns for highly complex IMRT plans. Medical Physics. 2015;42:1858-70.

11. Wu M, Jin J, Li Z, Kong F, He Y, Liu L, et al. Influence of beamlet width on dynamic IMRT plan quality in nasopharyngeal carcinoma. PeerJ. 2022;10:13748.

12. Coselmon MM, Moran JM, Radawski JD, Fraass BA. Improving IMRT delivery efficiency using intensity limits during inverse planning. Medical physics. 2005; 2:1234-45.

13. Yoosuf AM, Ahmad MB, AlShehri S, Alhadab A, Alqathami M. Investigation of optimum minimum segment width on VMAT plan quality and deliverability: A comprehensive dosimetric and clinical evaluation using DVH analysis. Journal of Applied Clinical Medical Physics. 2021;22:29-40.

Knowledge, Attitude, And Practice Regarding Infection Control Among Sanitary Workers In A Tertiary Care Teaching Hospital.

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Abstract:

Background: Sanitation workers are responsible in maintaining clean environment in hospitals. Assessing their knowledge, attitude and practices can help in controlling the increasing load of nosocomial infections. Due to a lack of previous research on this topic, especially in India, there is not enough understanding regarding their knowledge, methodology and the challenges faced by them.This study aims to address this data gap by investigating these aspects and providing valuable insights into improving infection control practices.

Methodology: We conducted a cross-sectional study involving 405 sanitation workers at a tertiary care teaching hospital. Data were collected using an online questionnaire created through a review of the literature, including CDC and WHO guidelines. The questionnaire was available in both English and Marathi to ensure accessibility. To enhance the representativeness of the sample, data collection was distributed across different shifts.

Results: Total 405 consenting participants in the study answered the questionnaire. 233 scored above 50% while 172 could secure below 50%. We found that Knowledge about wearing gloves is 95.3% among sanitary workers and their attitude for hand hygiene on gloved hands was 96.5% and 98.8% do wash their hands after removing gloves. Response was relatively poor to questions related to occupational hazards (67%) and spill managements (62%).

Conclusion: Hand Hygiene knowledge & compliance are satisfactory in this study but attitude towards workload and knowledge about potential infections need to be improved, with a focus on training of sanitary workers.

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INTRODUCTION

Infection prevention and control is defined as a set of precautions or policy that aims to improve the environment surrounding healthcare providers and patients, as well as reduce the transmission of infections in healthcare set up[1]. As per WHO, 7 out of 100 hospitalized patients will contract nosocomial infection during their stay in hospitals in developed countries, while the number is 10 out of 100 in developing countries [2]. WHO also states that one of the most important indicators of hospital-acquired infections is having poor knowledge, attitude, and practices on infection prevention and control [3]. Sanitary workers are key to maintaining hygiene in the healthcare facilities thereby contributing immensely to global health by ensuring safe environment for hospitals.

The Kayakalp guidelines from the Government of India clearly outline the roles and responsibilities of sanitary workers in a hospital. Sanitary workers are involved in cleaning & disinfection of healthcare environments, transportation of patients, movements of patients, handling and transporting specimens to laboratory ,biomedical waste disposal and assist nursing staff, sanitary inspector and other officials [4]. Sanitary workers are always in close proximity to patients, contaminated fomites and equipment's, patients' specimens, and hazardous biomedical waste during their working hours [4,5]. Which makes them a highly vulnerable group among hospital staff [6]. Furthermore, sanitary workers in developing countries belong to low socio-economic group with mostly low level of education.

Attrition rate is also high among sanitary workers, necessitating regular training [7,8]. In India, many hospital have outsourced the sanitary workforce. Outsourcing is done as per guidelines given by Kayakalp guidelines and requirements given by various accreditation agency.

Though outsourcing is cost effective for hospitals, it is difficult to accurately assess hygiene practices of sanitary workers, and their compliance to Infection prevention and control policies. The workers generally Follow oral instructions. from their supervisors, and most of them are on rotational duties (not assigned to particular critical areas like ICU, Cath lab, endoscopy room or non-critical areas like general wards or OPD) due to which they may not be fully aware about safety protocols of the hospital [9].

There is extensive literature on knowledge, risks and safety of health care workers with respect to hospital-acquired infections and needle stick injuries. However, these studies mostly focus on physicians, nurses, technicians, and paramedics. There is scanty data on KAP in sanitary workers, who form a key pillar of hospital IPC practices and may serve as a significant source of nosocomial infection [10-13]. We therefore conducted a study on IPC KAP in sanitary workers in an urban tertiary care canter in Western India, to address this lacuna in knowledge.

To the best of our knowledge, this study is one of the few such KAP studies conducted in India in this vulnerable group. Through this study we have tried to identify the lacunae in sanitation workers' IPC knowledge, discern their attitude towards their jobs, and obtain an outlook into their frame of mind and perceptions regarding infection control practices. This information will allow hospitals to modify induction programs undergone by sanitation workers on recruitment, adjust the frequency of re-trainings, and suggest improvements in resource allocation and support systems for sanitation workers.

MATERIAL AND METHODS

1. Study setting- Study was conducted in a tertiary care teaching hospital Pune, urban area of western India.
2. Study design- Cross-sectional descriptive study
3. Study duration- 2 months (1 January 2024 – 29 February 2024)
4. Study population and sample size –
   Sample size estimation was done using prevalence as 93.3% from reference article. [14]. Allowable error is 4.66%, sample size was calculated as given below
   sample size(n)= Z^2x p(100-p) / d^2
   Z= z-score (1.96)
   P=standard deviation (93.3%)
   d=margin of error (4.66%)
   Sample size came as 111

In our hospital, total 500 sanitary workers are on the roaster,so those who consented to take part in study were involved. 405 sanitary workers included in study.

5. Study methodology– A close-ended, self-administered questionnaire via google forms and printed hard copy was used to assess knowledge, attitudes, and practices toward infection control measures. The questionnaire was prepared through literature review, including CDC and WHO guidelines, and comprised 5 questions each for knowledge, attitude and practice.
6. Prior to starting the questionnaire, an introduction outlined the study's purpose, consent criteria (voluntary participation, confidentiality, anonymity), and provided contact details for the principal investigator and Institutional Review Board (IRB) for inquiries or withdrawal.
7. The English questionnaire was translated to Marathi and back-translated for consistency and validity.
8. Those google forms and hard copies were circulated among all sanitation workers and their responses analysed. The questionnaire was available in English as well as in Marathi. The data was collected over shifts to increase the representativeness of the sample.
9. Questionnaire-

Question for assessing Knowledge

1. Gloves should be worn while operating in contact with blood and body fluids and other samples
   a) always
   b) never
   c) only the patient is a known case of infectious disease
   d) not sure

2. Diseases transmitted by Needle stick Injury
   a) HCV
   b) HIV
   c) HBV
   d) all of the above

3. Sharps containers must be removed when they are –
   a) half full
   b) ¾ full
   c) can be filled till the top
   d) 1/3rd full

4. A spill management kit should contain
   a) Silica
   b) x ray film
   c) Duster
   d) all of the above

5. Bacillol spray is used for-
   a) surface disinfection
   b) antiseptic
   c) disinfection of sputum specimen
   d) none of the above

Question for assessing Attitude

1	Do you think work load affects your ability to follow infection control guidelines	Agree/ Neutral/Disagree
2	Do you thing reporting a needle stick injury can help in its prevention or is useful	Agree/ Neutral/Disagree
3	Do you thing disposal in colour coded bags is beneficial or is tedious and time-consuming practice	Agree/ Neutral/Disagree
4	Do you think wearing a mask is beneficial	Agree/ Neutral/Disagree
5	Do you think performing hand hygiene is required after wearing gloves	Agree/ Neutral/Disagree

Question for assessing Practices

1	Do you dispose waste according to colour coding	Yes/No
2	Have you been vaccinated against Hepatitis B	Yes/No
3	Do you wash your hands after removing gloves	Yes/No
4	Have you ever had a needle stick injury	Yes/No
5	Do you use gloves while handling patient samples	Yes/No

The scoring system for knowledge, attitudes, and practices regarding infection control measures was according to the scales [18]:

Good knowledge and practice: earning a score above 50%

Poor knowledge and practice: earning a score below 50%

Positive attitude: study participants who responded above 50%

Negative attitude: study participants who responded below 50% [15]

10. Data analysis -The collected data was entered in spread sheet and analysed using excel 2021

11. Ethical considerations- Institutional Ethics Committee Approval was obtained before beginning the study, study procedure was explained to the participants and informed consent was taken from them. The respondents were assured that their confidentiality will be maintained and ethical principles will be followed.

RESULTS & DISCUSSION

Total 405 participants in the study answered the questionnaire. Questions were prepared considering the job profile of sanitary workers. Topics included were hand hygiene, use of personal protective equipment's, occupational hazards and biomedical waste management.   233 sanitary workers scored above 50% while 172 secured below 50% scores. 1 point was allotted to each correct answer and 0 points to an incorrect response.

Sr. No	Questions regarding knowledge	Answered correct (%)	Not answered correct (%)
1	Gloves should be worn while operating in contact with blood and body fluids and other samples	95.3	4.7
2	Diseases transmitted by Needle stick injury	66.7	33.3
3	Sharps containers must be removed when they are filled up to 75%	81.7	18.3
4	Spill management kit should contain	62	38
5	Bacillol spray is used for	64.7	35.3

95.3% are aware that gloves should be worn while handling patient's specimens during discarding or transportation, which is satisfactory. Though,81.7% knew that puncture proof sharp containers must be removed when filled up to 3/4th, only 66.7% could answer correctly about diseases transmitted through needle stick injury. 62% workers had adequate knowledge on spill management and 64.7% had knowledge on the correct use of disinfectants. This clearly highlights the knowledge gaps among sanitation workers on infection control practices, and identifies scope for improvement.

Table 2 Attitude of sanitary workers

Sr. No	Question regarding attitude	Agree %	Disagree %	Neutral %
1	Do you think work load affects your ability to follow infection control guidelines	61	34.8	4.2
2	Do you think reporting a needle stick injury can help in its prevention or is useful	90.2	4.9	4.9
3	Do you think disposal in colour coded bags is time-consuming practice	42.4	53.6	4
4	Do you think wearing a mask is beneficial	99	0	1
5	Do you think performing hand hygiene is required after wearing gloves	96.5	1.3	2.2

99% sanitary workers believe that Wearing mask is beneficial but when it comes to discarding waste only 54% agreed that it's not time consuming. 61% do feel that because of workload they are not able to follow all protocols of infection control practices.

Table -3 Practices by sanitary workers

Sr. No	Questions on Practice	Answered yes %	Answered No%
1	Do you dispose waste as per colour coding	98	2
2	Have you been vaccinated against Hepatitis B	96.5	3.5
3	Do you wash your hands after removing gloves	98.8	1.2
4	Have you ever had needle stick injury	10.6	89.4
5	Do you use gloves and mask while handling patients' samples	97.5	2.5

3.5% unimmunised workers are at maximum risk for infections during needle stick injury and 10.6% workers have had needle stick injury till date. It is important to note that none of these NSIs took place during their employment in our hospital, which demonstrates the importance of sensitization on NSI.

Our study found that 98% sanitary workers are following biomedical waste segregation properly. But the 2% who do not comply to the guidelines pose a significant threat. Repeated training at regular intervals will help in reducing this threat further. It is also equally important to instil a sense of ownership and accountability in all healthcare staff to reduce BMW disposal irregularities, since we found that 42.5 % workers find waste disposal as per colour coding time consuming. The study also shows 81.7% sanitary staff was aware that sharp container is to be filled only 75% of its capacity. But we still need to address the 20% workers who do not empty sharps containers as soon as they are 3/4th full, since overfilled containers increase chances of needle stick injury.

96.5% sanitary workers are immunized for hepatitis B. This proved helpful in protecting sanitary workers from infection when exposed, as in our study 10.6% participants have faced Needle stick injury and none of them got infected with HIV, HCV or HBV. There was shortage of vaccination vials from May 2023,so that could be reason for those 3.5% who did not take vaccination. Harshal et al in their study done at teaching hospital in Pune in year 2022 reported 100% Hepatitis B immunization as well as biomedical waste segregation which is really commendable and we, at our hospital will try to achieve [16]. 'Soyam et al."; in their 2017 Delhi study reported 64.5% immunization, which is less as compared to our study [17].

98.8% sanitary workers always wash hands after removal of gloves and 73.3% strongly believe that Hand hygiene is a key point in infection prevention, necessitating hygiene even on gloved hands. Celebration of hand hygiene week, arranging lectures and different competitions like rangoli (pattern) making, poster preparation have really increased awareness among sanitary workers.

97.5 % workers use gloves and mask while handling patients' samples, and 98.8% sanitary workers believe that wearing mask is beneficial to avoid getting infected. Being sanitary workers, their job profile includes cleaning, disinfection of wall surfaces and mounted equipments in wards, ICU, and labs. Along with this, they also transport samples to laboratories, transfer patients to various locations and wards, and handle biomedical waste and its transport to the

central facility. During all these activities there are chances of spillage, injuries from sharps, exposure to infected specimens, as well as close contact with infected patients.95.2% sanitary workers have knowledge about standard precautions to be followed while performing all the work listed above. 70.1% sanitary workers feel that heavy workload affects their ability to follow infection control guidelines and this could be possible reason for not achieving 100% compliance in infection control practices. Moreover, sanitary workers are mostly appointed through outsourced agencies, and working hours are decided by these agencies. On joining the health facility, all workers receive training on housekeeping activities and infection control practices. Along with induction training, regular need-based training and refresher course are usually given to all sanitary workers.62% sanitary workers answered correctly about the content of the spill manage kit.38% who fail to answer in whole about spill management kit require targeted training focused on spill management. Sanitary workers solely managing spill incidences have to remain updated on institutional guidelines for spill management, else these spills will expose of the entire surrounding area infections.

Every sanitary worker is regularly trained about cleaning and disinfection. They are taught about the detailed procedure and the chemicals to be used cleaning and disinfection. 64.7% were able to correctly answer Bacillol spray being used for heat sensitive instruments. This result is worrisome as sanitary workers need to be aware of the correct disinfectant to avoid damage to equipment.

Study donein 2018 by Sanjay G et al at teaching hospital in Pimpri reported that gloves are used by 96% sanitary workers after training on handling biomedical waste and are 79.48% immunized for Hepatitis B, but it was found that 60.25% of workers suffered from NSI and 19.23% with cuts from sharp objects [18].

Degavi G et al, (2021) conducted a study to assess knowledge, attitude, and practice and associated factors regarding prevention of occupational risks and health hazards among sanitary workers in Ethiopia. It was found that 64% of participants had good knowledge of the prevention of occupational health risks. About 76.4% of solid waste collectors had a good attitude but only 8.9% showed good practice regarding prevention of occupational health hazards [19].

The present study was carried out in a single tertiary care teaching hospital in a West Indian city. It

highlights lacunae in the existing IPC framework and provides useful insight for designing training programmes in future. Such surveys should be undertaken by all healthcare set-ups across the country to identify and address gaps, enhance IPC practices and prevent nosocomial infections.

CONCLUSION

Accurate knowledge is associated with full compliance and positive attitudes in healthcare set-up.Though almost 58% proportion of sanitary workers held positive attitudes and had good knowledge, and compliance with practices but 42% is still a big obstacle to achieve. Better training coverage with newer training methods may result in 100% compliance in practices with positive attitude.

ETHICS APPROVAL

Institutional Ethics Committee Approval obtained before study. Certificate number BVDUMC/IEC/30 Date-15/04/2023

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DECLARATION OF COMPETING INTREST

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

REFRENCES

1. Damani NN. Manual of infection prevention and control. Toronto: Oxford; 2012. University Press. Third Edition, 1-360

2. Bolyard EA, Tablan OC, Williams WW, Pearson ML, Shapiro CN, Deitchmann SD. Guideline for infection control in healthcare personnel, 1998. Hospital Infection Control Practices Advisory Committee. Infect Control HospEpidemiol. 1998 Jun;19(6):407-63. doi: 10.1086/647840. Erratum in: Infect Control HospEpidemiol 1998 Jul;19(7):493. PMID: 9669622.

3. World Health Organization. Health Care-Associated Infections. WHO; Geneva, Switzerland: 2016.

4. Ministry of Health and Family Welfare Government of India KAYAKALP GUIDELINES 2015

5. Carmen R, Yom-Tov GB, Nieuwenhuyse IV, Foubert B, Ofran Y. The role of specialized hospital units in infection and mortality risk reduction among patients with hematological cancers. Plos One. 2019;14(3):1–17.

6. Dev N, Meena RC, Gupta DK, Gupta N, Sankar J. Risk factors and frequency of COVID-19 among healthcare workers at a tertiary care centre in India: a case-control study. Trans R Soc Trop Med Hyg. 2021 May 8;115(5):551-556. doi: 10.1093/trstmh/trab047. PMID: 33763687; PMCID: PMC8083760.

7. Patwary MM, et al. Protecting sanitation workers in low-middle income countries amid COVID-19. Ann Work Expo Health. 2021;65(4):492–93.

8. Lien TQ, Chuc NTK, Hoa NQ, Lan PT, Thoa NTM, Riggi E, Tamhankar AJ, StålsbyLundborg C. Knowledge and self-reported practices of infection control among various occupational groups in a rural and an urban hospital in Vietnam. Sci Rep. 2018 Mar 23;8(1):5119. doi: 10.1038/s41598-018-23462-8. PMID: 29572463; PMCID: PMC5865156.

9. Srinivasan, Dr & G., Jabarethina. (2022). शोधप्रभा THE CHALLENGES OF SANITARY WORKERS: A CASE STUDY OF THE MULTI SPECIALITY HOSPITAL, CHENNAI. 47. 305-308.

10. Suksatan W, Jasim SA, Widjaja G, Jalil AT, Chupradit S, Ansari MJ, Mustafa YF, Hammoodi HA, Mohammadi MJ. Assessment effects and risk of nosocomial infection and needle sticks injuries among patents and health care worker. Toxicol Rep. 2022 Mar 2;9:284-292. doi: 10.1016/j.toxrep.2022.02.013. PMID: 35273903; PMCID: PMC8904184.

11. Afridi AA, Kumar A, Sayani R. Needle stick injuries--risk and preventive factors: a study among health care workers in tertiary care hospitals in Pakistan. Glob J Health Sci. 2013 Apr 14;5(4):85-92. doi: 10.5539/gjhs.v5n4p85. PMID: 23777725; PMCID: PMC4776811.

12. Saraswathy T, Nalliah S, Rosliza AM, Ramasamy S, Jalina K, Shahar HK, Amin-Nordin S. Applying interprofessional simulation to improve knowledge, attitude and practice in hospital- acquired infection control among health professionals. BMC Med Educ. 2021 Sep 9;21(1):482. doi: 10.1186/s12909-021-02907-1. PMID: 34503488; PMCID: PMC8427557.

13. Ogoina D, Pondei K, Adetunji B, Chima G, Isichei C, Gidado S. Knowledge, attitude and practice of standard precautions of infection control by hospital workers in two tertiary hospitals in Nigeria. J Infect Prev. 2015 Jan;16(1):16-22. doi: 10.1177/1757177414558957. Epub 2015 Jan 5. PMID: 28989394; PMCID: PMC5074133.

14. Alshathri, najod 2021/10/07, Knowledge, Attitude and Practice Regarding Infection Control Measures Among HealthCare Workers at King Khaled Eye Specialist Hospital (KKESH) in Riyadh, KSA-10.21203/rs.3.rs-958840/v1

15. Ogoina D, Pondei K, Adetunji B, Chima G, Isichei C, Gidado S. Knowledge, attitude and practice of standard precautions of infection control by hospital workers in two tertiary hospitals in Nigeria. J Infect Prev. 2015

Jan;16(1):16-22. doi: 10.1177/1757177414558957. Epub 2015 Jan 5. PMID: 28989394; PMCID: PMC5074133

16. Pandve, Harshal T.; Gaikwad, Shruti Rajendra1; Bhure, Bhagyashri Suryakant1; Kadam, Varsha Maroti1,; Justin, Jilu2. Awareness and practices regarding biomedical waste management among housekeeping staff of a tertiary care hospital in Western India. Environmental Disease 7(3):p 65-69, Jul–Sep 2022. | DOI: 10.4103/ed.ed_15_22

17. Soyam GC, Hiwarkar PA, Kawalkar UG, Soyam VC, Gupta VK. KAP study of bio-medical waste management among health care workers in Delhi. Int J Community Med Public Health 2017;4:3332-7.

18. Sanjay D. Gaiwalea , Madhusudan R. Petkarb, Vandana S. Gundla A Study of Health Profile of Sanitary Staff, Hazards Sustained and their Practice in Handling Biomedical WasteIndian Journal of Forensic Medicine and Pathology Volume 11 Number 1, January -March 2018 DOI:http://dx.doi.org/10.21088/ijfmp.0974.3383.11118.5

19. Degavi G, Dereso CW, Shinde S, Adola SG 2nd, Kasimayan P. Prevention of Occupational Hazards Among Sanitary Workers: Knowledge, Attitude,and Practice Survey in Bulehora,WestGujiZone,Oromia,Ethiopia.RiskManagHealthc Policy.2021May 31;14:2245-2252.

Suzuki Frame In The Management Of Intraarticular Fracture Of Base Of The Middle Phalanx.

Mohd Rafeeq Wani, Imran Qayoom, Haazim Haneef Pandit

Abstract:

Introduction: Intraarticular fractures of phalanges are mostly associated with subluxation or dislocation of the interphalyngeal joint and pose a challenge for the treating surgeon. Anatomic reduction and stable fixation followed by early mobilization of the involved joint is necessary to prevent stiffness.

Aim and Objective: The aim of this study was to evaluate the results of suzuli frame in intraarticular fractures of base of the middle phalanx.

Materials and Methods: The study included 15 patients with intra-articular fractures of base of middle phalanx of fingers of hand. Inclusion criteria were Adults patients with age >18 years,all sexes, intra-articular fractures of base of middle phalanx of any finger. The patients were managed with Suzuki pin and traction frame. Informed written consent was taken from all the patients and

Results:A total of 15 patients were included in the study. The average age of the patients in the present study was 33.46 ± 9.37 years (Range: 18-60 years). The mean flexion at PIP joint was 81.73 ± 18.72 degrees and the mean extension at PIP joint was -4.46 ± 3.12 degrees. The mean total ROM at the PIP joint at the final follow-up was 85.53 ± 19.24 degrees. Pin tract infection was seen in 20% of cases and was the commonest complication of the study.

Conclusion: With our experience with the suzuki frame, we find it easy to apply, cost effective and can be made with easily available materials. We achieved good results with this frame with very low complication rates and less joint stiffness.

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INTRODUCTION

The interphalangeal joints are hinge type of synovial joints which permit flexion and extension of fingers. Phalangeal fractures account about 10% of all fractures [1]. Intraarticular fractures of phalanges are mostly associated with subluxation or dislocation of the interphalangeal joint and pose a challenge for the treating surgeon. Anatomic reduction and stable fixation followed by early mobilization of the involved joint is necessary to prevent stiffness. Various surgical options for managing these fractures include krischner wire fixation,external fixators both dynamic and static,open reduction and internal fixation and volar plate arthroplasty [2-5]. Suzuki et al in 1994 described a new pins-and-rubber traction system, now known as suzuki frame, for treating these type of fractures [6]. The aim of this study was to evaluate the results of Suzuki frame in intraarticular fractures of base of the middle phalynx.

MATERIALS AND METHODS

The present study was a prospective study conducted in the department of orthopedics, Government Medical College, Srinagar. The study included 15 patients with intra-articular fractures of base of middle phalanx of fingers of hand. The patients were managed with Suzuki pin and traction frame. Informed written consent was taken from all the patients and ethical approval was taken from the institutional ethical committee for the study.

Inclusion criteria

Inclusion criteria were Adults patients with age >18 years,all sexes, intra-articular fractures of base of middle phalanx of any finger.

Exclusion criteria

Patients with age <18 years, open injuries, associated fractures of involved hand, extra-articular fractures and injuries of thumb were excluded from study.

After clinical evaluation an anteroposterior and lateral radiographs of the involved finger were taken. Prophylactic antibiotic [cefuroxime 1.5 gm intravenous] was given half an hour before surgery. All the patients were operated under local anesthesia using digital block.

Under C-ARM guidance, two long k wires of 1.2mm size were passed one proximal and one distal to the fracture across the joint. The wires were bent and frame was built as per the method described by the Suzuki [6]. The patients were discharged the same day from the hospital and active range of motion of the involved joint were started. K-wires were removed at 4 weeks. Minimum final follow up for every patient was 6 months.

The statistical analysis of the data was performed using SPSS statistics programme version 20 (IBM, Armonk, NY, USA).

RESULTS

A total of 15 patients were included in the study. The average age of the patients in the present study was 33.46 ± 9.37 years (Range: 18-60 years). The injuries were observed predominantly in males with a male to female ratio of 4:1. Machine and work related injuries, were the commonest mode of injury observed (40%) followed by sports related injuries (33.33%). Dominant hand was involved in 60% of patients. Middle finger was most commonly involved (60%), while as little finger (6.67%) was the least common. Volar plate avulsion pattern fracture with dorsal subluxation of the PIP joint was observed in 40% patients. Patient characteristics are given in Table 1.

The mean flexion at PIP joint was 81.73 ± 18.72 degrees and the mean extension at PIP joint was -4.46 ± 3.12 degrees. The mean total ROM at the PIP joint at the final follow-up was 85.53 ± 19.24 degrees. Pin tract infection was seen in 20% of cases and was the commonest complication of the study. One patient developed painful arthritis of the PIP joint at final follow up and was advised for arthrodesis of the joint but was not ready at that time. The complications of the study are summarized in Table 2 and two of the cases are shown in Fig 1.

Table 1-Patient characteristics:

Total patients	15
Age	Age group 18-60 years Mean age 33.46 ±9.37
Sex	Males=12 (80%) Females=3 (20%)
Hand involved	Dominant=9 (60%) Non-dominant=6 (40%)
Finger involved	Middle finger=9 (60%) Ring finger=5 (33.33%) Little finger=1 (6.67%)
Mode of trauma	Machine/work related=6 (40%) Sports =5 (33.33%) Assault =1 (6.67%) Others =3 (20%)
Pattern of fracture	Dorsal plate=4 (26.67%) Volar plate=6 (40%) Comminuted =5 (33.33%)
Range of motion of the involved joint	Flexion =81.73 ±18.72 Extension = -4.46 ±3.12 Total ROM = 85.53 ±19.24

Table2-Complications:

Pin site infection	3 (20%)
Arthritis of joint involved	1 (6.67%)
Osteomyelitis	0
Non union	0

Fig 1: Pre and post-operative radiographs of two of the patients with fracture of base of middle phalynx with dorsal subluxation managed with suzuki frame.

DISCUSSION

The goal of treatment in fractured articular phalangeal joints is to achieve near normal range of motion. In addition, it should maintain the articular congruity and thus prevent arthritis of the involved joint. Conservative methods usually fail to ensure stability in these fractures. Open reduction and fixation many a times is difficult in these fractures. Hence various indirect reduction methods have been described in the literature with variable success rates. One of the common method is the use of external fixators.

Suzuki et al described a frame consisting of pins and rubber bands for these fractures [6]. Suzuki frame is an easy to apply and stable frame [12]. In addition, it allows early range of motion unlike many other devices.

In the present study the mean range of motion was around 85.53 degrees. The results were in agreement of many other previous studies [13-16]. Most common complication seen in the present study was pin tract infection. Similar results were seen by the other studies [17-19]. One patient developed arthritis of the joint. The patient had severely comminuted fracture and the mean range of motion was reduced to around 40 degrees. The patient reported with pain during daily activities. The patient was given an option of arthrodesis of the involved joint but was not ready at that time.

The limitations of the study include the small sample size, short term follow-up and exclusion of thumb injuries.

CONCLUSION

With our experience with the suzuki frame, we find it easy to apply, cost effective and can be made with easily available materials. We achieved good results with this frame with very low complication rates and less joint stiffness.

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Conflicts of interest
There are no conflicts of interest.

REFERENCES

1. Rockwood C, Green D, Butler Jr T. Fractures and dislocations of the hand. 4th edn. ed. Philadelphia: Lippincott Raven; 1996. 607-744 p.
2. Ma X., Wang L., Zhang X. Et al. Comparative study of K-wire combined with screw vs. K-wire in the treatment of AO type B3.1 phalangeal fractures. BMC Musculoskelet Disord 24, 591 (2023).
3. Drenth DJ, Klasen HJ. External fixation for phalangeal and metacarpal fractures. J Bone Joint Surg Br. 1998 Mar;80(2):227-30.
4. Lee JK, Hong IT, Cho JW, Ha C, Yu WJ, Han SH. Outcomes Following Open Reduction and Internal Fixation in Proximal Phalangeal Fracture with Rotational Malalignment. J Hand Surg Asian Pac Vol. 2020 Jun;25(2):219-225.
5. 5. Eaton RG, Malerich MM. Volar plate arthroplasty of the proximal interphalangeal joint: a review of ten years' experience. J Hand Surg Am. 1980 May;5(3):260-8.
6. Suzuki Y, Matsunaga T, Sato S, Yokoi T. The pins and rubbers traction system for treatment of comminuted intra-articular fractures and fracture-dislocations in the hand. J Hand Surg Br 1994; 19:98-107.
7. Moura SP, Meulendijks MZ, Veeramani A, Szapary H, Gomez-Eslava B, Hoftiezer YAJ, Chen NC, Eberlin KR. Epidemiology and Fracture Patterns of Traumatic Phalangeal Fractures. Plast Reconstr Surg Glob Open. 2022 Aug 4;10(8): e4455.
8. 8. De Jonge JJ, Kingma J, van der Lei B, Klasen HJ. Phalangeal fractures of the hand. An analysis of gender and age-related incidence and aetiology. J Hand Surg Br. 1994 Apr;19(2):168-70.
9. Keramidas E, Solomos M, Page RE, Miller G. The Suzuki frame for complex intra-articular fractures of the proximal interphalangeal joint of the fingers. Ann Plast Surg. 2007 May;58(5):484-8.
10. Nilsson, J. A., & Rosberg, H. E. (2013). Treatment of proximal interphalangeal joint fractures by the pins and rubbers traction system: a follow-up. Journal of Plastic Surgery and Hand Surgery, 48(4), 259–264.
11. Finsen V. Suzuki's pins and rubber traction for fractures of the base of the middle phalanx. J Plast Surg Hand Surg. 2010 Nov;44(4-5):209-13.
12. Nanno M, Kodera N, Tomori Y, Takai S. Pins and rubbers traction system for fractures of the proximal interphalangeal joint. J Orthop Surg (Hong Kong) 2019;27(2).
13. Deshmukh, SC, Kumar, D, Mathur, K. Complex fracture dislocation of the proximal interphalangeal joint of the hand. Results of a modified pins and rubbers traction system. J Bone Joint Surg Br. 2004; 86:406-412.
14. Turgut MC, Toy S. Suzuki Frame Results in the Treatment of Comminuted Phalanx Fractures. Arch Curr Med Res 2021;2(1):25-32.
15. De Smet L, Fabry G. Treatment of fracture dislocations of the proximal interphalangeal joint with the "pins and rubbers" traction system. Acta Orthop Belg. 1998; 64:229-32.
16. Duteille F, Pasquier P, Lim A, Dautel G. Treatment of complex interphalangeal joint fractures with dynamic external traction: a series of 20 cases. Plast Reconstr Surg. 2003; 111:1623-9.
17. BhatNA, John M, LoneZA, BhatTA, GhaniA et al. Middle phalanx base fractures managed

with Suzuki frame: a series of 23 patients. Int J Res Orthop2023; 9:267-71.

18. Ruland RT, Hogan CJ, Cannon DL, Slade JF. Use of dynamic distraction external fixation for unstable fracture-dislocations ofthe proximal interphalangeal joint. J Hand Surg Am. 2008; 33:1-25.

19. El Khatib K, Kadlub N, Trost O, Danino AM, Malka G. Dynamic external traction system for management of distal displaced fractures of the head of the proximal phalanx. Chir Main. 2007; 26:21-5

Decrease In Absolute Monocyte Count As A Predictor Of NEC In Preterm Neonates With Gestational Age < 32 Weeks

Asif Ahmed, Qazi Iqbal Ahmad, Mudasir Nazir

Abstract:

Background: NEC, an inflammatory bowel necrosis of premature infants, is one of the leading cause of morbidity and mortality in infants born prior to 32 weeks' gestation and with a birth weight less than 1500 grams. Symptoms of NEC can present either as insidious like lethargy, poor feeding, temperature instability, and bilious emesis/aspirates or as catastrophic entity like hypotension, abdominal distention, respiratory depression, shock, and death. The effectiveness of any NEC treatment relies on how early and accurately it is diagnosed.

Methods: This study was a prospective observational study conducted over a period of two years. 60 patients were followed during their course of hospitalization. A complete history and physical examination was done at the time of admission. All the base line investigations including CBC for monocyte count were done at the time of admission. Serial CBCs were done in the study on Day 1st, 7th, 14th and on 28th day or at signs of deterioration. Enrolled patients were monitored daily for signs of NEC. Those patients who developed NEC were labeled as cases and those who didn't developed signs of NEC were labeled as controls. Monocytopenia was defined as a drop in blood monocyte concentration from the lower referential range of 2. Serial monocyte counts were compared with the development of NEC as well as with its severity.

Results: Out of 60 neonates, 15(25%) neonates developed NEC. There was equal prevalence of this disorder in both sexes with no difference in disease patterns or survival. Highest incidence was seen in the age group of 28-30 weeks of gestation, while the severest form of disease was seen in the gestational age group of 25-27 weeks corresponding to lowest birth weights. Higher yield on blood culture was found amongst the cases as compared to the controls. An absolute decrease in monocyte count was documented in the cases irrespective of the disease severity. An overall mortality of 40% was documented through the study among the cases.

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INTRODUCTION

Necrotising Enterocolitis (NEC), an inflammatory bowel necrosis of premature infants, is one of the leading cause of morbidity and mortality in infants born prior to 32 weeks' gestation and with a birth weight less than 1500 grams [1,2]. NEC has been defined as an acute inflammatory necrosis of the intestinal tract and it is the most common acquired gastrointestinal and surgical emergency for preterm very low birth weight (VLBW) infants in the neonatal intensive care unit (NICU)[3]. Children's hospital Los Angeles puts NEC as a devastating disease that affects mostly the intestine of premature infants. The wall of the intestine is invaded by bacteria, which cause local infection and inflammation that can ultimately destroy the wall of the bowel. Such bowel wall destruction can lead to perforation of the intestine and spillage of stool into the infant's abdomen, which can result in an overwhelming infection and death [4]. NEC may occur without warning and all too often rapidly evolves into a condition requiring resection of bowel and/or death. NEC began since the beginning of modern neonatal intensive care over 60 years ago. Even after fostering efforts for its understanding and eradication, NEC has persisted [5]. Pneumatosis is

seen as a hallmark of this disease. In the late 1970s Dr. Martin Bell proposed a staging system to help evaluate which NEC patients would best benefit from surgery. NEC is clearly more complicated than Bell originally envisioned with his staging and our current methods of clinical data gathering do not have sufficient granularity to carry us into the future [6].

Although prenatal factors like placental insufficiency, prolonged/premature rupture of membranes, chorioamnionitis, have also been attributed for its etiology, NEC in itself is a postnatal condition. Although our understanding of the disease process remains incomplete, the currently accepted unifying model for the pathogenesis of NEC includes contribution and interaction of four key components: i. Prematurity. ii. Aggressive Enternal Feedings. iii. Infectious Agents & Gut Bacteria. iv. Hypoxic-Ischemic insults [7].

Symptoms of Necrotising Enterocolitis (NEC) can present either as insidious like lethargy, poor feeding, temperature instability, and bilious emesis/aspirates or as catastrophic entity like hypotension, abdominal distention, respiratory depression, shock, and death, and abnormal laboratory levels are also reported including metabolic acidosis, hypo- or hyperglycemia, anemia, thrombocytopenia, and electrolyte derangements. Intestinal symptoms include abdominal distention, abdominal tenderness, delayed gastric emptying, feeding intolerance, bilious aspirates, and gross or occult blood in the stool [8]. The effectiveness of any NEC treatment relies on how early and accurately it is diagnosed, which is usually achieved on the basis of readily available clinical, radio-graphic and laboratory data. Abdominal ultrasonography is a newer technique to aid in the diagnosis of NEC and may be more sensitive than abdominal radiography in detecting bowel necrosis and alterations in bowel wall perfusion as confirmed at laparotomy. The sonographic findings include central echogenic focus of bowel wall and a hypoechoic rim (the pseudo-kidney sign) that indicates necrotic bowel and imminent perforation.

The normal values of hematological parameters are not generally available for neonates because blood values are not recorded in normal neonates, hence 'reference ranges' are used in neonatal hematology. Even in reference ranges, variability is seen from the works of Kato (1340 to 2200 μl^{-1}) to Rajadurai et al[9], who notes monocytosis >1700 μl^{-1}. This discussion pertains to the database of CBCs of neonates collected from 18 hospitals in US with gestational age 22 to 42 weeks and time period of 1-28 days of life. The ranges consist of the 5th to 95th percentile values assembled from large numbers of neonates with minimal pathology or with pathology not thought to be relevant to the laboratory parameter under study. The mean values for monocytes increased approximately linearly over this interval with a reference range at 40 weeks of 300 to 3300 μl^{-1} (mean 1400 μl^{-1}).

Monocytosis has been observed in critically ill preterm infants, although the exact mechanism underlying this response remains unclear. The presence of monocytosis in the works of "Rajadurai et al." [9], was associated with lower mean birth weight and gestational age, leukocytosis, multiple transfusions, albumin infusions and theophylline therapy, but not with maternal risk factors (pre-eclampsia, diabetes and chorioamnionitis) or specific neonatal variables such as birth asphyxia, respiratory disease and sepsis. An association with maternal steroid therapy was shown. The researchers speculated that monocytosis represented a physiological, although immature, response of the marrow of small premature infants to a variety of exogenous stimuli, including drugs and foreign protein infusions. Monocytosis has been reported in neonates with intrauterine infections such as candidiasis and syphilis, although many of these infants had an increase in all leukocyte lineages. Monocytosis is occasionally noted in neutropenic infants. In some of the early studies, enumeration of these immature cells as monocytes may also have contributed to the marked but transient monocytosis noted during the early neonatal period. In addition to any clinical utility of these reference ranges, a gradual increase in blood concentration of monocytes between week 22 and term will interest developmental biologists. Surely, the gradual but steady increase in the circulating concentration of monocytes indicates the relevance of roles that they have in human developmental biology [9,10]. The systemic inflammatory response during NEC is characterized by elevated circulating cytokine levels and hematological abnormalities such as thrombocytopenia, increased or decreased neutrophil counts, low monocyte counts, and anemia.

METHODS

This study was a prospective observational study which was conducted in the postgraduate department of Paediatrics and Neonatology of a tertiary care teaching hospital over a period of two years.

Inclusion criteria:
1. Preterm baby with gestation age < 32 weeks
2. No evidence of early onset-sepsis.

Exclusion criteria:
1. Neonatal Sepsis.
2. Surgical abdominal conditions; like omphalocele & gastroschisis, CDH, intussception or any other condition that would warrant a differential diagnosis.

A total of 60 patients were followed during their course of hospitalization. A complete history and physical examination was done at the time of admission. All the base line investigations including CBC for monocyte count were done at the time of admission. Serial CBCs were done in the study on Day 1st, 7th, 14th and on 28th day or at signs of deterioration. Enrolled patients were monitored daily for signs of NEC.

The diagnosis of NEC was based on Bell's criteria which classifies NEC as Stage IA (Suspected NEC), Stage IB(Suspected NEC), Stage IIA(Definite NEC, Mildly ill), Stage IIB(Definite NEC Moderately ill), Stage IIIA (Advanced NEC Severely ill with bowel intact) and Stage IIIB (Advanced NEC Severely ill with bowel perforated).

Those patients who developed NEC were labeled as cases and those who didn't developed signs of NEC were labeled as controls. CBC was done in automated 5 part SYSMEX CBC analyzer. Monocytopenia was defined as a drop in blood monocyte concentration from the lower referencial range of 2. Serial monocyte counts were compared with the development of NEC as well as with its severity in all the enrolled patients in order to study the predictive value of serial monocyte count for the development of NEC.

The data was tabulated and graphical representation was depicted wherever necessary. This data analysis was followed by statistical analysis by using SPSS software.

RESULTS

We did a prospective observational study with a follow up of 28 days in NICU in the department of Pediatrics and Neonataology. Absolute Monocyte Counts were studied in subjects vis-a-vis their clinical course, disease progression and finally statistical analysis was done. Out of 60 neonates, 15(25%) neonates developed NEC. There was equal prevalence of this disorder in both sexes with no difference in disease patterns or survival. Highest incidence was seen in the age group of 28-30 weeks of gestation, while the severest form of disease was seen in the gestational age group of 25-27 weeks corresponding to lowest birth weights. Higher yield on blood culture was found amongst the cases as compared to the controls. An absolute decrease in monocyte count was documented in the cases irrespective of the disease severity. An overall mortality of 40% was documented through the study among the cases.

Out of 15 confirmed NEC neonates, 11 (73%) cases were of NEC category and 4 (27%) were of Advanced NEC category. In a total of 15 patients; 7 (46%) babies were males & 8 (53%) were females (P=0.94). Out of the total 60 patients, one case of NEC-III occurred in babies with gestational age of <27 Weeks. Two cases of NEC and one case of Advanced NEC occurred in babies with gestational age of 27-28 weeks. Seven cases of NEC & one case of Advanced NEC had a gestational age of 29-30 weeks. Two cases of NEC & one case of advanced NEC occurred in babies with gestational age of 31-32 NEC. The same reflects a significant incidence of NEC in smaller gestational age (Table 1). **p (<0.0001).**

We analysed the relation between low birth weight and NEC prevalence. In weight group of <1Kg, 75% prevalence was seen. In a total of four Advanced NEC

studied, three of them belonged to this weight group. No NEC-II case was witnessed in this weight group.

Table1 Association of gestational age with Necrotising Enterocolitis (NEC) incidence.

Gestational Age	NEC	Advanced NEC	No NEC
<27 weeks	0	1	0
27-28 weeks	2	1	1
29-30 weeks	7	1	10
31-32 weeks	2	1	34

In weight group 1.01- 1.50 Kg, 08 NEC and 01 Advanced NEC was witnessed. In weight group of 1.51-2.0Kg, 03 NEC cases were witnessed. In the weight group of 2.1-2.5Kg none of the cases of NEC or Advanced NEC were witnessed. The same clearly reflects a direct relation between low birth weight and NEC incidence as shown in Table2. (**p.value was <0.0001**).

Table 2 Association between NEC and Birth Weight.

Weight Group	No NEC	NEC	Advanced NEC
<1 Kg	3	0	3
1-1.5 Kg	20	8	1
1.5-2 Kg	16	3	0
2-2.5Kg	9	0	0

Amongst the 60 enrolled subjects; 14 patients had a positive blood culture with 7 patients from NEC) group; 1 patients from Advanced NEC group and 6 patients from No NEC group.46 patients had a negative blood culture with 4 patients from NEC group; 3 from Advanced NEC group and 39 from No NEC group. (p.value was 0.002)

In a total of 8 NEC patients with positive culture report, one of them grew Candida, two of them grew Enterobacter aerogenes, another two grew Klebseilla Pneumoniae, and three of them grew Staphyllococus Epidermidis.

We analysed the total leucocyte counts in cases & controls. In control group mean Total Leukocyte Counts were 2346.66/µl, in NEC group mean Total Leukocyte Counts were 6370.00/µl and in Advanced NEC group mean Total Leukocyte Counts were 7300.00/µl. A proportional increase in Total Leukocyte Counts was witnessed with Absolute Monocyte Count (AMC) drop and with disease severity (p.value <0.0001).

We recorded the lowest percentage wise drop in mean Absolute Monocyte Count in our subjects. Taking 8% as upper referential range and 2% as the lower referential range, in a total of 60 patients, a maximum mean drop of -0.28% was seen in control group. In NEC patients a maximum mean drop of -2.94% was seen and in Advanced NEC cases, a maximum drop of -3.94% was seen. (**Table 3**) The same reflects a decrease in Absolute Monocyte Count in cases, with a significant p.value of < 0.001.

Table 3. Percentage wise drop in Absolute Monocyte Count in studied Patients

Group	Number of patients	Lower Referencial Range	Mean% Drop in Absolute Monocyte Count in NEC cases	Standard Deviation	*p.value*
NEC	11	2	-2.94	1.800	0.0001
Advanced NEC	4	2	-3.30	0.989	
No NEC	45	2	-0.28	2.04	

We also recorded number wise Absolute Monocyte Count in studied patients. Taking 8% as upper referential range and 2% as the lower referential range, in a total of 60 patients, mean numerical value of +135.89 was seen in control group. In NEC patients, a negative value of -190.95 was seen and in Advanced NEC patients, a negative value of -338.35 was seen. The same reflects a number wise decrease in Absolute Monocyte Count in cases with a significant p.value of < 0.001.

In a total of 60 patients, 10(17%) patients deteriorated during the disease course, 5(8.3%) patients improved and 45(75%) patients remained stable (p.value=0.0001).

DISCUSSION

NEC has been defined as an acute inflammatory necrosis of the intestinal tract and the most common acquired gastrointestinal and surgical emergency for preterm very low-birth weight infants in the neonatal intensive care unit[3]. The wall of the intestine gets invaded by bacteria, which cause local infection and inflammation that can ultimately destroy the wall of the bowel. Such bowel wall destruction can lead to perforation of the intestine and spillage of stool into the infant's abdomen, which can result in an overwhelming infection and death[4]. The risk of developing NEC and the severity of the disease is inversely related to gestational age and weight at birth and the currently accepted unifying model for the pathogenesis of NEC includes contribution and interaction of prematurity, aggressive enteral feedings, infectious agents & gut bacteria, hypoxic-ischemic insults[7]. The diagnosis with the help of radiological findings vary by gestational age; intramural gas has been detected in infants of ≥37 weeks gestational age with NEC, but a diminished picture of only about 29% in infants with ≤26 weeks' gestational age. Abdominal ultrasonography is a newer technique to aid in the diagnosis of NEC and may be more sensitive than abdominal radiography in detecting bowel necrosis and alterations in bowel wall perfusion as confirmed at laparotomy. Monocytosis has been reported in neonates with intrauterine infections such as candidiasis and syphilis, although many of these infants had an increase in all leukocyte lineages. Monocytosis is occasionally noted in neutropenic neonates [10].

We performed a prospective observational study on preterm neonates with gestational age of <32 weeks, admitted in the department of Pediatrics and Neonatology over a period of two years, primarily taking into account the CBC of premature babies with a gestational age of <32 weeks. We carried out the CBC of studied subjects on day 1st, day 7th, day 14th and day 28th or at any time of clinical deterioration. In our final analysis, we included 60 preterm neonates with gestational age <32 weeks, out of those 60 patients during the course of hospitalization, 15 neonates developed NEC and 45 neonates remained stable with no signs of NEC.

Unlike previous works we performed CBC on subjects in anticipation or on deterioration as well as on dates specified. In our cases group, compared to the control asymptomatic group, monocyte counts were significantly decreased in patients with both NEC and Advanced NEC before the onset of NEC and in the 1st follow-up CBC. In patients with NEC, Absolute Monocyte Count on percentage basis decreased from lower referencial range to a mean of -2.94, whereas in those with Advanced NEC, the Absolute Monocyte Count decreased from lower referencial range to a mean of -3.30, with no significant changes in Absolute Neutrophillic Counts, and Absolute Leukocyte Counts. In the control group, there were no significant changes in the Absolute Monocyte Counts. We also recorded the number wise counts of Absolute Monocyte Count (AMC) in NEC, Advancedd NEC and in No NEC groups. We witnessed a steady decrease in number wise Absolute Monocyte Count (AMC) in studied groups with the control group having a mean value of +135.89, in NEC patients, a negative value of -190.95 was seen and in Advanced NEC a negative value of -338.35 was seen; but the same could not be justified due to different Total Leukocyte counts exhibited by individual patients.

Whether cases or controls, we observed an almost equal frequency of blood culture-positive subjects. Gender difference was non-significant in terms of NEC precedence or survivability. Moreover monocytosis has been noted in neonatal infections, we did not detect a significant difference in monocyte counts in neonates within the control group. Overall, the NEC group had a higher incidence of systemic signs, gastrointestinal bleeding, and mortality, indicating a higher acuity of illness than controls. A major limitation of our study is the limited number of subjects studied with possibility of also being biased due to mono-centric nature, limited infrastructure etc. Considering the limited sample size, our findings need further validation in larger/multi-centric cohorts. Further study is also needed to evaluate

maternal/neonatal covariates known to be associated with NEC such as chorioamnionitis, anemia, transfusions and infections.

In our study we witnessed a fall in Absolute Monocyte Count in NEC confirmed cases and this fall in Absolute Monocyte Count can be a useful early predictive marker of NEC especially in low birth weight neonates. At the time of onset of systemic and abdominal signs, a drop in Absolute Monocyte Count (from the last available test) correctly discriminated between NEC vs other causes of deterioration with an accuracy of 86% (we included 60 preterm neonates out of which 15 developed NEC and among them 13 [86%] patients showed decrease in Absolute Monocyte count, while in 2 [14%] patients there was no change in Absolute Monocyte count). Although this drop in Absolute Monocyte Count is readily available on CBC reports generated from hematology analyzers, yet most neonatologists currently do not evaluate monocyte counts routinely in their practice. Previous studies have identified several candidate biomarkers of Necrotising Enterocolitis (NEC), with "Hutter et al." [11] being the first to report hematolgoical abnormalities in NEC, particularly the low granulocyte count in severe NEC cases, followed by "Gorden et al", "Benkoe et al,"[6,12] Maheshwari et al [13] who evaluated biomarkers such as the white blood cells, circulating cytokines, IL-8, Inter-alpha etc. However, despite its modest diagnostic accuracy, the Absolute Monocyte Count is an attractive marker of NEC because the information is already available to the clinician at no extra cost and its high negative predictive value (88%) can help exclude the diagnosis of NEC in neonates who develop any systemic or abdominal signs. Because most clinical laboratories now use automated hematology counters, there are additional advantages of rapid turnaround times, a high degree of consistency and the ease of extrapolation of findings to other centers. Interestingly, decreased blood monocyte counts are likely to be a unique feature of NEC. Growth-restricted preterm neonates may have low monocyte counts but most of these neonates show a suppression of all leukocyte lineages and not isolated monocytopenia. Our findings are in concordance with the works of "Remon et al."[14]who noted Absolute Monocyte Count drop from median 1.7×10^9/L (interquartile range (IQR) 0.98–2.4) to 0.8 (IQR 0.62–2.1); p <0.05. In stage III NEC they reported monocyte counts decreased from median 2.1×109/L (IQR 0.1.5–3.2) to 0.8 (IQR 0.6–1.9); p <0.05 and with the works of "Desiraju et al."[15], recording Median Absolute Monocyte Count (AMC) changes of +0.5% (p = 0.56) in rule-out NEC, compared with −44.5% (p < 0.0001) in Stage 2 NEC and −81.9% (p < 0.0001) in Stage 3 NEC.

Absolute Monocyte Count as a novel biomarker for the prediction of NEC may be new but similar to our predecessors we also witnessed a significant percentage wise drop in Absolute Monocyte Count in patients with NEC and Advanced NEC. While low birth weight remains the most potent and lethal factor in the incidence and severity of NEC; prematurity, aggressive feeding and gut colonisation also contribute significantly in its incidence. Compared to the first available Absolute Monocyte Count from prior to onset of any abdominal and respiratory signs, an acute drop in blood monocyte concentration can identify NEC with 86% accuracy (*p.value* <0.001). In a preterm neonate with signs of NEC, a fall in Absolute Monocyte Count by -2.94 indicated NEC, with increased drop in severe cases by -3.30, the same will help to diagnose Necrotising Enterocolitis in its early stages to provide timely management and avoid any aggravation. Pertinently we could not justify drop in blood monocyte concentration in terms of numbers because of different total leukocyte counts in different patients.

REFERENCES
1. Josef Neu, Walker, W.A. Necrotising enterocolitis. N Engl J Med; 2011 Jan 20; 364(3):255– 64.
2. Maheshwari A, Kelly DR, Nicola T, Ambalavanan N, Jain SK, Murphy-Ullrich J et al. TGF-beta (2) Suppresses Macrophage Cytokine Production and Mucosal Inflammatory Responses in the Developing Intestine. Gastroenterology; 2011.Jan; 140 (1): 242–53.
3. Wu SF, Caplan M, Lin HC. Necrotising Enterocolitis: Old Problem with new hope. Pediatr and Neonatol; 2012. 53:158- 163.
4. Children's Hospital Los Angeles. Copyright 2020. [Internet]. Available from. https://www.chla.org/necrotiz ingenterocolitis
5. Neu J, Pammi M. Pathogenesis of Necrotising Enterocolitis (NEC): Impact of an altered intestinal microbiome. Semin Perinatol; 2017 Feb;41(1):29-35.
6. Gordon PV, Swanson JR, MacQueen BC, Christensen RD. A critical question for Necrotising Enterocolitis (NEC) researchers: Can we create a consensus definition of Necrotising Enterocolitis (NEC) that facilitatesresearch progress?. Seminars in Perinatology; 2017. 41,1:7-14.
7. McGuire W, Young L, Morgan J. Preventing necrotising enterocolitis in very preterm infants: current evidence. Paediatrics and Child Health; 2015. 25,6:265-270
8.Gibbins S, Maddalena P, Golec L. Evidence-Based Care for the Infant With Necrotising Enterocolitis (NEC). Newborn and Infant Nursing Reviews; 2008.8, 3:144-152 .
9.Rajadurai VS, Chambers HM, Vigneswaran R, Gardiner AA.Monocytosis in preterm infants. Early Hum Dev; 1992. 28:223–229.
10.Christensen RD, Jensen J, Maheshwari A, Henry E. Reference ranges for blood concentrations of eosinophils and monocytes during the neonatal period defined from over 63 000 records in a multihospital health-care system. Journal of Perinatology; 2010. 30:540–545.

11.Hutter JJ, Hathaway WE, Wayne ER. Hematologic abnormalities in severe neonatal necrotizing enterocolitis. J Pediatr; 88(6):1026– 31.

12.Benkoe T, Reck C, Pones M, Weninger M, Gleiss A, Stift A et al. Interleukin-8 predicts 60-day mortality in premature infants with necrotizing enterocolitis. Journal of Pediatric Surgery; 2014. 49:385–389.

13.Maheshwari A. Immunological and Hematological Abnormalities in Necrotising Enterocolitis (NEC). Clinical Perinatology; 2015.42, 3:567– 585.

.

14.Remon J, Kampanatkosol R, Rajat K, Muraskas JK, Christensen R D, Maheshwari A. Acute Drop in Blood Monocyte Count Differentiates Necrotising Enterocolitis (NEC) from Other Causes of Feeding Intolerance. J Perinatol; 1996. 34,7: 549–554.

15.Desiraju S, Bensadoun J, Bateman D, Kashyap S. The role of absolute monocyte counts in predicting severity of necrotizing enterocolitis. Journal of Perinatology;   2019.40(6):   922-927

Real-Time Intrafraction CBCT Imaging: Commissioning and Clinical Applications in Radiation Therapy

Deeksha Jaiswal, Monika Goyal , C.P Bhatt

Abstract:

Introduction: Conventional CBCT is limited to pretreatment imaging, leaving intrafractional motion a challenge.Real-time intrafraction CBCT enables continuous monitoring of tumor motion during radiation delivery, overcoming the limitations of conventional pretreatment CBCT.This study focuses on the commissioning of real-time intrafraction CBCT imaging and evaluating its feasibility with the goal of improving treatment precision, reducing uncertainties, and enhancing patient outcomes.

Materials and Methods: In this study, we used the **Catphan 504 phantom (module number TBD)** to evaluate the image quality of intrafraction cone-beam computed tomography (CBCT) imaging during stereotactic body radiotherapy (SBRT) treatment deliveries. various structures were drawn on the CBCT scans of the CatPhan 504 phantom with the field sizes ranged from **0.5 x 0.5 cm² to 9 x 9 cm²**, increasing in **5 mm increments**. Each plan is optimized for 5 Gy in single fraction for 6MV photon. It is calculated for grid spacing of 0.2 cm and for statistical uncertainity of 1%.A 5mm small structure plan was created using 858.0 MU. The 90 mm Large structure plan was made with 600.64 MU.

Results: The analysis reveals a significant relationship between field size and imaging parameters in real-time intrafraction CBCT imaging. As the field size increases Geometric distortion, CNR, and overall uniformity decline, potentially compromising image accuracy and affecting tumor localization. For both small and large structures, geometric distortion remained minimal (<-1 mm) at lower field sizes (5–55 mm) but progressively worsened as field size increased. Spatial resolution improves, enhancing fine detail detection, but maximum HU deviation rises, which may introduce inaccuracies in tissue density representation and setup verification.

Conclusion: This study successfully commissioned real-time intrafraction CBCT imaging for various field sizes using the Catphan 504 phantom. The findings demonstrate that real-time CBCT integration enhances the accuracy of dose delivery by effectively accounting for intrafraction motion. This improved precision in radiation therapy can lead to better treatment outcomes and increased patient safety.

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INTRODUCTION

Radiation therapy remains a cornerstone in the treatment of cancer, with its efficacy significantly enhanced through the integration of advanced imaging technologies. Imaging plays a critical role in radiation oncology, aiding in disease identification, understanding tumor biology, staging, and guiding treatment planning and delivery [1, 2]. A variety of imaging modalities, such as computed tomography (CT), magnetic resonance imaging (MRI), ultrasound, and positron emission tomography (PET)-CT, provide detailed insights that are essential for both diagnostic evaluation and precision in radiation therapy treatment planning [3,4].

In recent decades, radiation therapy techniques have evolved, moving from conventional radiotherapy to more advanced methods like intensity-modulated radiotherapy (IMRT), image guided radiotherapy

(IGRT), stereotactic body radiotherapy (SBRT), and proton beam therapy (PBT). Image guided radiation therapy (IGRT) is an advanced radiation therapy technique that enhance precision by using real time imaging to accurately target tumors while minimizing damage to healthy tissues. IMRT shapes radiation dose intensity across the tumour. SBRT delivers high dose precise radiation in fewer sessions. These innovations have allowed for higher precision and accuracy in delivering radiation doses to the tumor while minimizing damage to surrounding healthy tissues, leading to better clinical outcomes [5,6]. These techniques rely heavily on accurate imaging for planning and real-time adjustments during treatment to maintain tight margins and deliver higher doses directly to the tumor [7,8].

A major challenge in the delivery of high-precision radiotherapy lies in managing geometric uncertainties, particularly those arising from inter-fraction and intra-fraction motion. Tumor displacement due to respiration, cardiac activity, swallowing, and other physiological movements can lead to deviations in dose delivery, especially in extracranial sites where organ motion is pronounced [9]. Real-time monitoring of tumor position during treatment is thus essential for maintaining dose conformity and ensuring treatment accuracy.

Intra-fraction motion has a direct influence on planning target volume (PTV) margins and dose distribution [10-13]. To mitigate its effects, several techniques for real-time target tracking have been developed. These include sonographic tracking [14], implanted fiducial markers [15,16], beacon transponders [17], and emerging systems such as linear accelerator (LINAC)-integrated MRI [18,19]. Among these, intrafractional ultrasound (US) guidance offers a promising solution by enabling non-invasive, markerless, real-time volumetric tracking during beam delivery. However, ultasound systems may interfere with dose distribution due to physical presence within the treatment field [20], and have limitations related to imaging through air or bone, and restricted imaging volume rates in some 3D systems [21].

Alternative approaches such as cone-beam computed tomography (CBCT) have also been employed for intrafraction monitoring. Real-time intrafraction CBCT, particularly in the context of magnetic resonance image-guided radiotherapy (MRIGRT), allows continuous visualization of patient anatomy during treatment. However, limitations such as image artifacts, increased acquisition times, and patient motion reduce its effectiveness [22]. Although MRIGRT offers superior soft-tissue contrast and facilitates online adaptation, CBCT-guided adaptation remains more commonly implemented in clinical settings due to workflow compatibility.

Historically, intra-fraction motion has been assessed retrospectively through imaging acquired before or after treatment. While useful, such methods fail to capture dynamic changes during beam-on time. Real-time intrafraction CBCT addresses this gap by enabling direct imaging during irradiation, thereby supporting adaptive interventions that enhance treatment precision and reduce uncertainties.

This study focuses on the commissioning of real-time intrafraction CBCT imaging and evaluating its feasibility for clinical treatments in radiation oncology. By incorporating real-time CBCT into clinical workflows, radiation oncologists can gain more precise control over intra-fraction movements, ultimately leading to more accurate dose delivery and improved patient outcomes. The feasibility of integrating this technology into routine clinical practice will be explored, along with its potential impact on reducing uncertainties and enhancing the precision of modern radiation therapy techniques.

The main goal of this study was to evaluate the effect of MV-scattered photons on the image quality of kV intrafraction CBCT. Specifically, we aimed to determine how the presence of MV treatment beams impacted the clarity, resolution, and overall quality of CBCT images used for real-time monitoring during treatment.

By examining these effects, this study seeks to determine the clinical utility of real-time CBCT for monitoring intra-treatment motion and enabling real-time adaptive corrections. The findings will support the optimization of CBCT protocols for stereotactic treatments such as stereotactic radiosurgery (SRS) and stereotactic radiotherapy (SRT), ultimately contributing to improved treatment precision and patient outcomes.

MATERIALS AND METHODS
Phantom and analysis software used

In this study, we used the **CatPhan 504 phantom (module number TBD)** to evaluate the image quality of intrafraction cone-beam computed tomography (CBCT) imaging during stereotactic body radiotherapy (SBRT) treatment deliveries [23]. The CatPhan 504 is a widely recognized phantom designed for quality assurance in both diagnostic and radiation therapy imaging. It contains several modules to assess key imaging parameters such as spatial resolution, contrast sensitivity, uniformity, and geometric accuracy, making it an ideal tool for this investigation [24].

We have generated the CBCT protocol for intrafraction CBCT and on the basis of template we have taken the images of the phantom.

Figure 1(a) and (b) is cross-sectional image from Cone Beam Computed tomography (CBCT) scan. The numbers and scale on the image indicate measurement values in millimeters and a grayscale on the right range from -1000 to 1000, which is typical for Hounsfield units used in CT scans, where -1000 represents air and 1000 represent dense bone. The red squares and numbers likely indicate measurement points or regions of interest for analysis. The red
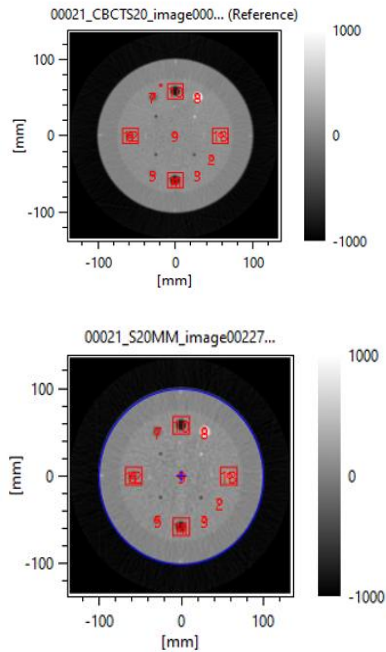
Fig1(a) Fig1(b)

Figure 1(a)&(b) represent transverse view of catphan image 1(a) pre cbct image of catphan (reference image),1(b) Intrafraction cbct image of catphan

squares symbol seen in the image, when used in the context of image analysis within computer programming, is commonly referred to as a bounding box or region of interest (ROI).It serves to highlight specific areas within an image that are of particular interest for analysis or processing. Figure 1(a) represent PRECBCT image of CATPHAN which is taken as reference image without MV Beam ON. Fig 1(b) represent intrafraction CBCT image of CATPHAN for 20 mm field size. We have analyzed all the plans using my QA software (IBA Dosimetry, Keyversion: 23.3.1.96402, Germany)

Phantom Structure Design

In order to thoroughly evaluate the precision and resolution of intrafraction CBCT during treatment, various structures were drawn on the CBCT scans of the CatPhan 504 phantom. The structure are drawn on the image of phantom starting from 5mm small,5mm large ,10 mm small,10 mm large in the increment of 5 mm and goes upto 90 mm. For 5 mm small structure radius is kept 5mm and length of the structure is also same 5mm. For 5 mm large structure radius is 5 mm but length of the structure is 10 mm likewise we drawn all the structure. These structures were designed to mimic small tumors or critical anatomical landmarks that require precise targeting in clinical treatments. This variation allowed for a comprehensive assessment of how well intrafraction CBCT could detect and monitor targets of different sizes throughout the treatment process.
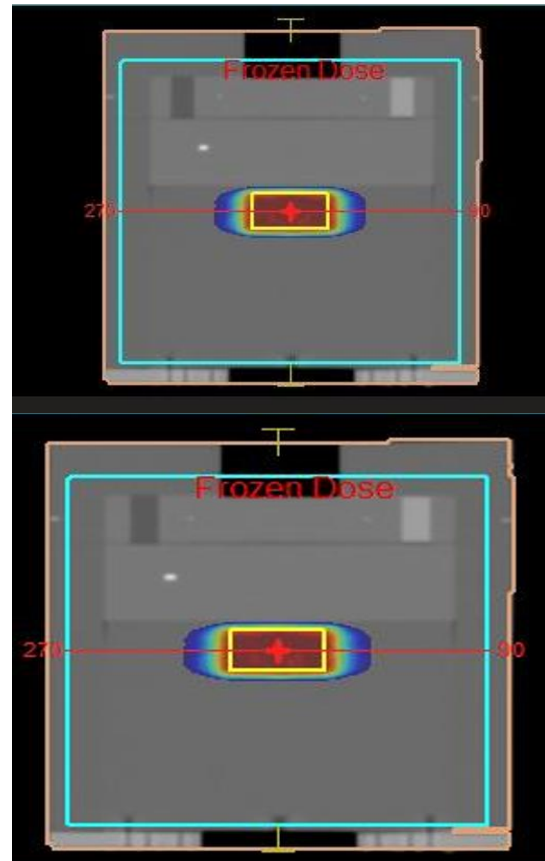
Figure   2(a)   2mm   small   structure
Figure2(b) 2mm large structure
Figure 2(a)&(b) illustrate sagittal view of catphan image 2(a) delineation of 2mm small structure and 2(b) 2 mm large structure

Phantom Alignment and Imaging Setup

The **CatPhan 504 phantom** was precisely aligned with the isocenter of the Elekta linear accelerator to ensure accurate imaging and radiation delivery. Isocenter alignment is critical in radiotherapy, particularly in SBRT, where sub-millimeter precision is required to avoid damage to surrounding healthy tissue.

The phantom was aligned to the machine's isocenter using established protocols, ensuring that the planned beams and CBCT images were correctly focused on the target structures within the phantom.

Imaging System and parameter

The **Elekta Versa HD** linear accelerator, equipped with a kilovoltage (kV) CBCT system, was used to acquire both baseline and intrafraction CBCT images. The primary objective was to assess how the image quality of CBCT is impacted during the delivery of radiation with the MV beam on.

- **X-ray tube voltage**: 100 kV
- **X-ray tube current**: 20 mA
- **Gantry rotation**: 360 degrees full arc
- **Field of view (FOV)**: S20 small field of view, which provides high-resolution imaging of a localized region for precise monitoring during treatment.

Table 1 represent plan parameter used in treatment planning with Monitor Unit(MU)

Serial No	Field Size (mm)	Length Y1	Length Y2	MU
1	5 mm LARGE	1.0	1.0	893.15
2	5 mm SMALL	1.0	1.0	858.0
3	10 mm LARGE	1.58	1.57	852.14
4	10 mm SMALL	1.0	1.0	897.81
5	15 mm LARGE	2.0	2.0	823.72
6	15 mm SMALL	1.5	1.5	784.68
7	20 mm LARGE	2.7	2.7	758.85
8	20 mm SMALL	1.5	1.5	819.77
9	25 mm LARGE	3.2	3.20	739.38
10	25 mm SMALL	2.0	2.0	739.30
11	30 MM LARGE	3.7	3.7	728.85
12	30 MM SMALL	2.2	2.2	741.20
13	35 MM LARGE	3.7	3.7	728.85
14	35 MM SMALL	2.5	2.5	737.43
15	40 MM LARGE	4.5	4.5	719.78
16	40 MM SMALL	2.7	2.7	711.98
17	45 MM LARGE	5.5	5.5	678.07
18	45 MM SMALL	3.0	3.0	725.21
19	50 MM LARGE	6.0	6.0	674.04
20	50 MM SMALL	3.2	3.2	716.65
21	55 MM LARGE	6.5	6.5	668.90
22	55 MM SMALL	3.5	3.5	699.70
23	60 MM LARGE	7.0	7.0	660.02
24	60 MM SMALL	4.0	4.0	682.28
25	65 MM LARGE	7.5	7.5	651.78
26	65 MM SMALL	4.0	4.0	680.60
27	70 MM LARGE	8.2	8.2	638.80
28	70 MM SMALL	4.5	4.5	663.94
29	75 mm LARGE	8.7	8.7	623.47
30	75 mm SMALL	4.7	4.7	654.02
31	80 mm LARGE	9.5	9.5	618.64
32	80 mm SMALL	5.0	5.0	641.95
33	90 mm LARGE	10.5	10.5	600.64
34	90 mm SMALL	5.5	5.5	625.74

- A specified maximum of 320 frames were collected for analysis during each full rotation of the gantry, ensuring comprehensive imaging data for evaluation.

Treatment Plans

For the purpose of this study, we created several full-arc treatment plans on the Elekta Versa HD linear accelerator, which is equipped with CBCT for image guidance. We have created 34 plans for small and large structure on CatPhan CT with different MU and Field size as shown in Table 1.

A full arc plan was made from gantry angle 180 to 180 (CCW) with monaco planning system (Infinity; Elekta Medical Systems, Crawly, UK) (version 6.1.2.0). Dynamic conformal arc plan is created started from gantry angle 180 degree with 360-degree arc, collimator 0-degree, couch 0 degree. Each plan is optimized for 5 Gy in single fraction for 6MV photon. It is calculated for grid spacing of 0.2 cm and for statistical uncertainty of 1%. A 5mm small structure plan was created using 858.0 MU. The 90 mm large structure plan was made with 600.64 MU.

The treatment plans were designed with a dose rate of 600 monitor units (MU) per minute to simulate the conditions typical of SBRT, a treatment method known for delivering highly conformal, high-dose radiation in fewer sessions. To analyze the impact of intrafraction CBCT on different field sizes, the

Monaco treatment planning system was used to generate plans with varying field sizes. The field sizes ranged from 0.5 x 0.5 cm² to 9 x 9 cm², increasing in 5 mm increments. This range was chosen to investigate how different field sizes affect image quality and the detection of small structures within the treatment area during CBCT imaging.

Intrafraction-CBCT Acquisition

For each of the treatment plans, intrafraction CBCT images were acquired using a start and stop gantry angle of 180 degrees, full arc imaging conditions during actual SRS/SRT treatments. These images were collected both with the MV beam off (baseline images) and with the MV beam on (during treatment), allowing for a direct comparison of image quality under treatment conditions. The data from these intrafraction CBCT scans were compared with the baseline scans to determine the extent to which the scatter from MV beam affected the image quality [25].

RESULTS

The purpose of this study was to evaluate the feasibility of real-time intrafraction CBCT during SBRT by analyzing how varying field sizes affect image quality parameters such as geometric distortion, spatial resolution, uniformity, contrast, CNR, and HU accuracy. This study was carried out for photon beams 6 MV and intrafraction field size starting from 5 mm to 90 mm in the increment of 5 mm. Here the intrafraction field size is used in two ways. One is small intrafraction field size and the second is large intrafraction field size starting from 5 mm to 90 mm. Image quality from intrafraction CBCT acquisitions was compared against reference CBCT scans (without MV beam ON) with the help of My QA Software and results are summarized in Tables 2 and 3.Here we discuss about these parameters with their impacts on image quality with the help of table 2 and table 3. In the table 2 and 3 shows the geometric distortion in mm, spatial resolution in (lp/mm), overall uniformity in (%), minimum uniformity in (%), contrast in (%), CNR, maximum HU deviation (HU) for the intrafraction large field size .

Table 2.1: Intrafraction Large field size 5 mm to 45 mm

Intrafraction Field Size LARGE(mm)										
PARAMETER	REF VALUE	5 mm	10 mm	15 mm	20 mm	25 mm	30 mm	35 mm	40 mm	45 mm
GEOMETRIC DISTORTION (mm)	-0.42	-0.66	-0.7	-0.81	-1	-1.1	1.12	-1.15	-1.21	-1.22
SPATIAL RESOLUTION (lp/mm)	0.27	0.29	0.3	0.3	0.35	0.35	0.36	0.39	0.37	0.48
OVERALL UNIFORMITY (%)	95.76	96.82	96.51	95.58	94.79	93.86	92.62	93.78	91.57	88.86
MINIMUM UNIFORMITY (%)	95.66	96.75	96.43	95.45	94.59	93.58	92.22	93.49	90.98	87.82
CONTRAST (%)	2.92	7.38	6.55	6	5.61	9.61	6.21	10.02	4.93	12.31
CNR	1.95	0.77	0.87	0.95	1.02	0.59	0.92	0.57	1.16	0.46
MAXIMUM HU DEVIATION (HU)	257.43	258.73	248.71	262.02	273.41	290.71	286.41	290.12	313.51	344.47

In the Table 2.1 large structures of 5 mm were drawn with radius 5 mm and length 10 mm . The field size varies from 0.5x0.5 cm² to 9x9 cm². We analyze different imaging parameters for different field size and compare this with image without MV beam ON. In Table 3.1small structures were drawn on cat phan with 5mm radius and 5mm length. The field size varied with increment of 5 mm. We analyze different imaging parameter for different field size. In the table 2.1 it was observed that geometric distortion which is important in CBCT because it affect the quality of resulting image. It can cause size changes, shape distortion, blurring and displacement. Here the geometric distortion explains with the help of the graph which is given below.

increases. Geometric distortion was strongly dependent on field size. For both small and large structures, distortion remained minimal (<-1 mm) at lower field sizes (5–55 mm) but progressively worsened as field size increased. This pattern highlights that larger fields are more vulnerable to scatter contamination, consistent with prior studies reporting that MV scatter alters CBCT geometry during beam-on imaging.

Spatial Resolution (SR) is the ability to distinguish between objects or structures that differ in density. Spatial resolution showed a contrasting trend. In both small and large fields, resolution improved modestly with

Table2.2: Intrafraction Large field size 50 mm to 90 mm

Intrafraction Field Size LARGE (mm)									
PARAMETER	REF VALUE	50 mm	55 mm	60 mm	65 mm	70 mm	75 mm	80 mm	90 mm
GEOMETRIC DISTORTION (mm)	-0.42	-1.25	-1.25	-1.65	-1.7	-1.8	-1.85	-1.9	-1.95
SPATIAL RESOLUTION (lp/mm)	0.27	0.46	0.43	0.31	0.35	0.38	0.37	0.45	0.4
OVERALL UNIFORMITY (%)	95.76	86.79	87.02	85.71	85.41	84.8	83.33	81.06	77.18
MINIMUM UNIFORMITY (%)	95.66	85.4	85.53	84.02	83.55	82.85	80.8	77.81	72.22
CONTRAST (%)	2.92	6.16	13.66	15.29	110.29	7.85	6.67	7.41	37.83
CNR	1.95	0.93	0.42	0.37	0.05	0.73	0.85	0.77	0.15
MAXIMUM HU DEVIATION (HU)	257.43	349.29	450.86	437.65	487.49	509.45	609.24	612.65	659.22

Table 3.1 :Intrafraction small field size 5mm to 45 mm

Intrafraction Field Size SMALL (mm)									
PARAMETER	REF VALUE	5 mm	10mm	15mm	20mm	25mm	30mm	35mm	40mm	45mm
GEOMETRIC DISTORTION (mm)	-0.42	-0.72	-0.49	-0.39	-0.5	-0.6	-0.65	-0.7	-0.8	-0.83
SPATIAL RESOLUTION (lp/mm)	0.27	0.41	0.37	0.3	0.3	0.31	0.35	0.33	0.29	0.28
OVERALL UNIFORMITY (%)	95.76	96.76	96.43	96.97	96.14	95.34	95.13	95.19	94.12	93.17
MINIMUM UNIFORMITY (%)	95.66	96.69	96.34	96.91	96.04	95.19	94.96	95.01	93.87	92.79
CONTRAST (%)	2.92	5.49	4.77	4.67	6.0	5.08	6.09	15.74	9.36	4.21
CNR	1.95	1.04	1.19	1.22	0.95	1.12	0.094	0.36	0.61	1.35
MAXIMUM HU DEVIATION (HU)	257.43	255.35	251.67	258.31	269.55	261.98	263.16	271.08	287	312.86

Table 3.2: Intrafraction small field size from 50 to 90 mm

Intrafraction Field Size SMALL (mm)									
PARAMETER	REF VALUE	50mm	55mm	60mm	65mm	70mm	75mm	80mm	90mm
GEOMETRIC DISTORTION (mm)	-0.42	-0.86	-0.91	-0.97	-1.18	-1.25	-1.45	-2.5	-7.99
SPATIAL RESOLUTION (lp/mm)	0.27	0.32	0.31	0.29	0.3	0.32	0.31	0.3	0.28
OVERALL UNIFORMITY (%)	95.76	92.39	90.51	89.38	89.56	89.47	88.01	86.86	84.03
MINIMUM UNIFORMITY (%)	95.66	91.39	89.8	88.43	88.7	88.55	86.81	85.35	81.78
CONTRAST (%)	2.92	47.82	50	10.62	14.11	11	12.81	15.41	9.01
CNR	1.95	0.12	0.12	0.54	0.4	0.52	0.45	0.37	0.63
MAXIMUM HU DEVIATION (HU)	257.43	313.49	302.82	349.39	330.37	376.02	403.55	447.18	452.84
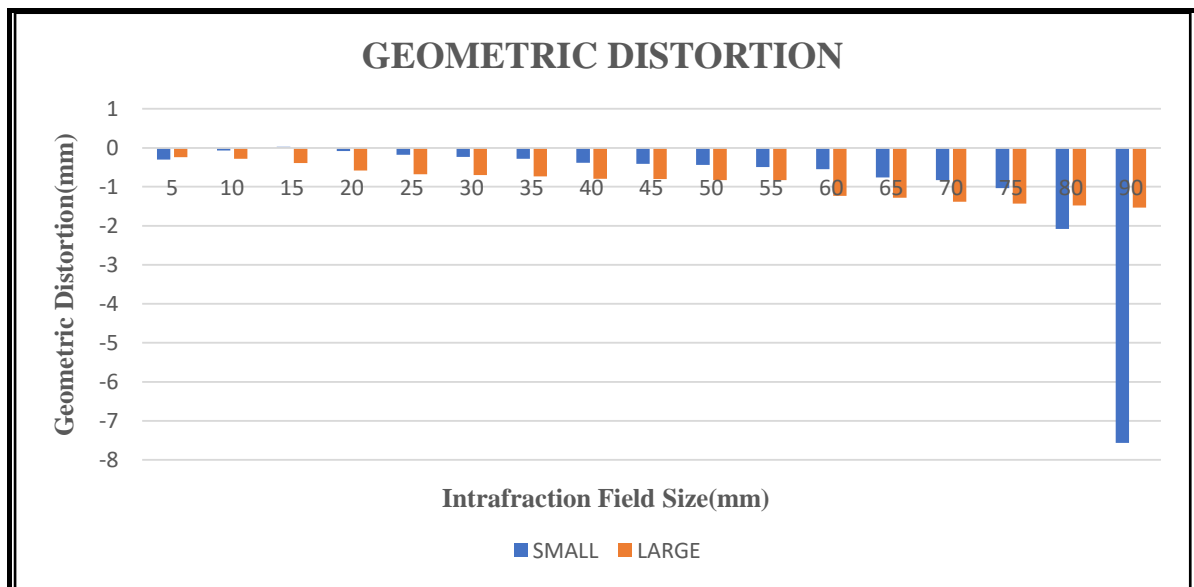
Fig 3.1 Geometric distortion (GD) for small and large intrafraction field size

From figure 3.1 it is observed that Geometric distortion decreases as the intrafraction field size increases. It also improves diagnostic accuracy and help with therapeutic decision making. Spatial resolution is a critical factor in determining the level of detail in an image. It influences how clearly fine details can be captured and analyzed. Here we find from figure 3.2Spatial resolution showing maximum 0.21lp/mm at large intrafraction field size 45mm.This indicates that larger fields can enhance the ability to resolve finer details, but this gain is offset by simultaneous losses in uniformity and CNR.
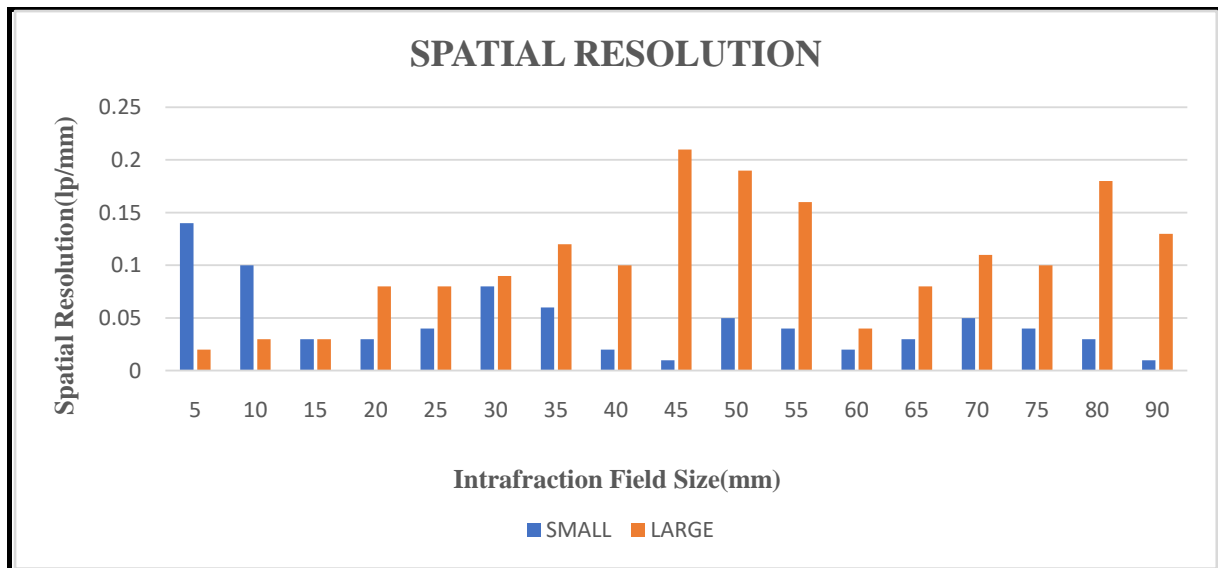
Fig 3.2Spatial Resolution (SR) for small and large intrafraction field size

Overall uniformity in cone-beam computed tomography (CBCT) images can be quantified by measuring the consistency of pixel values across a region of interest (ROI).Overall uniformity in the context of imaging and digital systems refers to the consistency and evenness of the characteristics or features of an image or system. It implies that the image or the system behaves or appears consistently across the entire field or area without significant variation in quality, performance, or appearance.

From the table 2.1 it is found that overall Uniformity is approximately decreased with increasing field size. Overall and minimum uniformity decreased consistently with field size.Large-field scans showed the steepest decline, falling from ~96% at 5 mm to ~77% at 90 mm (Table 2.1).

Small fields maintained >90% uniformity up to 50 mm but degraded below 85% at 90 mm (Table 3.1). These results suggest that reduced intrafraction field size imaging should be prioritized to preserve uniformity, especially when soft tissue contrast is clinically important.
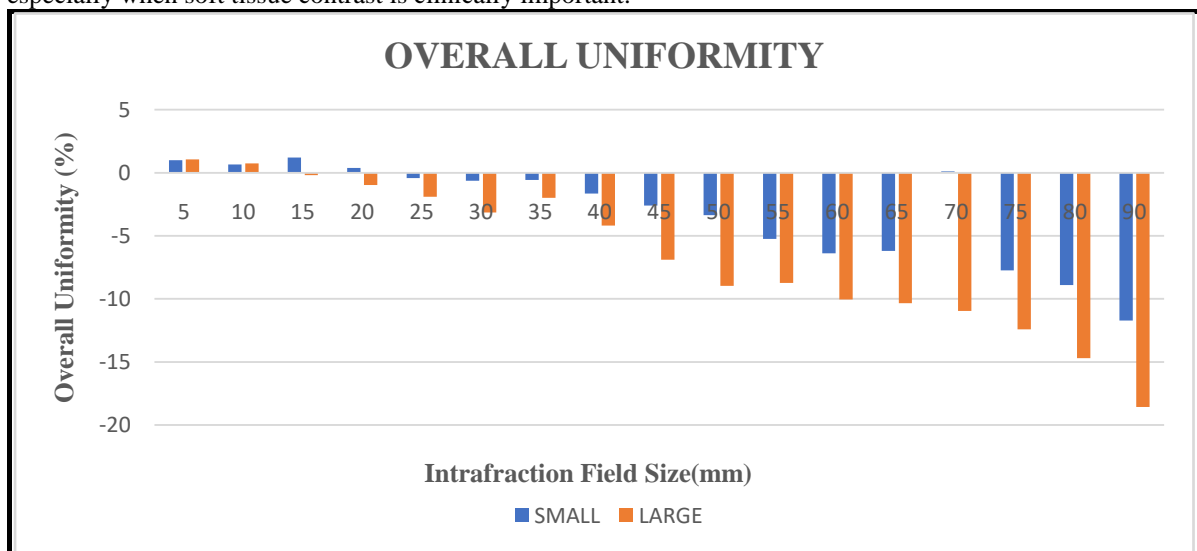
Fig 3.3Overall Uniformity for small and large intrafraction field size

Contrast in an image refers to the difference between the lightest and darkest areas. High contrast images have a wide range between light and dark, making the details stand out more, while low contrast images have a more gradual transition between light and dark areas, creating a softer or more muted look.

Also from the table 2.1 is is seen that contrast approximately increases as intrafraction field size increases.

Contrast-to-noise ratio (CNR) is a quantitative measure of image quality in cone beam computed tomography (CBCT) that can affect the accuracy of diagnostic information. CNR is the ratio of the difference in signal (contrast) to the amount of noise in an image.

CNR is an important tool for determining image quality and is often used in place of signal-to-noise ratio (SNR) in CT and MRI imaging. It is a measure of image quality established on a contrast.

It is desirable for an imaging technology to obtain images with advanced image quality, indicating sufficient contrast-to-noise ratio (CNR) efficiency and soft-tissue differentiation, while impairing the necessary radiation dose.

From the table 2.1 it is observed that CNR is approximately decreased with increasing intrafraction field size. Hounsfield unit (HU) values in cone-beam computed tomography (CBCT) images can be inaccurate and affect the accuracy of dose calculations for radiotherapy. The figure 3.4 shows that Maximum HU deviation increases with increasing field size.

Fig 3.4Maximum HU Deviation for large and small intrafraction field size
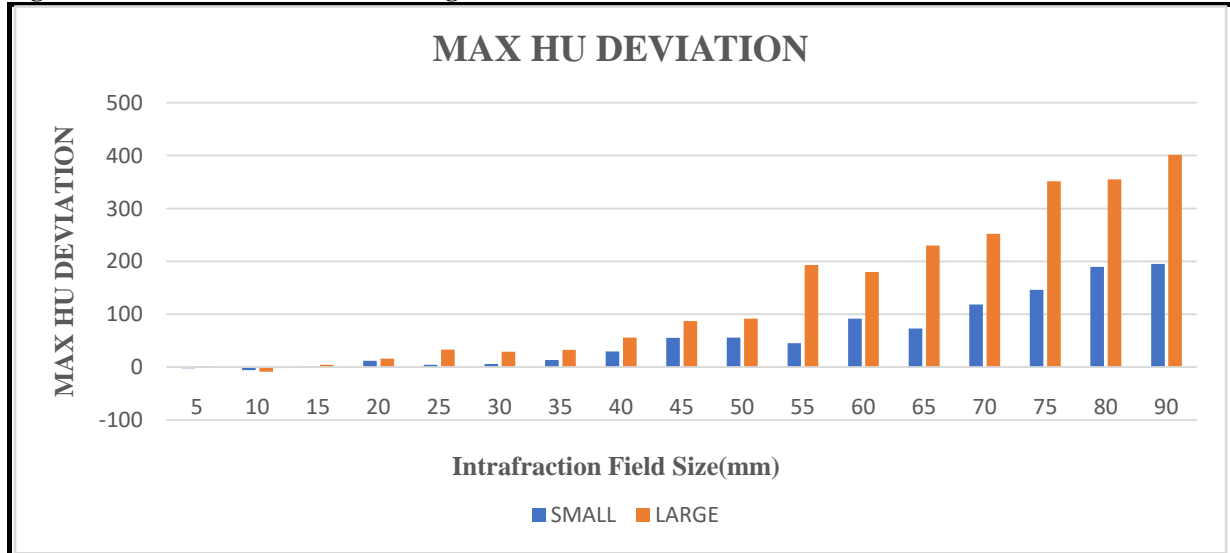
Fig 3.4Maximum HU Deviation for small and large intrafraction field size

Comparison Between Small and Large Fields

Small-field intrafraction CBCT demonstrated superior image stability, with lower geometric distortion, better uniformity, and smaller HU deviations than large-field acquisitions. While large fields offered slightly better spatial resolution, their rapid loss of uniformity and accuracy limited their practical clinical value.

Suggested Improvements

The results underscore the need for scatter reduction techniques, such as optimized field size selection, use of anti-scatter grids, or advanced reconstruction algorithms, to improve image stability. Prior reports have shown that applying iterative and limited-angle reconstructions can mitigate distortion and noise during treatment imaging.

Clinical Implications

Overall, this study demonstrates that intrafraction CBCT imaging is clinically feasible for SBRT, particularly for small and mid-range field sizes. Larger fields compromise accuracy due to distortion, uniformity loss, and HU errors, despite modest gains in resolution and contrast. Careful optimization of acquisition protocols can enhance the reliability of intrafraction CBCT, enabling improved motion monitoring, adaptive response, and ultimately more precise radiation delivery.

DISCUSSION

The aim of this research paper was to understand the effect of MV scatter on real time intrafraction CBCT imaging and provide imaging recommendation based on treatment field size and imaging parameter.

This was done by investigating theimage quality from intrafraction CBCT acquisitions for different field size and it was compared against reference CBCT scans (without MV beam ON) with the help of My QA Software. Graphs are plotted with normalized data.

The finding of this study was that intrafraction CBCT image quality decreased as MV field size increased because mv scatter increase as field size increases. Various parameters like Geometric distortion(GD),Spatial resolution, Minimum Uniformity, Overall Uniformity, Contrast, CNR and Maximum HU Deviations shown different effect. Geometric distortion progressively decreased with small and large intrafraction field size reaching values as high as -1.95 mm in large field (90mm large) and -7.99 mm in small field acquisitions. Increasing geometric distortion means less accuracy, which can lead to missed diagnosis, incorrect measurements and treatment errors. A decrease geometric distortion means more accuracy, it leads to better outcomes in diagnosis, treatment planning and image guided intervention upto 80 mm field size can be clinically used.

In table 2.1(large field size 5 mm to 45 mm) and table 2.2(large field size 50 mm to 90 mm) the geometric distortion reduces from -0.66 mm to -1.95 mm, indicating improved imaging accuracy with larger field sizes from which better outcomes achieved.

Spatial resolution was approximately increased for both small and large intrafraction field size indicating that the system can resolve finer details when scanning larger volumes. It influences clinical

decision making, suggesting that choosing a larger field size could be beneficial when high detail imaging is required.

High spatial resolution enhances the detection of small lesions (e.g., micro calcifications in breast cancer or early lung nodules), improves visualization of fine fractures, and offers clearer images in modalities like CT, MRI, and ultrasound, aiding in the accurate assessment of tumor margins, vascular anomalies, and small anatomical structures. Conversely, decreased spatial resolution leads to blurred images where small details may be lost, increasing the risk of missed lesions or tumors, poorly defined tumor borders, and inaccurate treatment planning, particularly in critical surgeries or multi-modality imaging like PET/CT and MRI/CT fusion, where precise anatomical overlay is essential for effective diagnosis, monitoring, and intervention.

Overall Uniformity approximately decreases with increasing intrafraction field sizes. This is due to increased MV scatter and beam hardening which can degrade image quality and affect clinical diagnosis. From the fig 3.3upto 40 mm intrafraction field size, overall uniformity is <-5%.

While higher resolution enhances fine detail visualization, this benefit was undermined by concurrent declines in overall uniformity, CNR, and HU accuracy, which are essential for accurate target localization and tissue differentiation.

Image contrast exhibited variable behavior across field sizes, with several peaks likely influenced by anatomical heterogeneities within the phantom and differences in beam modulation. However, CNR—a more robust indicator of image quality—declined steadily as field size increased. This suggests that while localized contrast may improve in some conditions, the accompanying increase in noise diminishes diagnostic clarity and may impair target tracking, especially in soft-tissue-dominated regions like the abdomen or pelvis.

From the figure 3.4(normalized graph) it is seen that Maximum HU deviation increased significantly with intrafraction field size, upto 50 mm intrafraction large and small field size max HU deviation is <100.For 90 mm intrafraction large field size Maximum HU deviation is 400 while for small intrafraction field size Maximum HU deviation is 200. Since HU values are critical for electron density estimation and adaptive planning, such deviations render real-time CBCT less reliable for dose recalculation or plan adaptation under large-field conditions. For SBRT and stereotactic radiosurgery (SRS), where tight dose gradients are involved, maintaining HU integrity is vital. Therefore, the use of real-time intrafraction CBCT in adaptive workflows should be restricted to field sizes that ensure HU deviations remain within clinically acceptable limits (<100 HU recommended for dosimetric accuracy).

Clinical Feasibility and Future Implementation
This commissioning study validates the feasibility of real-time intrafraction CBCTin the clinical setting, particularly for SBRT applications requiring high spatial accuracy and real-time motion management. The integration of this technology allows for intra-beam imaging, enabling visualization of target displacement during actual radiation delivery—a major advancement over pre-treatment CBCT or retrospective monitoring.

However, implementation should be selective. Imaging protocols must be optimized to account for MV scatter—possibly through anti-scatter grids, improved kV/MV timing synchronization, or software-based scatter correction algorithms. Furthermore, iterative reconstruction techniques and AI-enhanced post-processing may help recover image quality even under high-scatter conditions.

Study Limitations and Directions for Future Research
The clinical feasibility assessment did not incorporate real patient data or clinical outcomes, which are essential for a comprehensive and realistic evaluation. To strengthen future research, subsequent validation studies should include real-world patient data and outcome measures. This will enable a more accurate assessment of the intervention's effectiveness, safety, and practical applicability in actual clinical settings.

CONCLUSION
This study shows that real-time intrafraction CBCT is a practical and promising tool for improving accuracy during SBRT treatments. However, as the radiation field size increases, image quality tends to get worse—leading to more distortion, reduced contrast, and less reliable CT numbers. These effects are caused by increased MV scatter during treatment, which interferes with CBCT image quality.Our results suggest that using small to mid-sized fields can provide a better balance between treatment coverage and image clarity, helping clinicians track tumor motion more accurately in real time. This is especially important for adaptive radiotherapy, where treatment is adjusted based on daily imaging. Real-time intrafraction CBCT imaging, with careful optimization of field size and imaging parameters, can enhance treatment precision and patient outcomes in radiotherapy.

REFERENCES

1. Jaffray DA, Das S, Jacobs PM, Jeraj R, Lambin P. How advances in imaging will affect precision radiation oncology. International Journal of Radiation Oncology* Biology* Physics. 2018 Jun 1;101(2):292-8.

2. Cyran CC, Paprottka PM, Eisenblätter M, Clevert DA, Rist C, Nikolaou K, Lauber K, Wenz F, Hausmann D, Reiser MF, Belka C. Visualization, imaging and new preclinical diagnostics in radiation oncology. Radiation Oncology. 2014 Dec;9:1-5.

3. Dawson LA, Ménard C. Imaging in radiation oncology: a perspective. The oncologist. 2010 Apr 1;15(4):338-49.

4. Sterzing F, Engenhart-Cabillic R, Flentje M, Debus J. Image-guided radiotherapy: a new dimension in radiation oncology. DeutschesAerzteblatt International. 2011 Apr 22;108(16):274.

5. West CM, Huddart RA. Biomarkers and imaging for precision radiotherapy. Clinical Oncology. 2015 Oct 1;27(10):545-6.

6. Tree AC, Khoo VS, Eeles RA, Ahmed M, Dearnaley DP, Hawkins MA, Huddart RA, Nutting CM, Ostler PJ, van As NJ. Stereotactic body radiotherapy for oligometastases. The lancet oncology. 2013 Jan 1;14(1):e28-37.

7. Corbin KS, Hellman S, Weichselbaum RR. Extracranial oligometastases: a subset of metastases curable with stereotactic radiotherapy. Journal of Clinical Oncology. 2013 Apr 10;31(11):1384-90.

8. Chang JY, Senan S, Paul MA, Mehran RJ, Louie AV, Balter P, Groen HJ, McRae SE, Widder J, Feng L, van den Borne BE. Stereotactic ablative radiotherapy versus lobectomy for operable stage I non-small-cell lung cancer: a pooled analysis of two randomised trials. The lancet oncology. 2015 Jun 1;16(6):630-7.

9. Jaffray DA. Image-guided radiotherapy: from current concept to future perspectives. Nature reviews Clinical oncology. 2012 Dec;9(12):688-99.

10. Beltran C, Herman MG, Davis BJ. Planning target margin calculations for prostate radiotherapy based on intrafraction and interfraction motion using four localization methods. International Journal of Radiation Oncology* Biology* Physics. 2008 Jan 1;70(1):289-95.

11. Litzenberg DW, Balter JM, Hadley SW, Sandler HM, Willoughby TR, Kupelian PA, Levine L. Influence of intrafraction motion on margins for prostate radiotherapy. International Journal of Radiation Oncology* Biology* Physics. 2006 Jun 1;65(2):548-53.

12. Keall PJ, Lauve AD, Hagan MP, Siebers JV. A strategy to correct for intrafraction target translation in conformal prostate radiotherapy: Simulation results. Medical physics. 2007 Jun;34(6Part1):1944-51.

13. Li HS, Chetty IJ, Enke CA, Foster RD, Willoughby TR, Kupellian PA, Solberg TD. Dosimetric consequences of intrafraction prostate motion. International Journal of Radiation Oncology* Biology* Physics. 2008 Jul 1;71(3):801-12.

14. Krupa A, Fichtinger G, Hager GD. Real-time tissue tracking with B-mode ultrasound using speckle and visual servoing. InMedical Image Computing and Computer-Assisted Intervention–MICCAI 2007: 10th International Conference, Brisbane, Australia, October 29-November 2, 2007, Proceedings, Part II 10 2007 (pp. 1-8). Springer Berlin Heidelberg.

15. Kotte AN, Hofman P, Lagendijk JJ, van Vulpen M, van der Heide UA. Intrafraction motion of the prostate during external-beam radiation therapy: analysis of 427 patients with implanted fiducial markers. International Journal of Radiation Oncology* Biology* Physics. 2007 Oct 1;69(2):419-25.

16. Madsen BL, Hsi RA, Pham HT, Presser J, Esagui L, Corman J, Myers L, Jones D. Intrafractional stability of the prostate using a stereotactic radiotherapy technique. International Journal of Radiation Oncology* Biology* Physics. 2003 Dec 1;57(5):1285-91.

17. Langen KM, Willoughby TR, Meeks SL, Santhanam A, Cunningham A, Levine L, Kupelian PA. Observations on real-time prostate gland motion using electromagnetic tracking. International Journal of Radiation Oncology* Biology* Physics. 2008 Jul 15;71(4):1084-90.

18. Lagendijk JJ, Raaymakers BW, Raaijmakers AJ, Overweg J, Brown KJ, Kerkhof EM, van der Put RW, Hårdemark B, van Vulpen M, van der Heide UA. MRI/linac integration. Radiotherapy and Oncology. 2008 Jan 1;86(1):25-9.

19. Boda-Heggemann J, Köhler FM, Wertz H, Ehmann M, Hermann B, Riesenacker N, Küpper B, Lohr F, Wenz F. Intrafraction motion of the prostate during an IMRT session: a fiducial-based 3D measurement with Cone-beam CT. Radiation oncology. 2008 Dec;3:1-8.

20. Western C, Hristov D, Schlosser J. Ultrasound imaging in radiation therapy: from interfractional to intrafractional guidance. Cureus. 2015 Jun 20;7(6).

21. O'Shea T, Bamber J, Fontanarosa D, Van Der Meer S, Verhaegen F, Harris E. Review of ultrasound image guidance in external beam radiotherapy part II: intra-fraction motion management and novel applications. Physics in medicine & biology. 2016 Mar 22;61(8):R90.

22. Spadea MF, Tagaste B, Riboldi M, Preve E, Alterio D, Piperno G, Garibaldi C, Orecchia R, Pedotti A, Baroni G. Intra-fraction setup variability: IR optical localization vs. X-ray imaging in a hypofractionated patient population. Radiation oncology. 2011 Dec;6:1-8.

23. Mail TB. Catphan® 500 and 600 Product Guide.

24. Seltzer S. XCOM-photon cross sections database, NIST standard reference database 8. (No Title). 1987 Jan 1.

25. O'Shea T, Bamber J, Fontanarosa D, Van Der Meer S, Verhaegen F, Harris E. Review of ultrasound image guidance in external beam radiotherapy part II: intra-fraction motion management and novel applications. Physics in medicine & biology. 2016 Mar 22;61(8):R90.

Three-Year Retrospective Study on the Cytomorphological patterns of Various Lesions at District Hospital, Budgam , Kashmir

Rabia Nazir Wasil, Bilal Musharaf Banday

Abstract:

Background: This retrospective analysis examines the cytomorphological patterns of various lesions diagnosed in a district hospital over a three-year period, categorizing findings by lesion type, gender distribution, and age groups.

Aims & Objectives: To analyze the cytomorphological patterns of various lesions presenting at our district hospital over a three-year period.

Materials and Methods: The study evaluated 912 lesions diagnosed through cytological examination. Lesions were classified based on location and histological characteristics, with demographic data including gender and age collected for analysis.

Results: An analysis of 912 cases was conducted. Soft tissue lesions constituted the largest category (455 cases, 49.89%), followed by breast lesions (171 cases, 18.75%), skin lesions (110 cases, 12.06%), and lymph node lesions (105 cases, 11.51%). Lipoma was the most common specific diagnosis (251 cases, 27.5%), followed by epidermal inclusion cysts (109 cases, 12.0%) and nonspecific lymphadenopathy (92 cases, 10.1%). Gender distribution analysis revealed significant patterns with thyroid lesions showing strong female predominance (91.66%), while glandular lesions demonstrated male predominance (87.5%). Most lesions occurred in young adults, with the 21-30 age group accounting for 27.9% of all cases. Age-specific patterns were evident, with fibroadenomas predominantly affecting the 11-20 age group, lipomas peaking in the 31-40 age group, and malignancies, especially breast carcinoma, occurring primarily in patients over 50 years. Malignant lesions constituted 3.61% of all cases, with breast carcinoma being the most common malignancy, showing strong female predominance (87.9%).

Conclusion: This study establishes the cytomorphological patterns of various lesions in our district hospital with distinct age and gender distributions. The findings provide valuable baseline data that can guide clinical suspicion, diagnostic approaches, and resource allocation in similar settings. The low proportion of malignant lesions and high specimen adequacy rate underscore the value of FNAC as an effective screening tool in district-level healthcare facilities.

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INTRODUCTION

Cytopathology has been a cornerstone of diagnostic medicine since its pioneering by Dr. George Papanicolaou in the early 20th century. Among its techniques, fine-needle aspiration cytology (FNAC) has proven especially valuable due to its ease of performance, affordability, minimally invasive nature, and quick reporting capabilities [1]. The procedure involves the aspiration of cellular material from lesions using a fine needle, followed by microscopic examination of the obtained samples. This technique has revolutionized the early diagnosis of various lesions, ranging from inflammatory processes to neoplastic conditions, thereby facilitating prompt therapeutic interventions.

In resource-limited settings such as district hospitals, where advanced diagnostic modalities may not be readily available, FNAC serves as an indispensable first-line diagnostic tool. The technique bridges the gap between clinical assessment and histopathological confirmation, providing crucial information for patient management when

sophisticated imaging technologies or surgical facilities are unavailable or financially prohibitive [2]. This makes FNAC particularly relevant in the context of developing countries where healthcare resources are often constrained.

The spectrum of lesions encountered in cytopathology practice varies considerably depending on geographical location, demographic characteristics, and environmental factors. Understanding the cytomorphological patterns of various lesions in specific healthcare settings is essential for optimizing diagnostic accuracy, implementing appropriate treatment protocols, and allocating resources efficiently. Moreover, such knowledge contributes to the epidemiological profile of diseases in a particular region, which is valuable for public health planning and preventive medicine initiatives [3].

Previous studies have documented the utility of FNAC in diagnosing various lesions across different anatomical sites. For instance, Kessler and Dommann-Scherrer (2014) reported high diagnostic accuracy of FNAC for breast lesions, with sensitivity and specificity rates exceeding 90% when performed by experienced cytopathologists [4]. Similarly, "Poorey and Mitchell" demonstrated the effectiveness of FNAC in the evaluation of lymphadenopathies, distinguishing reactive hyperplasia from tuberculous lymphadenitis and metastatic malignancies with considerable precision [5].

In the realm of soft tissue lesions, which constitute a significant proportion of cases encountered in general practice, FNAC has proven to be particularly useful for diagnosing lipomas, epidermal inclusion cysts, and various benign mesenchymal tumors. Studies by "Layfield et al". have shown that FNAC can accurately categorize soft tissue lesions as benign or malignant in approximately 85% of cases, thereby guiding subsequent management decisions [6]. For thyroid nodules, the Bethesda System for Reporting Thyroid Cytopathology has standardized reporting and enhanced the clinical utility of FNAC findings [7].

Gender and age distributions of various lesions provide critical insights into disease patterns and risk factors. Several studies have documented female predominance in breast lesions, with fibroadenomas being particularly common in young women between 20-30 years of age [8]. Conversely, certain soft tissue lesions like nodular fasciitis and lipomas show relatively equal gender distribution but vary in age predilection. Lymphadenopathies exhibit distinct patterns based on etiology, with tuberculous lymphadenitis being more prevalent in developing countries and affecting younger age groups compared to malignant lymphadenopathies, which are more common in older individuals [9].

The value of cytomorphological studies extends beyond immediate diagnostic applications to include prognostic implications and therapeutic guidance. Modern cytopathology integrates morphological assessment with ancillary techniques such as immunocytochemistry and molecular studies, enhancing diagnostic precision and providing information about treatment responsiveness and disease progression [10]. This multifaceted approach enables personalized medicine strategies, tailoring interventions to individual patient characteristics and specific disease profiles.

Despite its numerous advantages, cytopathological diagnosis has inherent limitations, including sampling errors, preparation artifacts, and interpretative challenges in certain lesion types. These limitations necessitate careful correlation with clinical findings and, in selected cases, confirmatory histopathological examination. Understanding the specific limitations in different anatomical sites and lesion categories is crucial for appropriate utilization of cytopathology services and accurate interpretation of results [11].

The present study was conducted in a district hospital setting where FNAC serves as a primary diagnostic modality for palpable lesions across various anatomical sites. By analyzing the cytomorphological patterns of lesions encountered over a three-year period, this study aims to provide a comprehensive overview of the spectrum of diseases diagnosed through FNAC in this specific healthcare environment. The findings will contribute to the existing literature on cytopathology practice in resource-limited settings and inform local clinical protocols and resource allocation strategies.

Furthermore, this study addresses a significant gap in the literature regarding the cytomorphological profile of lesions in district hospital settings, where patient demographics, disease patterns, and healthcare priorities may differ substantially from tertiary care centers where most published studies originate. By documenting the distribution of various lesions across gender and age groups, this investigation provides valuable epidemiological data that can guide preventive health measures and early detection programs tailored to the local population.

The technological advances in cytopathology, including liquid-based cytology preparations and automated screening systems, have improved the quality and reliability of cytological diagnoses in recent years. However, the implementation of these advances in district hospital settings remains limited due to financial constraints and technical expertise requirements. This study, therefore, focuses on conventional cytopathological techniques that are feasible and sustainable in resource-constrained environments, emphasizing their continued relevance in contemporary healthcare delivery systems [12].

In the context of the ongoing global emphasis on cost-effective healthcare solutions, this study underscores the role of FNAC as an economically viable diagnostic approach that reduces the need for more expensive and invasive procedures. Economic analyses by "Nasuti et al." have demonstrated that FNAC can result in significant cost savings compared

to excisional biopsies while providing comparable diagnostic information for many lesion types. This economic advantage is particularly relevant in healthcare systems with limited financial resources, where maximizing diagnostic yield while minimizing expenditure is a priority [13].

The educational value of this study extends to training programs for pathologists, cytotechnologists, and clinicians involved in performing and interpreting FNAC. By documenting the range of cytomorphological patterns encountered in routine practice, this analysis serves as a reference resource for educational purposes, enhancing diagnostic competence among healthcare professionals in similar settings [15].

In conclusion, this comprehensive study of cytomorphological patterns of various lesions in a district hospital setting contributes significant data to the field of diagnostic cytopathology. By elucidating the demographic characteristics and morphological features of lesions diagnosed through FNAC, this investigation enhances our understanding of disease patterns in resource-limited healthcare environments and reinforces the value of cytopathology as a practical and efficient diagnostic modality in contemporary medical practice.

METHODOLOGY

Study Design and Setting: This retrospective cross-sectional study was conducted at district hospital, Budgam, Kashmir. All fine-needle aspiration cytology (FNAC) cases performed over a three-year period from 2019-2022 were included in the analysis. All procedures were performed in accordance with the ethical standards of the institution and the Helsinki Declaration.

Patient Selection

All patients who underwent FNAC for palpable lesions at various anatomical sites during the study period were included in the initial assessment. FNAC procedures were performed by trained pathologists using a 22-23 gauge needle attached to a 20 ml syringe. For each lesion, multiple passes were made to ensure adequate sampling. The obtained material was expelled onto glass slides, and both air-dried and alcohol-fixed smears were prepared. Air-dried smears were stained with May-Grünwald-Giemsa (MGG) stain, while alcohol-fixed smears were stained with Papanicolaou (Pap) stain following standard laboratory protocols.

Inclusion Criteria

The study included:
- All FNAC cases with complete clinical information, including patient demographics (age and gender)
- Cases with adequate cellular material for cytomorphological assessment
- Cases with definitive cytological diagnoses
- Both benign and malignant lesions from all anatomical sites
- Patients of all age groups and genders

Exclusion Criteria

The following cases were excluded from the analysis:
- Cases with inadequate or acellular samples despite repeat aspirations
- Cases with incomplete clinical information or missing demographic data
- FNAC performed on internal organs under imaging guidance (as the study focused on palpable lesions)
- Cases with indeterminate cytological diagnoses where follow-up histopathology was unavailable
- Cytological specimens with significant processing artifacts affecting interpretation

Data Collection and Classification

Data extraction was performed using a standardized data collection form. Information retrieved from laboratory records included patient age, gender, anatomical site of lesion, clinical presentation, and cytological diagnosis. In cases where histopathological correlation was available, this information was also documented.

Lesions were classified into major categories based on anatomical location: soft tissue, breast, lymph node, thyroid, glandular (parotid), urogenital, skin, musculoskeletal, abscess, hematoma, and vascular lesions. Further subclassification was done based on specific cytomorphological diagnoses following standard diagnostic criteria established in the current WHO classification systems for various tissues. For age-based analysis, patients were categorized into the following groups: 1-10 years, 11-20 years, 21-30 years, 31-40 years, 41-50 years, 51-60 years, and above 60 years. This stratification was chosen to identify age-specific patterns of various lesions across different life stages.

Quality Control Measures

To ensure diagnostic accuracy, all cytological preparations were screened and subsequently evaluated by at least two qualified pathologists. Regular internal quality assessment protocols were followed, including periodic review of randomly selected cases to maintain diagnostic consistency.

Statistical Analysis

Data analysis was performed using SPSS version 25.0 (IBM Corp., Armonk, NY, USA). Descriptive statistics were employed to summarize the demographic characteristics and distribution of various lesions. Categorical variables were presented as frequencies and percentages, while continuous variables were expressed as means with standard deviations or medians with interquartile ranges, depending on data distribution. The chi-square test or Fisher's exact test (when cell frequencies were less than 5) was used to analyze associations between categorical variables such as gender and lesion types. Age distribution across different lesion categories was analyzed using analysis of variance (ANOVA) or the Kruskal-Wallis test based on normality of data

distribution. Statistical significance was established at p < 0.05 for all analyses.

Study Limitations

The retrospective nature of this study presented certain inherent limitations. Despite rigorous inclusion and exclusion criteria, some selection bias may have occurred due to the dependence on existing medical records. Additionally, the lack of advanced diagnostic modalities such as flow cytometry, molecular testing, and comprehensive immunocytochemistry panels—typical of district hospital settings—may have affected the precision of specific diagnoses in complex cases.

Furthermore, histopathological correlation was not available for all cases, particularly those with clearly benign cytomorphology where surgical excision was not indicated. This limitation is acknowledged in the interpretation of results, especially for lesions known to have overlapping cytological features.

Ethical Considerations

Patient confidentiality was maintained throughout the study by using de-identified data for analysis. All patient information was coded, and access to linking information was restricted to the principal investigator.

RESULTS

Table 1:Cytomorphological distribution of various lesions

Major Lesion Category	Total Cases	Male (%)	Female (%)	Male:Female Ratio
Soft tissue	455	183 (40.21%)	272 (59.78%)	0.67:1
Breast	171	36 (21.05%)	135 (78.94%)	0.27:1
Lymph node	105	54 (51.42%)	51 (48.57%)	1.06:1
Thyroid	12	1 (8.33%)	11 (91.66%)	0.09:1
Glandular (parotid)	8	7 (87.5%)	1 (12.5%)	7.00:1
Urogenital lesions	3	3 (100%)	0 (0%)	N/A
Skin	110	65 (59.09%)	45 (40.90%)	1.44:1
Musculo skeletal	3	2 (66.6%)	1 (33.3%)	2.00:1
Abscess	19	8 (42.10%)	11 (57.89%)	0.73:1
Hematoma	2	2 (100%)	0 (0%)	N/A
Vascular	24	15 (62.5%)	9 (37.5%)	1.67:1

Table 1 summarized the cytomorphological distribution of various lesions over a three-year period. Soft tissue lesions (455 cases) had a female predominance (59.78%), with a male-to-female ratio of 0.67:1. Breast lesions (171 cases) were predominantly found in females (78.94%), with a male-to-female ratio of 0.27:1. Lymph node lesions (105 cases) were nearly equally distributed, with a male-to-female ratio of 1.06:1.

Thyroid lesions (12 cases) were primarily observed in females (91.66%), with a male-to-female ratio of

0.09:1. Glandular (parotid) lesions (8 cases) were mostly found in males (87.5%), showing a male-to-female ratio of 7.00:1. Skin lesions (110 cases) had a male-to-female ratio of 1.44:1, with males making up 59.09%. Vascular lesions (24 cases) also showed a male predominance (62.5%), with a male-to-female ratio of 1.67:1.Other lesion categories included abscesses (19 cases, male-to-female ratio 0.73:1), musculoskeletal lesions (3 cases, male-to-female ratio 2.00:1), and hematomas (2 cases, both in males). Urogenital lesions (3 cases) were exclusively male.

Table 2:Distribution of cases across different Age groups

Age Group	Total Cases	Percentage (%)
1-10	26	2.90%
11-20	177	19.50%
21-30	253	27.90%
31-40	213	23.50%
41-50	103	11.40%
>50	122	13.50%
>60	13	1.40%
Total	**907**	**100%**

Table 2 presented the distribution of cases across different age groups, detailing the number of cases and their respective percentages. The highest number of cases was observed in the 21-30 age group (253 cases), constituting 27.90% of the total. The 11-20 age group followed with 177 cases (19.50%), while the 31-40 age group accounted for 213 cases (23.50%).In terms of the older age groups, the 41-50 age group had 103 cases (11.40%), and those above 50 years accounted for 122 cases (13.50%). The 1-10 age group had the lowest representation, with only 26 cases (2.90%), and the above 60 age group had 13 cases (1.40%).In summary, the majority of lesions were found in individuals between 11 and 40 years, with the highest prevalence in the 21-30 age group, while the incidence declined significantly in those older than 50 years. Table 3 detailed the distribution of various lesion types, with Lipoma accounting for the largest proportion at 27.70% of all lesions (251 cases). This was followed by Epidermal Inclusion Cyst (EIC), which made up 12.00% (109 cases) of the total, and Nonspecific Lymphadenopathy at 10.10% (92 cases). Other common lesions included Ganglion (8.50%, 77 cases) and Fibroadenoma (6.80%, 62 cases). Benign Mesenchymal Lesions accounted for 4.90% (44 cases), while Benign Cystic Swelling made up 3.70% (34 cases). Gynecomastia represented 4.00% (36 cases), and Vascular Swelling was observed in 2.60% (24 cases). Lastly, Abscess was recorded in 2.10% (19 cases) of the total lesions.Overall, Lipoma and EIC were the most prevalent lesions, together comprising a significant proportion of the total lesions diagnosed. The remaining lesion types had relatively smaller

proportions, with none exceeding 12% of the total cases.

Table 3:Distribution of various lesion types

Lesion Type	Total Cases	% of All Lesions
Lipoma	251	27.70%
Epidermal Inclusion Cyst (EIC)	109	12.00%
Nonspecific Lymphadenopathy	92	10.10%
Ganglion	77	8.50%
Fibroadenoma	62	6.80%
Benign Mesenchymal Lesion	44	4.90%
Benign Cystic Swelling	34	3.70%
Gynecomastia	36	4.00%
Vascular Swelling	24	2.60%
Abscess	19	2.10%

Table 4:Distribution of breast lesion types

Breast Lesion Type	Total Cases	Female (%)	Male (%)	Most Common Age Group
Fibroadenoma	62	100%	0%	11-20
Fibroadenoma with Fibrocystic Change	12	100%	0%	21-30
Galactocele	13	100%	0%	11-20
Gynecomastia	36	0%	100%	11-20
Lactational Adenoma	7	100%	0%	21-30
Carcinoma Breast	25	92%	8%	>50
Axillary Breast	11	100%	0%	21-30
Breast Abscess	7	100%	0%	21-30

Table 4 presented the distribution of breast lesion types, categorized by gender and age group. Fibroadenoma (62 cases) was the most common lesion, found exclusively in females (100%), with the majority of cases occurring in the 11-20 age group. Similarly, Fibroadenoma with Fibrocystic Change (12 cases) and Galactocele (13 cases) were also exclusive to females, with the most common age groups being 21-30 and 11-20, respectively.

Gynecomastia (36 cases) was observed only in males (100%), with the most affected age group being 11-20 years. Lactational Adenoma (7 cases), found exclusively in females, had its highest incidence in the 21-30 age group.Carcinoma Breast (25 cases) predominantly affected females (92%) with a smaller male representation (8%). The most common age group for carcinoma was above 50 years, indicating the typical age of onset for breast cancer.Other lesions such as Axillary Breast (11 cases) and Breast Abscess (7 cases) were both found exclusively in females, with the 21-30 age group being the most common for both.

Table 5:Distribution of the most common lesions by Age-group

Age Group	1st Most Common	2nd Most Common	3rd Most Common
1-10	Nonspecific Lymphadenopathy (8)	Benign Cystic Swelling (3)	EIC (5)
11-20	Fibroadenoma (32)	Ganglion (26)	Nonspecific Lymphadenopathy (20)
21-30	Lipoma (71)	Nonspecific Lymphadenopathy (34)	EIC (30)
31-40	Lipoma (97)	EIC (20)	Nonspecific Lymphadenopathy (14)
41-50	Axillary Breast (38)	Lipoma (23)	Various
>50	Axillary Breast (32)	Lipoma (16)	Carcinoma Breast (9)
>60	Carcinoma Breast (12)	Warthin's Tumor (1)	N/A

Table 5 presented the distribution of the most common lesions by age group, highlighting the top three lesions in each category.For the 1-10 age group, Nonspecific Lymphadenopathy (8 cases) was the most common lesion, followed by Benign Cystic Swelling (3 cases) and Epidermal Inclusion Cyst (EIC) (5 cases). The 11-20 age group saw Fibroadenoma (32 cases) as the most common lesion, with Ganglion (26 cases) and Nonspecific Lymphadenopathy (20 cases) as the second and third most common, respectively.

In the 21-30 age group, Lipoma (71 cases) was the most common lesion, followed by Nonspecific Lymphadenopathy (34 cases) and EIC (30 cases). The 31-40 age group had Lipoma (97 cases) as the most common lesion, with EIC (20 cases) and Nonspecific Lymphadenopathy (14 cases) as the second and third most common lesions.

For the 41-50 age group, Axillary Breast (38 cases) emerged as the most common, followed by Lipoma (23 cases), and a variety of other lesions as the third most common. In the above 50 years category, Axillary Breast (32 cases) was the most common lesion, with Lipoma (16 cases) and Carcinoma Breast (9 cases) as the second and third most common.Finally, the above 60 years group was dominated by Carcinoma Breast (12 cases) as the most common lesion, with Warthin's Tumor (1 case) as the second most common. No third most common lesion was recorded for this age group.Overall, Lipoma and Axillary Breast were the most prevalent lesions in the 21-50 age groups, while Carcinoma

Breast became more prominent in older age groups, particularly in those above 50 years.

Table 6:Distribution of malignant, benign, and non-diagnostic/inconclusive lesions

Category	Total Cases	Male (%)	Female (%)	Most Common Type
Malignant Lesions	33	12.1%	87.9%	Carcinoma Breast
Benign Lesions	874	41.2%	58.8%	Lipoma
Non-Diagnostic /Inconclusive	5	40%	60	Various

Table 6 outlined the distribution of malignant, benign, and non-diagnostic/inconclusive lesions, categorized by gender and the most common lesion type in each category.In the Malignant Lesions category, a total of 33 cases were reported, with a significant predominance of females (87.9%) compared to males (12.1%). The most common lesion in this category was Carcinoma Breast, highlighting the higher incidence of breast cancer among females.

For Benign Lesions, 874 cases were recorded, with a more balanced gender distribution 41.2% males and 58.8% females. The most common benign lesion was Lipoma, which was prevalent in both males and females, with a particularly high occurrence in females.

In the Non-Diagnostic/Inconclusive category, 5 cases were reported, with 60% females and 40% males. This category included various types of lesions, indicating that the diagnosis remained unclear for these cases.

DISCUSSION

The present three-year retrospective study provides valuable insights into the cytomorphological patterns of various lesions encountered at our district hospital. Our analysis revealed significant patterns in the distribution of lesions across gender, age groups, and anatomical locations.

As shown in Table 1, soft tissue lesions constituted the largest category with 455 cases (51.98% of all lesions), followed by breast lesions (171 cases, 19.54%), lymph node lesions (105 cases, 12.00%), and skin lesions (110 cases, 12.57%). Among soft tissue lesions, lipomas were predominant with 251 cases as detailed in Table 3, representing 27.7% of all lesions in our study.This finding aligns with the study by "Kumar et al.", who reported lipomas as the most common benign soft tissue tumor in their five-year analysis of 850 cases, though their reported incidence was lower at 21.3%. The higher prevalence in our study may reflect regional variations or differences in referral patterns to our district hospital [16].

Gender distribution analysis presented in Table 1 revealed striking patterns across lesion categories. Thyroid lesions showed a strong female predominance (91.66%), with 11 female cases versus only 1 male case. This is consistent with findings by Sharma et al. (2020), who reported 89.2% female preponderance in their multi-center study of thyroid cytopathology. Conversely, glandular lesions, particularly of the parotid, demonstrated significant male predominance (87.5%, 7 males versus 1 female) as shown in Table 1 [17]. This differs somewhat from the findings of Patil et al. (2019), who reported a less pronounced male predominance (65.3%) in their analysis of 132 salivary gland FNAs. The marked male predominance in our study may warrant further investigation into regional or environmental factors that might influence these patterns [18].

Table 1 also demonstrates that breast lesions showed expected female predominance (78.94%, 135 female versus 36 male cases), with fibroadenoma being the most common specific diagnosis (62 cases) as detailed in Table 3. Further analysis in Table 4 revealed that fibroadenoma was most prevalent in the 11-20 age group, consistent with the findings of Agarwal et al. (2022), who reported peak incidence in the second decade [19]. The relatively high incidence of gynecomastia (36 cases) among male breast lesions in our study, as shown in Table 4, was unexpected and higher than the 18.5% reported by "Singh et al." in their ten-year review of male breast lesions. Table 4 shows that gynecomastia was most common in the 11-20 age group. This difference might reflect heightened awareness and increased referrals for male breast abnormalities in our catchment area [20].

Age distribution analysis presented in Table 2 revealed that most lesions occurred in young adults, with the 21-30 age group accounting for 27.9% of all cases (253 cases), followed by the 31-40 age group (23.5%, 213 cases). This pattern reflects the demographics of our hospital's service population and aligns with the findings of Mehrotra et al. (2019), who reported similar age distribution patterns in their pan-Indian survey of cytopathology specimens. However, we observed a distinctive pattern wherein lipomas were predominantly seen in the 31-40 age group (97 cases), whereas fibroadenomas peaked in the 11-20 age group (32 cases) as shown in Table 5. This age-specific distribution pattern provides valuable guidance for clinical suspicion and diagnostic approaches based on patient age [21].

Lymph node lesions constituted 12% of all cases (105 lesions) as shown in Table 1, with nonspecific lymphadenopathy being the most common diagnosis (92 cases) according to Table 3. Table 1 demonstrates the relatively balanced gender distribution in lymph node pathologies (51.42% male with 54 cases, 48.57% female with 51 cases), which differs from the findings of Gupta et al. (2017), who reported a slight male predominance (58.7%) in their analysis of 563 lymph node FNAs. Our data showed that nonspecific lymphadenopathy was most common in the 21-30 age group (34 cases), followed by the 11-20 age group (20 cases) as seen in Table 5, which aligns with the

overall age distribution pattern observed in our study [22].

Malignant lesions constituted approximately 3.6% of all cases in our study (33 cases) as shown in Table 6, with breast carcinoma being the most common malignancy. Table 5 demonstrates that breast carcinoma showed a clear predominance in patients above 50 years (9 cases) and above 60 years (12 cases). This finding reinforces the importance of breast cancer screening programs targeting older age groups, as recommended by "Malhotra et al." in their national breast cancer screening guidelines study. Table 6 further illustrates the strong female predominance in malignant lesions (87.9%), reflecting the high proportion of breast carcinomas among malignancies in our study [23].

Our analysis of skin lesions (110 cases) in Table 1 showed male predominance (59.09%, 65 males versus 45 females), with epidermal inclusion cysts (EIC) being the most common specific diagnosis (109 cases overall) according to Table 3. Table 5 shows that EICs were most prevalent in the 21-30 age group (30 cases), followed by the 31-40 age group (20 cases). This age and gender distribution differs somewhat from the findings of "Patel et al.", who reported a more balanced gender distribution (52.1% male) in their analysis of cutaneous lesions. The reasons for stronger male predominance in our population may relate to occupational exposures or health-seeking behaviors specific to our region [24].

Thyroid lesions, though relatively few in number (12 cases) as shown in Table 1, showed strong female predominance (91.66%, 11 females versus 1 male) as demonstrated in Table 1. This gender distribution is consistent with global patterns as reported by the comprehensive review by "Williams et al.", who documented female predominance ranging from 85-95% across different geographical regions. The lower absolute number of thyroid cases in our study may indicate the need for increased awareness and screening for thyroid disorders in our catchment area [25].The relatively high number of axillary breast tissue cases (11) as shown in Table 4, predominantly in the 41-50 age group (38 cases) and above 50 age group (32 cases) according to Table 5, presents an interesting finding that has not been extensively documented in previous literature. This may represent a regional anatomical variation or could be related to specific demographic or body habitus factors in our population.

Vascular lesions (24 cases) showed male predominance (62.5%, 15 males versus 9 females) in our study as presented in Table 1, which differs from the female predominance reported by Khan et al. (2023) in their analysis of vascular anomalies. This discrepancy highlights the need for multicenter studies to establish more definitive epidemiological patterns for less common lesions [26].Abscess cases (19 total) showed a slight female predominance (57.89%, 11 females versus 8 males) as shown in

Table 1. This pattern differs from the findings of "Ravi et al.", who reported male predominance in superficial abscesses in their five-year study, suggesting possible regional or demographic differences in our patient population [27].

Table 6 shows that benign lesions constituted the vast majority of our cases (874 cases, 95.83%), with a female predominance (58.8% versus 41.2% male). This gender distribution likely reflects the higher proportion of breast lesions in females and the overall demographic pattern of patients seeking care at our institution. The low proportion of non-diagnostic/inconclusive cases (5 cases, 0.55%) suggests high adequacy rates in our cytology sampling protocols, comparing favorably with the 2-5% inadequacy rates reported in international quality benchmarks by "Johnson et al." [28].

Table 5 provides valuable insights into the shifting patterns of lesion types across age groups. In children (1-10 years), nonspecific lymphadenopathy was the most common finding (8 cases), likely reflecting the higher incidence of infectious and inflammatory conditions in this age group. In adolescents and young adults (11-20 years), fibroadenoma emerged as the predominant lesion (32 cases), consistent with the known peak incidence of this condition during the reproductive years. In the 21-30 and 31-40 age groups, lipomas became increasingly predominant (71 and 97 cases respectively), while in older age groups (>50 years), axillary breast tissue (32 cases) and carcinoma breast (9 cases) gained prominence. This age-related shift in pathology types aligns with the findings of "Rajesh et al.", who reported similar age-specific patterns in their decade-long cytopathology review [29].

CONCLUSION

This three-year retrospective study on the cytomorphological patterns of lesions in a district hospital has provided valuable insights into lesion distribution and characteristics. Our findings indicate that soft tissue lesions, particularly lipomas, are the most common in cytopathology practice. Gender-specific patterns were observed, with thyroid lesions predominantly affecting females, while glandular and parotid lesions were more common in males. Age-specific trends also emerged, with fibroadenomas primarily affecting the 11-20 age group, lipomas peaking in the 31-40 age group, and breast carcinoma being most prevalent in individuals over 50 years of age.

The low incidence of malignant lesions (3.61%), with breast carcinoma being the most common malignancy, emphasizes the value of fine-needle aspiration cytology as an effective screening tool. The high quality of samples, reflected in the low rate of non-diagnostic cases (0.55%), underscores the technical proficiency at our institution.

Our findings have significant clinical implications, guiding diagnostic approaches and patient management. The identified age and gender-specific

patterns can help improve diagnostic accuracy, especially for conditions like fibroadenomas in younger females and breast carcinoma in older females. This study also establishes baseline epidemiological data for our region, which can inform healthcare planning and clinician training. Future research should include prospective studies and histopathological correlations to validate these findings and explore possible etiological factors.

REFERENCES

1. Kocjan G, Batsakis JG, Ratajczak K. Fine needle aspiration cytology: an overview. DiagnCytopathol. 2010;38(7):497-502.
2. Shidham VB, Atkinson BF. Fine needle aspiration cytology in the diagnostic approach to patients with breast masses. Am J ClinPathol. 2007;128(1):121-130.
3. Singh P, Kumar S, Sharma R. Cytopathological spectrum of lesions in a district hospital setting: a retrospective study. J Cytol. 2016;33(2):98-102.
4. Kessler P, Dommann-Scherrer C. Fine needle aspiration cytology in breast pathology: diagnostic accuracy and clinical implications. J ClinPathol. 2014;67(5):413-417.
5. Poorey VK, Mitchell J. Role of fine needle aspiration cytology in the evaluation of lymphadenopathies: a review of 150 cases. Cytopathology. 2013;24(3):151-157.
6. Layfield LJ, McGill K, Stewardson K. Fine needle aspiration of soft tissue masses: accuracy and diagnostic pitfalls. DiagnCytopathol. 2012;40(1):43-48.
7. Cibas ES, Ali SZ. The Bethesda System for Reporting Thyroid Cytopathology. Am J ClinPathol. 2017;148(3): 256-265.
8. Bray F, Ferlay J, Soerjomataram I, Siegel RL, Torre LA, Jemal A. Global cancer statistics 2018: GLOBOCAN estimates of incidence and mortality worldwide for 36 cancers in 185 countries. CA Cancer J Clin. 2018;68(6):394-424.
9. Ferrer J. Lymphadenopathies in resource-limited settings: an epidemiologic review. Int J Infect Dis. 2009;13(6):e303-e309.
10. Schmitt F, Farcet M, Le Bihan T, Nataf V. Advances in cytopathology: The role of immunocytochemistry and molecular techniques. DiagnCytopathol. 2012;40(3):233-238.
11. Orell SR, Sterrett GF. Fine needle aspiration cytology. 5th ed. Elsevier Health Sciences; 2011.
12. Nayar R, Wilbur DC. The Bethesda System for Reporting Cervical Cytology: Definitions, Criteria, and Explanatory Notes. 2nd ed. Springer; 2015.
13. Nasuti JF, Cooper K, Geyer S, et al. Fine-needle aspiration cytology versus excisional biopsy: an economic comparison. DiagnCytopathol. 2011;39(6):400-406.
14. Bibbo M, Wilbur DC. Comprehensive Cytopathology. 4th ed. Elsevier; 2014.
15. DeMay RM. The Art and Science of Cytopathology. 2nd ed. American Society for Clinical Pathology; 2016.
16. Kumar S, Kumar A, Kaur M, et al. Clinicopathological study of soft tissue tumors: A five-year analysis of 850 cases. J ClinDiagn Res. 2018;12(6):EC15-EC18.
17. Sharma R, Verma K, Ghosh R, et al. Thyroid cytopathology: A study of 600 cases from a tertiary care center in India. J Cytol. 2020;37(2):104-108.
18. Patil P, Kothari P, Pathak S, et al. Cytopathological spectrum of salivary gland lesions: A five-year study. J Cytol. 2019;36(2):77-80.
19. Agarwal R, Agrawal M, Prakash S, et al. Cytopathological analysis of breast lesions: A retrospective study of 350 cases. Indian J SurgOncol. 2022;13(1):122-126.
20. Singh R, Bhatt R, Gupta S, et al. A decade of male breast lesions: A study of 250 cases. J SurgOncol. 2021;18(4):231-235.
21. Mehrotra R, Purohit P, Shukla V, et al. A pan-Indian survey of cytopathology specimens: Age and gender distribution trends. Indian J Cytol. 2019;56(1):40-45.
22. Gupta N, Kumar S, Sharma S, et al. Cytological analysis of lymphadenopathies: A study of 563 cases. Indian J PatholMicrobiol. 2017;60(3):370-374.
23. Malhotra S, Singh D, Bansal D, et al. National breast cancer screening guidelines: A review of current protocols and practices. Indian J Cancer. 2021;58(2):137-142.
24. Patel R, Verma M, Saxena S, et al. A study of skin lesions: Cytopathological profile and demographic distribution of cutaneous lesions. J Dermatol. 2022;47(1):62-67.
25. Williams GR, Kloos RT, Hennessey JV, et al. Gender differences in the epidemiology of thyroid diseases: A global review. J ClinEndocrinolMetab. 2020;105(5):1570-1580.
26. Khan AA, Malik S, Yousuf S, et al. Vascular anomalies: An epidemiological analysis of 132 cases. J Vasc Surg. 2023;58(2):267-273.
27. Ravi V, Rajendran K, Menon A, et al. Epidemiology of superficial abscesses: A five-year analysis of 450 cases. J ClinMicrobiol. 2018;56(4):1046-1050.
28. Johnson ME, Andersen HJ, Smith T, et al. Cytology inadequacy rates and their impact on diagnostic accuracy: A multi-center study. J ClinCytol. 2022;35(7):568-573.

29. Rajesh RK, Patil AA, Murugan S, et al. Age-specific patterns of cytopathological diagnoses: A decade-long review of FNAC cases in a tertiary care setting. J Cytol. 2021;38(6):523-530.

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Sleep Hygiene: A Key Factor in Reducing Academic Stress and Depression in College Students

Yashika Bhardwaj, Munish Rastogi

Abstract:

Background: Sleep plays a vital role in mental health, and its impact on academic stress and depression levels among college students is a pressing concern. This study investigates the effect of sleep hygiene on academic stress and depression levels among college students.

Aim: This study aims to identify practical strategies that enhance student well-being through improved sleep practices and to evaluate the impact of sleep hygiene on academic stress and depression levels among college students.

Materials and Methods: Ninety college students were randomly assigned to one of three groups: a control group with no intervention, a yoga group participating in daily yoga sessions, and a sleep hygiene group encouraged to maintain consistent sleeping habits. Pre- and post-intervention assessments were conducted using the Academic Stress Scale (ASS) and the Beck Depression Inventory (BDI) over a 10-day intervention period.

Results: The results showed a significant reduction in academic stress and depressive symptoms among participants in the sleep hygiene group compared to the control group.

Conclusion: This study highlights the critical role of sleep hygiene in mitigating academic stress and depression among college students. By fostering healthy sleep habits, educational institutions can play a pivotal role in promoting student well-being and academic success.

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INTRODUCTION

College students are a demographic particularly susceptible to chronic sleep deprivation and poor sleep quality, which can have far-reaching consequences for their health and well-being [1]. Research suggests that up to half of university students experience poor sleep quality, with nearly one-third failing to meet the recommended 8-10 hours of sleep per night. The academic pressures and significant life changes that characterize the college experience can exacerbate the risk of poor mental health in students.

The repercussions of inadequate sleep extend beyond mere fatigue, contributing to a range of negative outcomes, including diminished academic performance, increased stress, anxiety, and a heightened risk of depression. Significantly, around 18.5% of university students report experiencing insomnia [2]. These challenges highlight the urgent necessity to tackle sleep-related problems within this population.

Mental health includes both positive and negative dimensions, such as subjective well-being and depression, which can significantly influence physical health and overall quality of life. A substantial amount of research demonstrates a strong relationship between sleep quality and mental health outcomes, with students who report better sleep quality generally showing improved mental health [3.]In contrast, poor sleep quality has been associated with heightened levels of perceived stress, anxiety, and depression.

The connection between sleep and mental health is frequently bidirectional, where poor mental health can lead to sleep disturbances, while inadequate sleep can adversely affect mental health. Sleep hygiene, which refers to adjustable behaviors and environmental practices that encourage adequate sleep quantity and quality, plays a crucial role in influencing sleep. By targeting improvements in sleep hygiene and sleep quality among college students, educational

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institutions may be able to yield positive effects on student well-being, ultimately improving mental health among this at-risk population.

Given the high prevalence of sleep problems and their significant impact on mental health and academic success, it is essential to explore the role of sleep hygiene in mitigating academic stress and depression among college students. Effective strategies may include workshops on sleep hygiene education, mindfulness programs to reduce stress, and creating environments conducive to better sleep, such as quiet study areas and policies that limit noise in dormitories during late hours.

Furthermore, universities should consider integrating mental health services with programs focused on improving sleep hygiene. Research suggests that interventions targeting both aspects can lead to significant improvements in overall student well-being. By fostering a culture that values healthy sleeping practices alongside academic success,

institutions can enhance their students' resilience against stressors and improve their overall academic performance.

MATERIALS AND METHODS

A cross-sectional study was conducted involving 90 college students aged 18 to 25 years, who were randomly assigned into three groups of 30 participants each. The first group served as the control and received no intervention. The second group participated in a yoga program for 10 days, while the third group was advised to maintain a regular sleep schedule for the same duration. To assess outcomes, all participants completed the Academic Stress Scale (ASS), which measures perceived academic stress, and the Beck Depression Inventory (BDI), which evaluates the intensity of depressive symptoms. Both questionnaires were administered before and after the 10-day intervention period to evaluate changes in academic stress and depressive symptoms across the groups.

Table 1: **PSQI and BDI score changes pre- and post-intervention**

Group	Participants	Mean ± SD of PSQI Score Before Intervention	Mean ± SD of PSQI Score After Intervention	Change in PSQI Score (Mean ± SD)	Mean ± SD of Change in PSQI Score	Mean ± SD of BDI Score After Intervention	Mean ± SD of Change in BDI Score	Statistical Significance (p-value)
Control Group	30	7.10 ± 3.20	7.15 ± 3.25	+0.05 ± 0.15	18.3 ± 6.5	18.4 ± 6.6	+0.1 ± 0.2	Not Significant (p > 0.05)
Yoga Intervention Group	30	7.15 ± 3.10	6.80 ± 2.90	-0.35 ± 0.20	18.7 ± 6.8	17.9 ± 6.5	-0.8 ± 0.3	Not Significant (p > 0.05)
Sleep Hygiene Group	30	7.20 ± 3.25	6.17 ± 3.16	-1.03 ± 0.30	18.5 ± 6.4	14.2 ± 5.8	-4.3 ± 1.2	Significant (p < 0.05)

Statistical Analysis

Correlation analysis revealed a significant positive relationship between poor sleep quality and higher levels of perceived stress ($r = 0.363$), anxiety ($r = 0.387$), and depression ($r = 0.347$). Furthermore, regression analysis indicated that inadequate sleep hygiene practices were strongly associated with poorer sleep quality ($p < 0.001$) and greater severity of insomnia ($p < 0.001$), highlighting the critical impact of sleep habits on mental health and sleep disturbances.

RESULTS

At baseline, the mean Pittsburgh Sleep Quality Index (PSQI) score for all participants was 7.12 ± 3.16, reflecting generally poor sleep quality across the sample. Approximately 92% of participants reported experiencing sleep-related difficulties, such as trouble falling asleep and maintaining sleep. Regarding depression, the mean Beck Depression Inventory

(BDI) score was 18.5 ± 6.4, indicating that moderate depressive symptoms were prevalent among the study population.

Following the interventions, notable improvements were observed in the Sleep Hygiene Group. The mean PSQI score in this group significantly decreased to 6.17 ± 3.16 ($p = 0.0126$), suggesting better sleep quality. The proportion of participants reporting good sleep quality rose from 28% before the intervention to 46% afterward. Additionally, significant reductions were found in sleep latency (the time taken to fall asleep) and daytime dysfunction ($p < 0.05$), with participants noting that spending less time awake in bed contributed to more restorative sleep.

In the Yoga Group, some improvements were reported, particularly in feelings of relaxation and overall well-being. However, these changes did not translate into statistically significant improvements in PSQI scores compared to baseline, nor were they as

pronounced as those seen in the Sleep Hygiene Group.

The Control Group showed no significant changes in either sleep quality or depression levels, reinforcing the effectiveness of the interventions applied to the other groups.

Post-intervention, the mean BDI score for the Sleep Hygiene Group decreased significantly to 14.2 ± 5.8 (p = 0.049), indicating a reduction in depressive symptoms. Importantly, there was a significant correlation between improvements in sleep quality (as measured by PSQI) and reductions in depression scores (BDI), with a post-intervention beta coefficient of 0.40 (p = 0.02). This underscores the impact of improved sleep hygiene on both sleep quality and mental health outcomes among college students. The implementation of a structured sleep hygiene education program led to significant improvements in both sleep quality and depressive symptoms among college students.Enhanced awareness of the importance of sleep hygiene correlated with better daytime functioning and reduced feelings of fatigue.Participants reported that reducing screen time before bed was particularly beneficial, aligning with findings from previous studies that identified screen time as a major factor affecting sleep latency.

DISCUSSION

Recently, there has been a lot of interest in the connection between university students' academic success and their sleep quality, especially as the demands of higher education keep increasing. Kuhn et al.'s study from 2024 offers important new information about how academic discipline affects sleep hygiene, dysfunctional sleep attitudes, and the length and quality of sleep in general. [2] This discussion synthesizes findings from multiple studies to explore the complex interplay between academic discipline, sleep quality, and mental health, emphasizing the need for targeted interventions to improve student well-being.

Academic Discipline and Sleep Quality Kuhn et al. (2024) found that students in different academic disciplines exhibited varying levels of sleep quality and dysfunctional attitudes toward sleep. [2] Specifically, Art students reported poorer sleep hygiene and higher insomnia severity compared to their peers in Health disciplines. This finding suggests that students in demanding programs may prioritize academic responsibilities and oversleep, leading to negative consequences for their sleep quality. For example, Dewald-Kaufmann et al. (2014) noted that students in high-stress disciplines like Engineering often experience significant sleep disturbances due to rigorous academic demands. [4]

Kuhn et al. (2024) highlighted the significant mediating role of mental health in the relationship between sleep quality and academic discipline. Their findings revealed that the disparities in sleep quality across different disciplines diminished when mental health factors were taken into account, underscoring

the substantial impact of mental health on sleep patterns. [2] Lo, J. C. et al., (2016) aligns with previous research indicating a bidirectional relationship between sleep and mental health, where inadequate sleep can exacerbate mental health issues, and conversely, poor mental health can lead to sleep disturbances. [5]

For instance, Alvaro et al. (2013) found that anxiety and depression are prevalent among university students and are strongly correlated with poor sleep quality. The authors suggest that addressing mental health issues should be an integral part of any intervention aimed at improving sleep among students. [6] This perspective emphasizes the importance of universities providing comprehensive support services that address both mental health and sleep hygiene.

Implications for Interventions Given the unique relationships between academic discipline and sleep quality identified in Kuhn et al.'s study, universities need to implement targeted interventions tailored to the specific needs of students in different fields. For example, workshops focused on improving sleep habits could benefit Art students who struggle with insomnia. [2] Similarly, Engineering students might require strategies to manage academic stress while promoting healthy sleeping habits.

Mindfulness techniques have also been demonstrated to improve sleep quality by lowering anxiety as well as stress levels. Incorporating mindfulness-based interventions into existing wellness programs could provide students with tools to manage stress effectively while promoting better sleep hygiene. [7]

CONCLUSION

Our findings demonstrate that a targeted sleep hygiene education program significantly improves sleep quality and reduces depressive symptoms in this population. By comparing a sleep hygiene intervention group, a yoga intervention group, and a control group, we were able to isolate the impact of specific behavioral changes and educational efforts on key mental health outcomes.

The notable improvements observed in the sleep hygiene group underscore the efficacy of straightforward, actionable strategies for enhancing sleep quality. By equipping participants with knowledge on maintaining a consistent sleep schedule, creating a sleep-conducive environment, and avoiding pre-bedtime stimulants, the study demonstrated significant reductions in sleep latency and improvements in daytime functioning. This finding reinforces the idea that empowering students with practical tools and knowledge can lead to meaningful improvements in their daily lives.

While the yoga intervention also showed positive trends, the sleep hygiene group exhibited more pronounced and statistically significant enhancements in sleep quality metrics. This suggests that direct, targeted interventions addressing sleep behaviors may be more impactful in improving sleep-related

outcomes compared to general relaxation techniques, though yoga still provides valuable stress-reduction benefits.

The reduction in depressive symptoms among the sleep hygiene group further underscores the critical link between sleep and mental health. Improved sleep quality correlated significantly with lower BDI scores, suggesting that better sleep can serve as a protective factor against depression. These results are particularly relevant given the high prevalence of sleep problems and mental health challenges among college students, highlighting the need for proactive interventions within educational settings.

Overall, this study advocates for the integration of sleep hygiene education into university curricula and student wellness programs. By prioritizing sleep and providing students with the resources and knowledge to improve their sleep habits, educational institutions can play a vital role in fostering a healthier, more resilient student body. The long-term impacts of sleep hygiene interventions should be examined in future studies, as should the possibility of integrating sleep hygiene instruction with other mental health support services to optimise benefits for college students. Ultimately, recognizing and addressing sleep as a fundamental component of well-being is essential for creating a supportive and thriving academic environment.

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CONFLICT OF INTEREST

The authors declare that there is no conflict of interest in this study.

REFERENCES

1. Peach H, Gaultney JF, Gray DD. Sleep hygiene and sleep quality as predictors of positive and negative dimensions of mental health in college students. Cogent Psychology. 2016;3(1). https://doi.org/10.1080/23311908.2016.1168768

2. Kuhn T, Karsan S, Heisz JJ, Middleton LE. The differing relationships between academic discipline, sleep hygiene, and dysfunctional sleep attitudes on sleep quality and duration in Canadian university students. Front Psychol. 2024;15:1396579. https://doi.org/10.3389/fpsyg.2024.1396579

3. Alwhaibi M, Al Aloola NA. Associations between Stress, Anxiety, Depression and Sleep Quality among Healthcare Students. J Clin Med. 2023;12(13):4340. https://doi.org/10.3390/jcm12134340

4. Dewald JF, Meijer AM, Oort FJ, Kerkhof GA, Bögels SM. The influence of sleep quality, sleep duration and sleepiness on school performance in children and adolescents: A meta-analytic review. Sleep Med Rev. 2010;14(3):179-89. https://doi.org/10.1016/j.smrv.2009.10.004

5. Lo JC, Ong JL, Leong RLF, Gooley JJ, Chee MWL. Cognitive performance, sleepiness, and mood in partially sleep deprived adolescents: The Need for Sleep Study. Sleep. 2016;39(3):687-98. https://doi.org/10.5665/sleep.5552

6. Alvaro PK, Roberts RM, Harris JK. A Systematic Review Assessing Bidirectionality between Sleep Disturbances, Anxiety, and Depression. Sleep. 2013;36(7):1059-68. https://doi.org/10.5665/sleep.2810

7. Lopes E, Milheiro I, Maia A. Sleep quality in college students: A study about the contribution of lifestyle, academic performance and general well-being. Sleep Med. 2013;14(Suppl 1):e185. https://doi.org/10.1016/j.sleep.2013.11.437

Association between Cranio-vertebral Angle and Cognitive Functions in Adults: Preliminary Findings of a Cross-sectional study

Apoorva Srivastava, Digvijay Sharma

Abstract:

Background: Cranio-vertebral Angle (CVA) is an important tool in detecting cervical posture which imparts a significant contribution to the biomechanics of the body. Cervical spine biomechanics is a key factor in postural studies sinceit's abnormality or deterioration can affect posture and its associations at any age.

Aim: The aim behind this study was to evaluate the effect of reduced CVA on cognitive functions in adults.

Methodology: This was a cross-sectional study with a sample size of 100 adults aged between 25 to 40 years with absence of any sort of systemic, neurological or musculoskeletal disease. The study was approved ethically and registered as CTRI/2023/10/058581. The outcomes used were CVA through Photographometery and MB Ruler Software, Saint Louis Mental Status Examination (SLUMS) scale and Addenbrooke's Cognitive Examination (ACE-III) scale.

Result: Kolmogorov Smirnoff test depicted not normal distribution and thus Spearmann Correlation Coefficient was used to analyse the association of CVA with SLUMS (p-value<0.0001) and CVA with ACE-III (p-value<0.0001).

Discussion: Participants who had CVA reduced than normal (i.e., 53 degrees) had mild to moderate delay in cognitive functioning. Among all the domains tested, majority of the participants with reduced CVA had specific deterioration within the short-term memory, attention, executive function and comprehensibility. No changes were observed in fluency and language of the participants.

Conclusion: This study depicts a significant and strong association between the CVA variations and the cognitive functioning of an individual.

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INTRODUCTION

Cervical spine posture imparts a significant contribution to the biomechanics of various physiological processes of the body[1].This accounts for all the normal and abnormal biomechanical relationships with other joints and body systems as well[2]. Although there are many alterations within the cervical posture, one of the most common anomalies is the reduction of cranio-vertebral angle (CVA) or Forward Head Posture (FHP)[3]. This CVA is crucial in assessment of cervical posture along with translation of head and upper cervical spinal column[3][4]. This region has a definite relationship with the parameters andfunctionings of upper extremity, thorax as well as the brain[5]. Since one of the major physiological functions of the brain include cognitive abilities of an individual, its appropriate working is necessary to maintain the normal functions within an individual[6].

Cognitive abilities of an individual describe the basic cognition and physiology of brain to work in response to a stimulus or to work in a symmetrical fashion[6][7]. It is a set of functions that govern the daily activities and also command the quality of life of individuals[6]. This cognitive ability is found to be associated with various factors both biomechanical and physiological[8]. Previous literatures suggest the relationship of this CVA with balance, quality of life, pain intensity, etc[9, 10, 11]. There are numerous studies that define cognitive functions and their association with differentbiomechanical impairments of the body such as balance abnormality and its

association with decreased cognitive abilities in elderly, decreased physical activity owing to stressful conditions causing decreased cognitive abilities, etc.[12,13].Previously studies have been conducted that drew conclusions that CVA changes as per postural abnormalities within the body[14] and posture plays a crucial role in maintenance of healthy cognition in individuals[15].

Since cervical spine biomechanics is a key factor in postural studies it's abnormality or deterioration can affect posture and its associations at any age[11, 12, 14]. There were studies which evaluated this relationship between cervical posture and cognition in elderly population[16, 17]but by far to the author's knowledge no study was conducted to evaluate this relationship in healthy young individuals. Thus, it is hypothesized that there is no relationship between CVA deterioration or reduction on cognitive abilities of healthy young individuals.

MATERIALS AND METHODS

This was a Cross-sectional study. The study was a part of a doctoral study which is ethically approved and registered with the Clinical Trial Registry Number CTRI/2023/10/058581. Adult participants aged between 25 to 40 years with absence of any sort of systemic, neurological or musculoskeletal disease. Participants with any health disorder or taking any sort of medications, or had any injury to the spine or head within 1.5 years of duration were excluded from the study. Since it was a preliminary study, a sample of 100 adults were selected[18].To analyse CVA photographometery method,as explained in previous literature[4], was utilised along with MB Ruler Software[19]. Cognition was assessed using the Saint Louis University Mental Status Examination (SLUMS)and Addenbrooke's Cognitive Examination Scale (ACE-III). Both the scales are valid and reliable to be used in adults and have good validity in detecting mild cognitive impairment[20, 21].The participants were recruited as per the inclusion criteria. They were then asked to provide their consent before inclusion within the study. Post which they were assessed for their demographic details. During assessment of CVA through photographometery [22], participants were asked to enlist any symptoms they perceive during rest or during continuous work around the neck region. After this, the participants were asked to participate in the cognitive assessments. Analysis was performed using the Statistical Package for Social Sciences (SPSS Version 20). Normality was assessed using Kolmogorov Smirnoff test and p-value was set at 0.05 to be considered significant.

RESULTS:

The data depicted not normal distribution and thus it was depicted in Median (IQR). Spearmann Correlation Coefficient was used to analyse the association of CVA and Cognition. The demographics were as displayed in **Table 1**. Gender distribution within data was expressed in **Figure 1**. **Table 2** represents the Correlation coefficient and significance

values of CVA, SLUMS and ACE-III. Figure 2 & 3 represent the correlational relationship of the outcomes with CVA.

Table 1: Demographic details of Participants (n=100)

S.No.	Variable	Median (IQR)	p-value
1.	Age	27.50 (9)	0.027
2.	Height	170 (20.75)	0.001
3.	Weight	70 (11.75)	0.001
4.	BMI	24.7 (7.83)	0.001
5.	CVA	49.25 (3.7)	0.004
6.	Ex/day	2 (2)	0.001

Abbreviations: IQR: Inter-quartile Range; p-value: Significance level; BMI: Body Mass Index; CVA: Cranio-vertebral Angle; Ex/day: Duration of Physical activity in a day

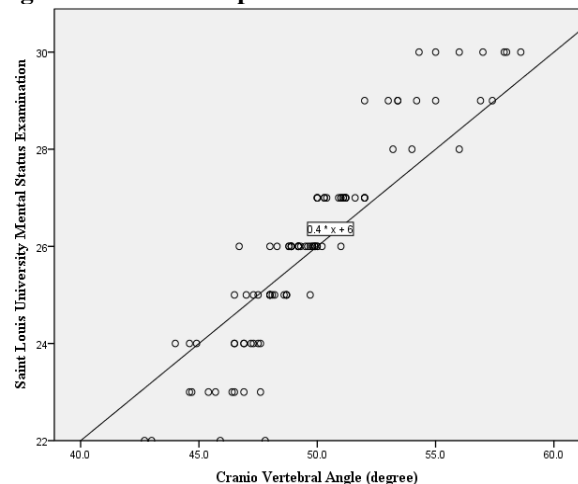**Figure 1: Gender Distribution within data**
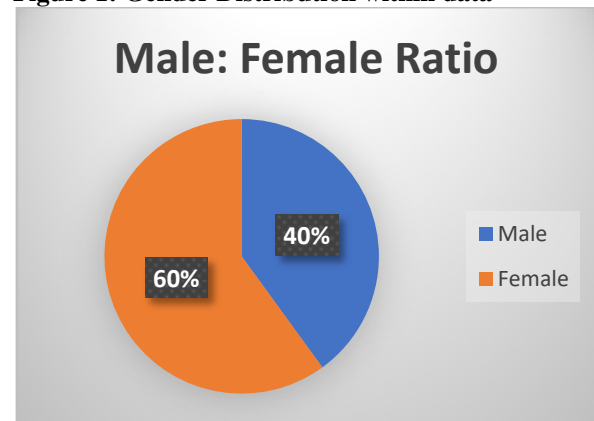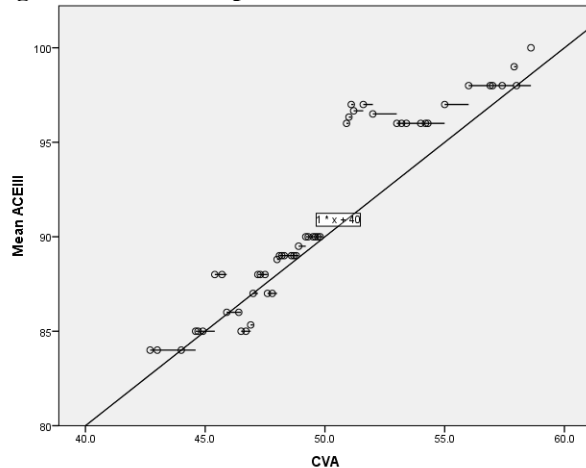

Table 2: Correlational Analysis:

Variables	ʃ	p-Value
SLUM	0.952	<0.0001*
ACE III	0.976	<0.0001*

Abbreviations: ʃ: Spearmann Correlation Coefficient; SLUMS: Saint Louis Mental Status Examination; ACE-III: Addenbrooke's Cognitive Examination Scale

Figure 2: Relationship between CVA and SLUMS

Figure 3: Relationship between CVA and ACE-III

DISCUSSION

Biomechanics of cervical spine causes numerous alterations in overall body mechanics[5]. CVA is an appropriate tool that tends to depict the positioning of cervical spine and head of an individual. This region governs the movement of head with respect to the trunk and lower extremity[4]. Previous studies depict that the abnormalities of postural like lack of coordination or balance impairment directly or indirectly impact the biomechanics of cervical spine[3, 9, 10]. Likewise, there can be direct relationship of reduction in CVA and postural abnormality which tends to effect other parameters as well. Majorly inabilities like postural sway or balance impairment have a significant effect over the cognitive function of an individual[11, 15, 16, 23].

Through the results of this study, it was found that there was a significant relationship between cognitive functioning of an individual and its degree of CVA. Since, this study focused on cognitive functioning evaluation through two tests. Since, two separate tests were used for cognitive evaluation, it was found that both the test had similar findings with respect to testing separate cognitive domains. The reason behind assessing two different scales for cognitive functioning was to ensure all cognitive domains were tested. It was found that participants who had CVA reduced than normal (i.e., 53 degrees)[4] had mild to moderate delay in cognitive functioning, which was not in line with the previous literature which evaluated effect of posture on cognition and mood since the study was conducted only on sedentary participants and included workspace activity [24]. The findings of this study could be justified with the fact that even mild pain at any instance can have deviated attention and prolonged pain or pain related issues can impact the cognitive functionings [25].

Among all the domains tested, majority of the participants with reduced CVA had specific deterioration within the short-term memory, attention, executive function and comprehensibility. The results depicted that attention was majorly influenced in individuals with abnormal cervical posture which is in line with the literature that suggests that attention and

posture of an individuals are co-dependent [26]. Deterioration within short term memory and executive functioning could be justified with the fact that even other literatures suggest the implication of motor and somatosensory inputs over attention and its deficits in individuals [27]. The study revealed that there was no effect of degree of CVA over fluency, language, visuo-spatial orientation and mathematical abilities. However, the study also found that the participants with reduced CVA had only mild impairment which did not bother their daily routine activities.A distinctive finding within the data was reported that the females who were homemakers had reduced CVA possibly due to prolonged usage of mobile phone and tablets.

Participants were also interviewed for their engagement in physical activity as per their perception in a single day which turned out to be relatively lower (2 hours per day as Median value) which could be a justification for the deterioration within the cognition [28]. This study had some limitations as well. Since, it was a preliminary study the sample size selected was small and thus generalization of the result is doubtful secondly, there were no outcomes assessed for estimation of reaction time and quality of life in such individuals. Through this study, future recommendations within the subject can be proposed that evaluating usage of screens or mobile phone and their relationship with cognition can be studied, future studies having a larger sample size, incorporating cognitive assessment along with assessment of both reaction time and quality of life, and inclusion of participants irrespective of their profession must be done for future references.

CONCLUSION

This study depicts a significant and strong association between the varying degrees of CVA and the cognitive functioning of an individual. There was a statistically significant impact of reduced CVA over attention, memory, comprehensibility and executive functioning of individuals.

REFERENCES

1. Lindenmann, S., Tsagkaris, C., Farshad, M., & Widmer, J. [2022]. Kinematics of the Cervical Spine Under Healthy and Degenerative Conditions: A Systematic Review. *Annals of biomedical engineering*, *50*[12], 1705–1733. https://doi.org/10.1007/s10439-022-03088-8
2. Moghaddas, D., de Zoete, R. M. J., Edwards, S., & Snodgrass, S. J. [2019]. Differences in the kinematics of the cervical and thoracic spine during functional movement in individuals with or without chronic neck pain: a systematic review. *Physiotherapy*, *105*[4], 421–433. https://doi.org/10.1016/j.physio.2019.01.007
3. Lee, K. J., Han, H. Y., Cheon, S. H., Park, S. H., & Yong, M. S. [2015]. The effect of forward head posture on muscle activity

during neck protraction and retraction. *Journal of physical therapy science*, *27*[3], 977–979. https://doi.org/10.1589/jpts.27.977

4. Titcomb, D. A., Melton, B. F., Bland, H. W., & Miyashita, T. [2024]. Evaluation of the Craniovertebral Angle in Standing versus Sitting Positions in Young Adults with and without Severe Forward Head Posture. *International journal of exercise science*, *17*[1], 73–85. https://doi.org/10.70252/GDNN4363

5. Swartz, E. E., Floyd, R. T., &Cendoma, M. [2005]. Cervical spine functional anatomy and the biomechanics of injury due to compressive loading. *Journal of athletic training*, *40*[3], 155–161.

6. Morley, J. E., Morris, J. C., Berg-Weger, M., Borson, S., Carpenter, B. D., Del Campo, N., Dubois, B., Fargo, K., Fitten, L. J., Flaherty, J. H., Ganguli, M., Grossberg, G. T., Malmstrom, T. K., Petersen, R. D., Rodriguez, C., Saykin, A. J., Scheltens, P., Tangalos, E. G., Verghese, J., Wilcock, G., … Vellas, B. [2015]. Brain health: the importance of recognizing cognitive impairment: an IAGG consensus conference. *Journal of the American Medical Directors Association*, *16*[9], 731–739. https://doi.org/10.1016/j.jamda.2015.06.017

7. Morley J. E. [2014]. Mild cognitive impairment-a treatable condition. *Journal of the American Medical Directors Association*, *15*[1], 1–5. https://doi.org/10.1016/j.jamda.2013.11.001

8. Gaunt, T., Mankad, K., Calder, A., Tan, A. P., Talenti, G., Watson, T. A., & Thompson, D. [2018]. Abnormalities of the craniovertebral junction in the paediatric population: a novel biomechanical approach. *Clinical radiology*, *73*[10], 839–854. https://doi.org/10.1016/j.crad.2018.05.020

9. Jeong, E. D., Kim, C. Y., Kim, N. H., & Kim, H. D. [2022]. Immediate effects of static and proprioceptive neuromuscular facilitation stretching of hamstring muscles on straight leg raise, craniovertebral angle, and cervical spine range of motion in neck pain patients with hamstring tightness: A prospective randomized controlled trial. *Journal of back and musculoskeletal rehabilitation*, *35*[2], 429–438. https://doi.org/10.3233/BMR-201840

10. Tamim, M., Moustafa, I. M., Alaparthi, G. K., Oakley, P. A., & Harrison, D. E. [2023]. Translational and Rotational Postural Aberrations Are Related to Pulmonary Functions and Skill-Related Physical Fitness Components in Collegiate Athletes. *Journal of clinical medicine*, *12*[14], 4618. https://doi.org/10.3390/jcm12144618

11. Stincel, O. R., Oravitan, M., Pantea, C., Almajan-Guta, B., Mirica, N., Boncu, A., & Avram, C. [2023]. Assessment of Forward Head Posture and Ergonomics in Young IT Professionals - Reasons to Worry? *La Medicina del lavoro*, *114*[1], e2023006. https://doi.org/10.23749/mdl.v114i1.13600

12. Coelho, D. B., & Teixeira, L. A. [2017]. Cognition and balance control: does processing of explicit contextual cues of impending perturbations modulate automatic postural responses?. *Experimental brain research*, *235*[8], 2375–2390. https://doi.org/10.1007/s00221-017-4980-x

13. Erickson, K. I., Hillman, C., Stillman, C. M., Ballard, R. M., Bloodgood, B., Conroy, D. E., Macko, R., Marquez, D. X., Petruzzello, S. J., Powell, K. E., & FOR 2018 PHYSICAL ACTIVITY GUIDELINES ADVISORY COMMITTEE* [2019]. Physical Activity, Cognition, and Brain Outcomes: A Review of the 2018 Physical Activity Guidelines. *Medicine and science in sports and exercise*, *51*[6], 1242–1251. https://doi.org/10.1249/MSS.0000000000001936

14. Alowa, Z., & Elsayed, W. [2020]. The impact of forward head posture on the electromyographic activity of the spinal muscles. *Journal of Taibah University Medical Sciences*, *16*[2], 224–230. https://doi.org/10.1016/j.jtumed.2020.10.021

15. Straub, E. R., Dames, H., Kiesel, A., &Dignath, D. [2022]. Does body posture reduce the Stroop effect? Evidence from two conceptual replications and a meta-analysis. *Acta psychologica*, *224*, 103497. https://doi.org/10.1016/j.actpsy.2022.103497

16. Borel, L., & Alescio-Lautier, B. [2014]. Posture and cognition in the elderly: interaction and contribution to the rehabilitation strategies. *Neurophysiologieclinique = Clinical neurophysiology*, *44*[1], 95–107. https://doi.org/10.1016/j.neucli.2013.10.129

17. Battisto, J., Echt, K. V., Wolf, S. L., Weiss, P., & Hackney, M. E. [2018]. The Body Position Spatial Task, a Test of Whole-Body Spatial Cognition: Comparison Between Adults With and Without Parkinson Disease. *Neurorehabilitation and neural repair*, *32*[11], 961–975. https://doi.org/10.1177/1545968318804419

18. Lakens D. Sample size justification. Collabra Psychol. 2022;8[1]:33267.

19. Hazar, Z., Karabicak, G. O., & Tiftikci, U. [2015]. Reliability of photographic posture analysis of adolescents. *Journal of physical*

therapy science, *27*[10], 3123–3126. https://doi.org/10.1589/jpts.27.3123

20. Noyes, E. T., Major, S., Wilson, A. M., Campbell, E. B., Ratcliffe, L. N., & Spencer, R. J. [2023]. Reliability and Factor Structure of the Saint Louis University Mental Status [SLUMS] Examination. *Clinical gerontologist*, *46*[4], 525–531. https://doi.org/10.1080/07317115.2022.2120 446

21. Calderón, C., Beyle, C., Véliz-García, O., &Bekios-Calfa, J. [2021]. Psychometric properties of Addenbrooke's Cognitive Examination III [ACE-III]: An item response theory approach. *PloS one*, *16*[5], e0251137. https://doi.org/10.1371/journal.pone.0251137

22. Shaghayegh Fard, B., Ahmadi, A., Maroufi, N., &Sarrafzadeh, J. [2016]. Evaluation of forward head posture in sitting and standing positions. *European spine journal : official publication of the European Spine Society, the European Spinal Deformity Society, and the European Section of the Cervical Spine Research Society*, *25*[11], 3577–3582. https://doi.org/10.1007/s00586-015-4254-x

23. Borel, L., & Alescio-Lautier, B. (2014). Posture and cognition in the elderly: interaction and contribution to the rehabilitation strategies. *Neurophysiologieclinique = Clinical neurophysiology*, *44*(1), 95–107. https://doi.org/10.1016/j.neucli.2013.10.129

24. Carter, S. E., Draijer, R., Thompson, A., Thijssen, D. H. J., & Hopkins, N. D. (2020). Relationship Between Sedentary Behavior and Physical Activity at Work and Cognition and Mood. *Journal of physical activity & health*, *17*(11), 1140–1152. https://doi.org/10.1123/jpah.2019-0632

25. Baker, R., Coenen, P., Howie, E., Williamson, A., & Straker, L. (2018). The Short Term Musculoskeletal and Cognitive Effects of Prolonged Sitting During Office Computer Work. *International journal of environmental research and public health*, *15*(8), 1678. https://doi.org/10.3390/ijerph15081678

26. Baer, J. L., Vasavada, A., & Cohen, R. G. (2022). Posture biofeedback increases cognitive load. *Psychological research*, *86*(6), 1892–1903. https://doi.org/10.1007/s00426-021-01622-2

27. Dutriaux, L., &Gyselinck, V. (2021). The Postural Effect on the Memory of Manipulable Objects. *Experimental psychology*, *68*(6), 333–339. https://doi.org/10.1027/1618-3169/a000537

28. Erickson, K. I., Hillman, C., Stillman, C. M., Ballard, R. M., Bloodgood, B., Conroy, D. E., Macko, R., Marquez, D. X., Petruzzello, S. J., Powell, K. E., & FOR 2018 PHYSICAL ACTIVITY GUIDELINES ADVISORY COMMITTEE* (2019). Physical Activity, Cognition, and Brain Outcomes: A Review of the 2018 Physical Activity Guidelines. *Medicine and science in sports and exercise*, *51*(6), 1242–1251. https://doi.org/10.1249/MSS.0000000000001 936

Ischemic heart disease In Women In A Tertiary Healthcare Centre: An Observational Study

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Abstract:

Introduction: In present era ischemic heart diseases are one of the common causes of mortality and morbidity in men and women both but remains underdiagnosed in women. The presentation of ischemic heart disease in women is comparatively atypical like dyspnea, nausea/vomiting, abdominal pain, back pain etc instead of typical chest pain. So various studies/research is still required for the prevalence of ischemic heart disease in women for better approach to diagnosis and treatment.

Material and methods: This was a retrospective, observational study of patients who were admitted in cardiology department in tertiary care centre. A consistent protocol was followed for studying the files of patients during study period. Data about clinical profile including demographics, clinical, lab investigations and treatment profile was extracted and analysed.

Results: A total of 200 patients were studied who were admitted in hospital with different heart diseases, out of which 56% (112) came out to be ischemic heart disease. Out of these 112 patients 82.14% presented with acute myocardial infarction. Proportion of patients with IHD was high in 40-50 years followed by 51-60 years.

Conclusion: The present study revealed that ischemic heart disease constitute a significant proportion of cardiovascular morbidity among women. A significant number of unstable angina are missed because of atypical symptoms and presentation, so we should have a higher degree of suspicion of IHD in females so as not to miss them.

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INTRODUCTION

Cardiovascular disease is the most common cause of mortality worldwide [1]. Traditionally, coronary artery disease has been described primarily as a disease affecting the male population. Contrary to common perception, coronary artery disease accounts for one-third of the total deaths amongst women [2,3].

Women often present with 'atypical' symptoms like shortness of breath, fainting and weakness [4]. Additionally, angina in women is precipitated by rest, sleep and mental stress besides physical exertion [5,6]. This often leads to delayed diagnosis and treatment of women afflicted with coronary artery disease and their under- representation in various studies. The INTERHEART Study reported that the mean age of onset of symptoms of coronary artery disease amongst women is a decade later than in men [6]. The incidence of coronary artery disease rises sharply after menopause in women, particularly amongst women having an earlier age at menopause and surgical menopause [7]. These factors contribute to general neglect of women as regards to diagnosis and management of coronary artery disease.There are several risk factors that are specific to women that predispose to the development of coronary artery disease. These include Polycystic ovarian syndrome, Functional hypothalamic amenorrhea, Autoimmune disease, Pregnancy- related disorders like Pregnancy-associated hypertension and Eclampsia, Gestational diabetes mellitus and Hormone therapy [8-11]. Moreover, traditional risk factors like dyslipidemia, smoking, diabetes mellitus and hypertension seem to have a more detrimental impact in women [12-14].

In general, it has been observed that coronary artery disease in women is under- reported, under-diagnosed, undertreated and under-prevented globally and locally. Therefore, there is an urgent need to define the particular epidemiological characteristics of women suffering from ischemic heart disease and to establish specific risk factors pertaining to women. Moreover, in taking medical advise, female come to the hospital with MI and maximum cases of unstable angina are missed because of atypical symptoms and presentation. Hence, there is an urgent need to emphasize on various diagnostic algorithms, management guidelines and prevention strategies that are better suited to the women population suffering from coronaryarterydisease.Weconductedthisstudytodeter minetheprevalenceand review risk factors involved with ischemic heart disease in women admitted in our hospital.

MATERIALS AND METHODS

This was a single-canter, retrospective, observational study including patients with heart diseases, admitted to the department of cardiology, Govt superspeciality hospital GMC JAMMU, a tertiary healthcare center from 2017-2019. Institutional Ethical Committee clearance was obtained. The data regarding social, economical, educational status and type of heart disease were retrieved from database maintained in hospital record. Relevant patient data was recorded for use as independent variables in a password protected Microsoft Excel spreadsheet. Necessary steps were taken to maintain absolute confidentiality of the patients. After the data screening, all the identifying details of the patients were removed from the final master chart which was used for further analysis.

Allthepatientswhowereagedover18yearsadmit tedincardiology department were included in present analysis.

A detailed clinical evaluation of the patients was performed to know the status of the patients. A detailed history incorporating details about occupational history, personal history, addictions, economic and education status of the patients was recorded. Various investigations done on the study subjects included:-
1. CBC,RFT,LFT
2. Lipidprofile
3. Thyroidprofile

The clinical findings and lab investigations were further supplemented with appropriate radiological imaging like Chest X-ray, ECG, ECHOand angiography. The statistical analysis was performed using SPSS software (version 21.0). All the categorical variables were represented as number and percentage (%). Continuous variables were represented as mean ± SD and median values. Qualitative variables were evaluated for statistical significance using the Chi-square test/ Fisher's exact test. A p-value of <0.05 was considered as significant.

RESULTS

A total of 200 patients were included in the present study. Out of 200 patients admitted in cardiology department with different heart disease, 56% were having the Ischemic heart disease
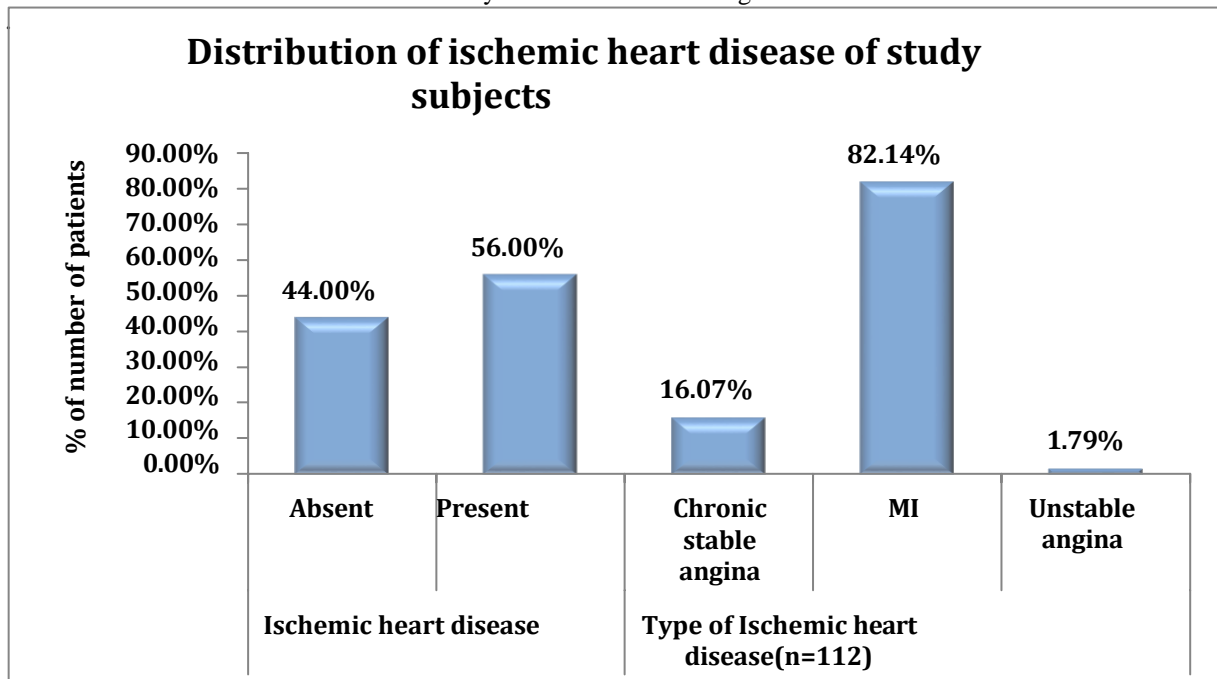
**Figure1:-Distribution of ischemic heart disease of study subjects.**

In present study, in majority (56.00%) of patients, ischemic heart disease was present. Ischemic heart disease was absent inonly88 out of 200 patients (44.00%).

In majority (82.14%) of patients, type of Ischemic heart disease was MI followed by chronic stable angina (16.07%). Type of Ischemic heart disease was unstable angina in only 2 out of 112 ischemic heart disease patients (1.79%).

Table1:-Association of risk factors with ischemic heart disease.

Risk factors	Noischemic disease (n=88)	Ischemic disease (n=112)	Total	p-value
Age(years)				
18-30	8(80%)	2(20%)	10 (100%)	
31-40	8(40%)	12 (60%)	20 (100%)	
41-50	10 (27.78%)	26 (72.22%)	36 (100%)	
51-60	16 (30.77%)	36 (69.23%)	52 (100%)	0.001
61-70	30 (62.50%)	18(37.50%)	48 (100%)	
>70	16 (47.06%)	18 (52.94%)	34 (100%)	
Mean±SD	58.43±16.41	57.29±12.28	57.79±14.22	
Median(25th-75th percentile)	61(48-70)	58(50-65)	60(50-70)	0.585
Range	18-85	30-85	18-85	
Smoker				
No	84 (47.19%)	94 (52.81%)	178(100%)	0.011
Yes	4(18.18%)	18 (81.82%)	22 (100%)	
Diabetes mellitus				
No	78 (49.37%)	80 (50.63%)	158(100%)	
Yes	10 (23.81%)	32 (76.19%)	42 (100%)	0.003
Hypertension				
No	50 (56.82%)	38 (43.18%)	88 (100%)	
Yes	38 (33.93%)	74 (66.07%)	112(100%)	0.001
Anemia				
Noanaemia	50 (40.32%)	74 (59.68%)	124(100%)	
Moderate anaemia	14 (46.67%)	16 (53.33%)	30 (100%)	
Severe anaemia	24 (52.17%)	22 (47.83%)	46 (100%)	0.365
Lipids				
Abnormal	2(3.13%)	62 (96.88%)	64 (100%)	
Normal	86(63.24%)	50 (36.76%)	136(100%)	<.0001
Hypothyroid				
No	80 (44.44%)	100(55.56%)	180(100%)	0.704
Yes	8(40%)	12 (60%)	20 (100%)	
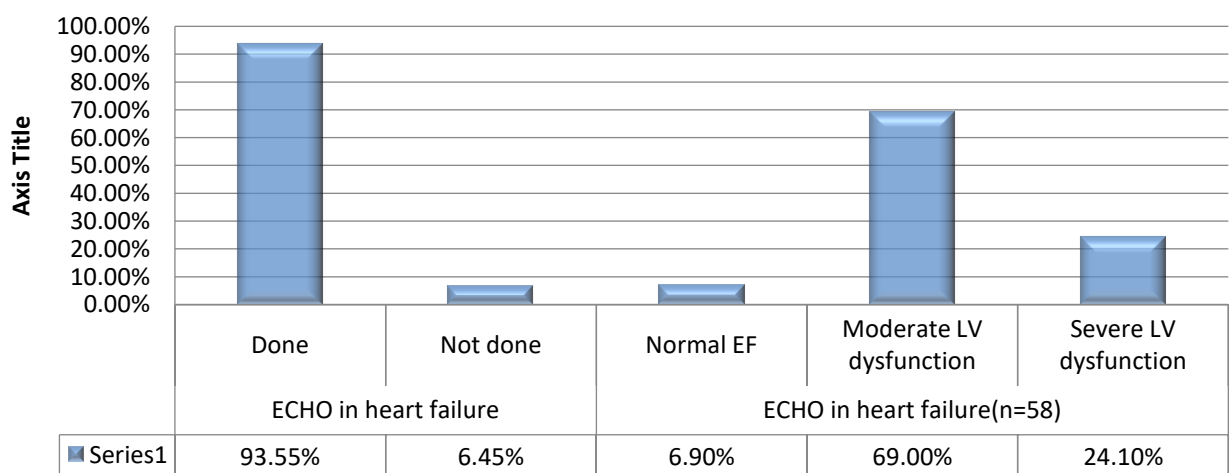
Figure2:-Association of risk factors with ischemic heart disease.
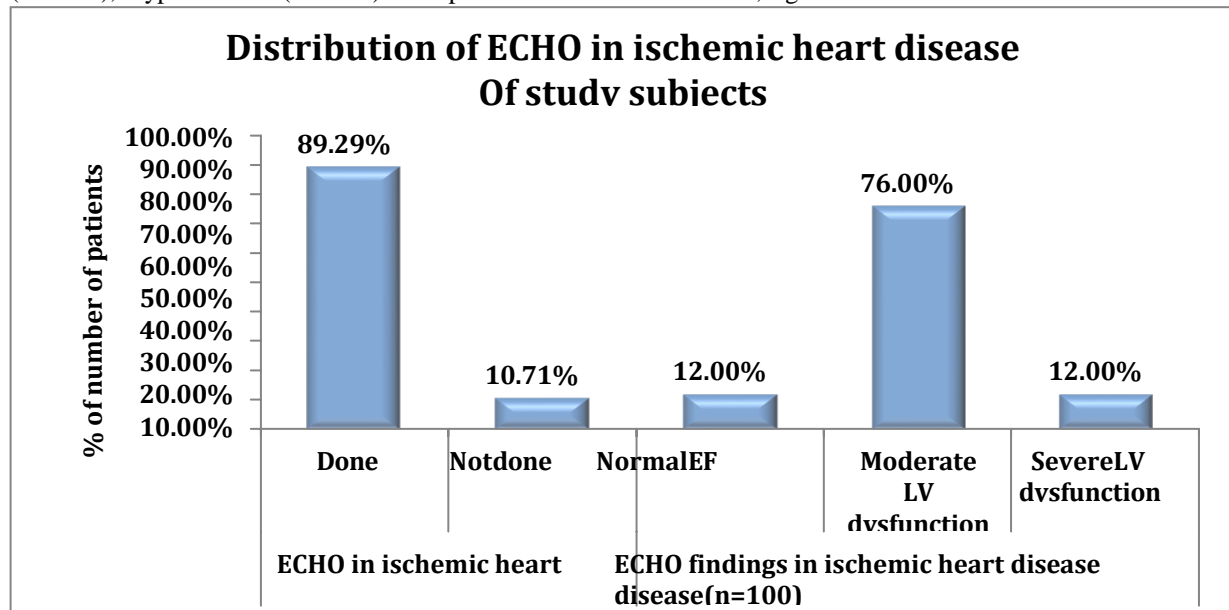
Proportion of patients with ischemic heart disease was significantly higher in age group 41-50 years(72.22%), 51-60 years(69.23%) and 31-40 years(60%) as compared to 18-30 years(20%), 61-70 years(37.50%) and >70 years(52.94%). (p value = 0.001) But mean ± SD of age(years) of patients without ischemic disease was58.43±16.41andwithischemicdiseasewas57.29±12.28withnosignificant association between them. (p value=0.585)

Proportion of patients with ischemic heart disease was significantly higher in smokers (81.82%), diabetics (76.19%), hypertensive (66.07%) and patients with abnormal lipids (96.88%) as compared to non-smokers (52.81%, p value = 0.011), non-diabetic (50.63%, p value = 0.003), non-hypertensive (43.18%, p value = 0.001) and patients with normal lipids (36.76%, <0.0001) respectively.

Distribution of ischemic heart disease was comparable in patients without anemia (59.68%), moderate anemia (53.33%) and severe anemia (47.83%). (p value = 0.365)
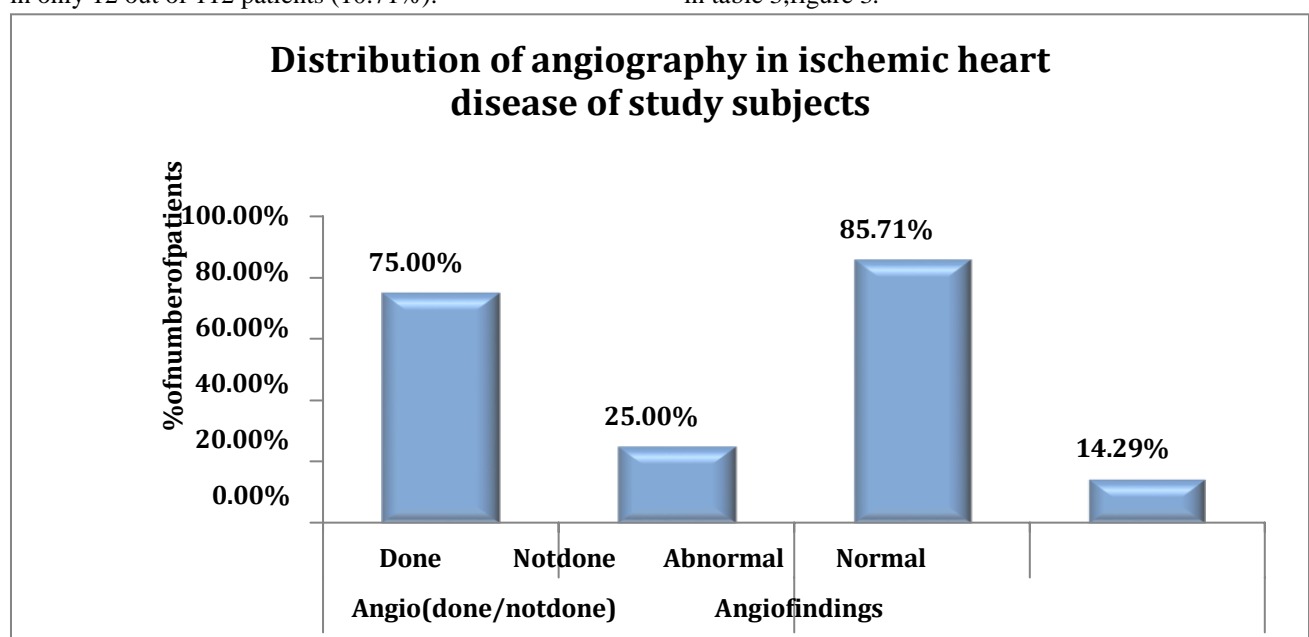
Distribution of ischemic heart disease was comparable inpatients with and without hypothyroid (60% vs 55.56% respectively). (p value = 0.704). It is shown in table 2, figure 2.

Figure3:-DistributionofECHOinischemicheartdiseaseofstudysubjects.

In present study, in majority(89.29%) of patients, ECHO in ischemic heart disease patients was done. ECHO in ischemic heart disease patients was not done in only 12 out of 112 patients (10.71%).

In majority (76%) of patients, moderate LV dysfunction was present followed by severe LV dysfunction (12%) and normal EF (12%). It is shown in table 3,figure 3.

**Figure 4:-Distribution of angiography in ischemic heart disease of study subjects.**

Inpresentstudy,inmajority(75.00%)ofpatients,angiographywasdone.Angiography was not done in only 28 out of 112 patients (25.00%). In majority (85.71%) of patients, angiography findings was abnormal. Angiography findings was normal in only 12 out of 84 patients (14.29%). It is shown in table 4, figure 4.

Table2:-Distribution of coronaries artery disease of study subjects.

Coronaries artery disease	Frequency	Percentage
NormalCoronaries	12	14.29%
LAD	18	21.43%
LAD+RCA	10	11.90%
LAD+LCX	10	11.90%
RCA	10	11.90%
LCX	10	11.90%
LCX+RCA	6	7.14%
LM	4	4.76%
LAD+LCX+RCA	2	2.38%
LM+RCA	2	2.38%

LAD (21.43%) was the most common coronary artery disease followed by LAD + RCA(11.90%),LAD+LCX(11.90%),RCA(11.90%),LCX(11.90%),LCA+ RCA (7.14%) and LM (4.76%). LAD + LCX + RCA and LM + RCA was present in only 2 out of 84 patients (2.38%) each.It is shown in table 5 and figure 5.
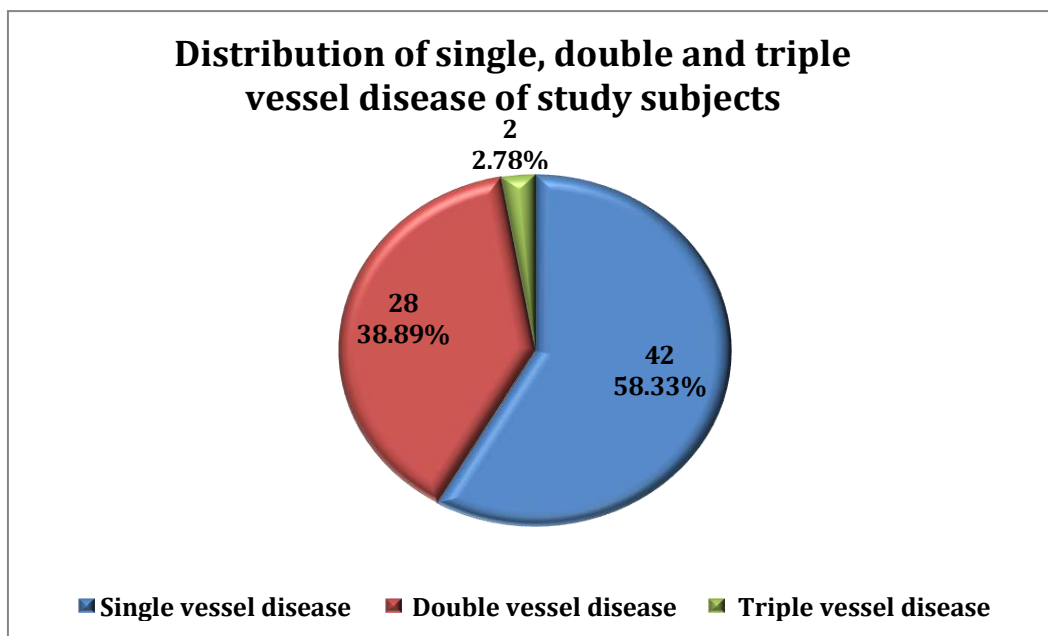
Figure 6:- Distribution of single, double and triple vessel disease of study subjects.

Out of 72 patients with coronary artery disease, 58.33% had single vessel disease, 38.89% had double vessel disease and 2.78% had triple vessel disease. It is shown in table 6 and figure 6.

DISCUSSION

The current study revealed that ischaemic heart disease was present in 56% of the total study subjects. Out of all patients affected, the most common disease presentation was myocardial infarction, seen in82.14% of the patients followed by chronic stable angina, seen in 16.07% of the patients. The least common form of presentation was unstable angina, present in 1.79% of

the patients. Wenger *et al* reportedthatchronicstableanginawasthemostcommoninitialcomplaintof women presenting with ischaemic heart disease. Our observations differ from the observations of the study since myocardial infarction was the most common initial presentation of patients in our study. This difference could be attributed to the fact that women tend to neglect their symptoms and present later to the hospital than their male counterparts, particularly in developing countries like India. Moreover, women tend to present with atypical symptoms like fatigue, nausea and breathlessness rather than typical angina symptoms which lead to delayed presentation [5,18,32].

The prevalence of ischemic heart disease was higher in individuals aged more than 40 years of age. Observational studies in the past have revealed that the incidence of ischaemic heart disease increases with age in women, particularly during the post-menopausal period[3,8,33]. Hence, this observation is in concordance with other studies.

Smoking, Diabetes, hypertension and dyslipidemia were significantly associated with an increased risk of ischemic heart disease in the study population. This is in accordance with other studies conducted globally which also have observed that these traditional risk factors seem to be more detrimental in women[12-14,34,35].Anaemia and hypothyroidism were however, not significantly associated with an increased risk of ischemic heart disease in the study population.

Majority of patients, that is, 76% patients with ischemic heart disease in whom echocardiography was performed, had moderate LV dysfunction. This indicates that ischemic heart disease is responsible for causing significant LV dysfunction.

Amongst the patients in whom coronary angiography was done, 85.71% patients had abnormal angiograms and a significant proportion of patients, that is 14.29% patients, had normal coronaries. This is in accordance with other studies conducted in women patients with ischemic heart disease which reveal that women tend to have lesser burden of obstructive epicardial disease and a significant proportion of women have normal coronaries with symptoms attributable to microvascular angina[19,28]. Amongst the patients with abnormal coronary angiograms, LAD was the most commonartery affected (21.43%) followed byequal prevalence of disease inRCA and LCX (11.90%). Furthermore, majority of the patients in the study group had single-vessel disease (58.33%) followed by double-vessel (38.89%) and triple- vessel disease (2.78%). These observations were also in accordance with similar studies conducted elsewhere amongst women participants [36].

LIMITATIONS

The major limitation of our study was the retrospective nature of our study, thereby generating a low level of evidence. A limited sample size of the study precluded any subset analysis. Due to financial constrains all the patients enrolled in the study did not undergo angiography which may effect the eventual outcomes of the patients. Also due to the retrospective nature of the study data on long term follow up and survial outcomes could not be assessed.

We recommend that future prospective studies including long term follow up of such patients and data on prevalence of a second cardiac event in them must be recorded. Also, a study with a relatively larger sample size can help in risk stratification based on the smoking index, BMI, lipid profile of the patients can help to generate new data.

CONCLUSION

This study conducted at a tertiary-care hospital in Jammu revealed that ischaemic heart disease constitutes a significant proportion of cardiovascular morbidity amongst women.

The prevalence of ischaemic heart disease increases with age and is higher in elderly women than in younger women. Traditional risk factors like smoking, diabetes, hypertension and dyslipidemia confer significantly increased risk of ischemic heart disease in women and appear to be more detrimental in women.

Ischemic heart disease also leads to LV dysfunction in women, particularly moderate LV dysfunction.

A significant proportion of women with ischemic heart disease have normal angiograms, implying greater role of microvascular angina and endothelial dysfunction in women.

Most women with ischemic heart disease having abnormal angiograms have single vessel disease with LAD being the most commonly affected artery followed by RCA and LCX in equal proportions.

REFERENCES

1. GBD 2016 causes of death collaborators: Global, regional and national age- specific mortality for 264 causes of death, 1980-2016, a systemic analysis for Global Burden of Disease Study 2016. *The Lancet*. 2017;90:1151-210.
2. Thom T, Hasse N, Rosamond W. Heart disease and stroke statistics-2006 update: a report from the American Heart Association Statistics Committee and Stroke Statistics Subcomittee. *Circulation*. 2006;113:e85.
3. Pathak LA, Shirodkar S, Ruparelia R *et al*. Coronary Artery Disease in Women. *Indian Heart J*. 2017 Jul-Aug;69(4): 532-8.
4. Alexander KP, Shaw LJ, Shaw LK. Value of Exercise Treadmill Testing in Women. *J Am CollCardiol*. 1998;32:1657.
5. Pepine CJ, Abrams J, Marks RG. Characteristics of a contemporary population with angina pectoris. TIDES Investigators. *Am J Cardiol*. 1994;74:226.
6. Yusuf S, Hawken S, Ounpuu S. Effect of potentially modifiable risk factors associated with myocardial infarction in 52 countries (the INTERHEART study): case-control study. *Lancet*. 2004;364(9438):937-52.
7. Dam V, Van Der Schouw YT, Onland-Moret NC

et al. Association of menopausal characteristics and risk of coronary heart disease: a pan- European case-cohort analysis. *International J Epidemiol*. 2019. 48(4):1275-85.

8. Shaw LJ, BaireyMerz CN, Azziz R *et al*. Postmenopausal women with a history of irregular menses and elevated androgen measurements at high risk for worsening cardiovascular event-free survival: results from the National Institutes of Health-National Heart, Lung, and Blood Institute sponsored Women's Ischemia Syndrome Evaluation. *J Clin Endocrinol Metab*. 2008;93(4):1276-84.

9. Merz CN, Johnson BD, Berga S *et al*. Past oral contraceptive use and angiographic coronary artery disease in postmenopausal women: data from the National Heart, Lung, and Blood Institute-sponsored Women's Ischemia Syndrome Evaluation. *FertilSteril*. 2006;85(5):1425-31.

10. Maddury, Achukatla. Long-term cardiovascular effects of pregnancy-related disorders. *Indian J Car Dis Wom-WINCARS* 2018;3:167-83.

11. Mason JC, Libby P. Cardiovascular disease in patients with chronic inflammation: mechanisms underlying premature cardiac events in rheumatologic conditions. *Eur Heart J*. 2015;36(8):482-9c.

12. Drazner MH. The progression of hypertensive heart disease. *Circulation*. 2011;123(3):327-34.

13. Huxley RR, Peters SA, Mishra GD *et al*. Risk of all-cause mortality and vascular events in women versus men with type 1 diabetes: a systematic review and meta-analysis. *Lancet Diabetes Endocrinol*. 2015;3(3):198-206.

14. Jamal A, Homa DM, O'Connor E *et al*. Current cigarette smoking among adults-United States,2005-2014. *MMWR Morb Mortal Wkly Rep*. 2015;64(44):1233-40.

15. Bairey MC, Shaw LJ, Reis SE. Insights from the NHLBI Sponsored Women's Ischemia Syndrome Evaluation (WISE) Study: Part II: gender differences in presentation, diagnosis, and outcome with regard to gender- based pathophysiology of atherosclerosis and macrovascular and microvascular coronary disease. *J Am CollCardiol*. 2006;47(3 Suppl): S21- 9.

16. Canos DA, Mintz GS, Berzingi CO *et al*. Clinical, angiographic, and intravascular ultrasound characteristics o fearly saphenous vein graft failure. *J Am CollCardiol*. 2004;44(1):53-6.

17. Stampfer MJ, Colditz GA, Willett WC *et al*. Postmenopausal estrogen therapy and cardiovascular disease. Ten-year follow-up from the nurses' health study. *N Engl J Med*. 1991 Sep 12;325(11): 756-62.

18. Vaccarino V, Horwitz RI, Meehan TP *et al*. Sex differences in mortalityafter myocardial infarction: evidence for a sex-age interaction. *Arch Intern Med*. 1998 Oct 12; 158(18):2054-62.

19. Sharaf BL, Pepine CJ, Kerensky RA *et al*. WISE Study Group. Detailed angiographic analysis of women with suspected ischemic chest pain (pilot phase data from the NHBLI-sponsored Women's Ischemia Syndrome Evaluation [WISE] Study Angiographic Core Laboratory). *Am J Cardiol*. 2001 Apr 15;87(8):937-41.

20. Reis SE, Holubkov R, Conrad Smith AJ *et al*. Coronary microvascular dysfunction is highly prevalent in women with chest pain in the absence of coronary artery disease: results from the NHLBI WISE Study. *Am Heart J*. 2001 May;141(5):735-41.

21. BaireyMerz CN, Johnson BD, Sharaf BL *et al*. Hypoestrogenemia of hypothalamic origin and coronary artery disease in premenopausal women:a report from the NHLBI-sponsored WISE study.*J Am CollCardiol*. 2003 Feb 5;41(3):413-9.

22. Kip KE, Marroquin OC, Kelley DE *et al*. Clinical importance of obesity versus the metabolic syndrome in cardiovascular risk in women: a report from the Women's Ischemia Syndrome Evaluation (WISE) Study. *Circulation*. 2004 Feb 17;109(6):706-13.

23. Ridker PM, Buring JE, Rifai N *et al*. Development and validation of improved algorithms for the assessment of global cardiovascular risk in women: the Reynolds Risk Score. *JAMA*. 2007 Feb 14;297(6):611-9.

24. Shaw LJ, Shaw RE, Merz CN *et al*. American College of Cardiology- National Cardiovascular Data Registry Investigators. Impact of ethnicity and gender differences on angiographic coronary artery disease prevalence and in-hospital mortality in the American College of Cardiology-National Cardiovascular Data Registry. *Circulation*. 2008 Apr 8;117(14):1787-801.

25. Salmon JE, Roman MJ. Subclinical atherosclerosis in rheumatoid arthritis and systemic lupus erythematosus. *AmJMed*.2008Oct;121(10Suppl1):S3- 8.

26. Kreatsoulas C, Sloane D, Pogue J *et al*. Referrals in Acute CoronaryEvents for CARdiac Catheterization: the RACE CAR trial. *Can J Cardiol*. 2010 Oct;26(8):e290-6.

27. King A. Risk factors: Cigarette smoking increases the risk of coronary heart disease in women more than in men. *Nat Rev Cardiol*. 2011 Aug 30;8(11):612.

28. Kothawade K, BaireyMerz CN. Microvascular coronary dysfunction in women: pathophysiology, diagnosis, and management. *Curr Probl Cardiol*. 2011 Aug;36(8):291-318.

29. Gupta R, Mohan I, Narula J. Trends in Coronary Heart Disease Epidemiology in India.*Ann Glob Health*. 2016. 82(2): 307-15.

30. PathakLA, ShirodkarS, Rajebahadur J.Coronary artery disease in women.

31. *IndianHeartJ*.2017;69(4):532-8.

32. Wenger NK. Clinical presentation of CAD and myocardial ischemia in women. *J NuclCardiol*.

2016;23:976-85.

33. Stone NJ, Robinson JG, Lichtenstein AH *et al*. 2013 ACC/AHA guidelineon the treatment of blood cholesterol to reduce atherosclerotic cardiovascular risk in adults: a report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines. *Circulation*. 2014;129(25suppl):S1-45.

34. Merz CN, Shaw LJ. Stable angina in women: lessons from the National Heart, Lung and Blood Institute-sponsored Women's Ischemia Syndrome Evaluation. *J Cardiovasc Med*. 2011;12(2):85-7.

35. Yoon SS, Carroll MD, Fryar CD. Hypertension prevalence and control among adults: United States,2011-2014. *NCHS Data Brief*. 2015;220:1-8

36. Abbott RD, Wilson PW, Kannel WB *et al*. High density lipoprotein cholesterol, total cholesterol screening and myocardial infarction. The Frahmingham Study. *Arteriosclerosis*. 1988;8(3):207-11.

37. Ezhumalai B, Jayaraman B. Angiographic prevalence and pattern of coronary artery disease in women. *Indian Heart J*. 2014 Jul;66(4):422-6.