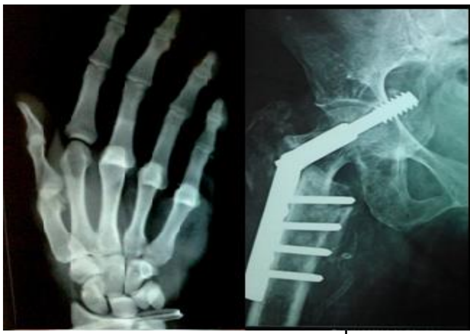

International Journal of Orthopaedics Sciences

E-ISSN: 2395-1958
P-ISSN: 2706-6630
IJOS 2024; 10(3): 174-178

www.orthopaper.com
Received: 15-05-2024
Accepted: 22-06-2024

Raman Singh
MBBS and Junior Resident, Department of Orthopaedics, MGM Institute of Health Sciences, Navi Mumbai, Maharashtra, India

Dr. Anuj Parikh
MBBS and Junior Resident, Department of Orthopaedics, MGM Institute of Health Sciences, Navi Mumbai, Maharashtra, India

Sanjeev Kumar Singh
MS Orthopedics and Assistant Professor, MGM Institute of Health Sciences, Navi Mumbai, Maharashtra, India

Dr. Deepak Jain
MS Orthopedics and Assistant Professor, MGM Institute of Health Sciences, Navi Mumbai, Maharashtra, India

Ameya Velankar
MS Orthopedics and Assistant Professor, Department of Orthopaedics, MGM Institute of Health Sciences, Navi Mumbai, Maharashtra, India

Gaurav Singh
MBBS and Junior Resident, Department of Orthopaedics, MGM Institute of Health Sciences, Navi Mumbai, Maharashtra, India

Corresponding Author:
Dr. Deepak Jain
MS Orthopedics and Assistant Professor, Department of Orthopaedics, MGM Institute of Health Sciences, Navi Mumbai, Maharashtra, India

A retrospective study to evaluate the effectiveness of radiographs versus computed tomography in determining fracture morphology in intertrochanteric fractures

Raman Singh, Dr. Anuj Parikh, Sanjeev Kumar Singh, Dr. Deepak Jain, Ameya Velankar and Gaurav Singh

DOI: https://doi.org/10.22271/ortho.2024.v10.i3c.3596

Abstract
Introduction: Femur Intertrochanteric fractures is a commonplace hip fractures seen in orthopaedic practice. The intertrochanteric fractures stability decides the most suitable treatment modality. Imaging is the primary investigation to determine fracture morphology and the degree of comminution. Radiographs and Computed tomography are the two viable options for classifying the fractures.
Materials and Methods: We conducted a retrospective study spanning from 1st of January 2022 to 31st of December 2023 with a sample size of 20. We recorded the responses of three subjects for radiographs and tomography of the 20 intertrochanteric fractures and analysed them for Interobserver and Intraobserver variability.
Results: There was narrower variability in responses with Computed Tomography than Radiography. Our study could not reach statistical significance when variability between the two modalities were compared for each subject.
Conclusion: Computed tomography should be included in the workup of Intertrochanteric fractures since studies have indicated to their usefulness in determining accurate fracture morphology. It is especially significant in the unstable fracture patterns. The degree to which Computed tomography is useful has still not been established definitively. This should prompt further research in future.

Keywords: Radiographs, computed tomography, intertrochanteric fractures, intraobserver variability, interobserver variability

Introduction
According to various studies conducted worldwide the Hip fractures result in significant morbidity and mortality due to Fragility fractures. The numbers were estimated to be 9 million worldwide in 2000 and is estimated to reach 6.3 million by 2050 [1]. Almost half of these fractures are Intertrochanteric fractures [2]. India had about 6,00,000 cases of Osteoporotic hip fractures in 2004 [1].
The decision about the stability of fracture and type of implant chosen is made by determining the fracture morphology and lateral wall thickness on radiographs routinely. But sometimes it is difficult to appreciate posteromedial comminution and trochanteric split in radiographs. Despite the availability of various radiological classification systems in the literature, it is difficult to appreciate the fracture morphology only on Xrays and sometimes we end up choosing the wrong implant for a particular fracture. Computed tomography remains the Gold standard for determining the fracture morphology but it's used only sparingly for intertrochanteric fracture evaluation [3]. We have started using Computed tomography for all patients with intertrochanteric fractures who present to us and we have found that there is high interobserver and intraobserver variability in classifying the fractures on basis of radiographs and computed tomography
The goal of this study is to estimate the extent of improvement in determining fracture morphology for intertrochanteric fractures by using Computed tomography in comparison to Radiography and the Interobserver and Intraobserver variability for the two investigations.

Materials and Methods

On retrospective evaluation of total 60 patients sustaining Intertrochanteric femur fractures who presented to our institute between January 2022 to December 2023 out of which both Radiographs and Computed tomography were available for 20 cases. Out of 20 patients one had been previously operated for a contralateral intertrochanteric fracture, one had a contralateral femur fracture. A Computed tomography scan of pelvis and both hips was done for all patients using 16 slice CT preoperatively. The fracture patterns were analysed using a Diacom viewer. No post-operative tomography scans were done fo our study.

Inclusion criterion was a skeletally mature patient with isolated closed displaced Intertrochanteric fractures whose preoperative radiographs and tomographs are available. We excluded all patients who were either less than 18 years or more than 90 years and patients sustaining polytrauma. Using the Radiographs and Computed tomography for the selected patients we attempted to classify the fracture patterns according to AO classification 2018.

After evaluating the fracture patterns, choice of implant has been thoroughly deliberated according to patient's profile individually. We would choose between extramedullary construct like the Dynamic hip screw system with a derotation screw using the Corticocancellous screw and Intramedullary implant like- short proximal femoral nail or long proximal femoral nail. These implants are available at our institute.

Results

Upon statistical analysis we find that there exists intraobserver variability among the responses from Radiographs and Computed tomography. When we compare the krippendorf values for variability for the Radiographs and Computed tomography we observe that the variability is less in for Computed tomography among the subjects. We also observed an interesting trend that subjects tend to overestimate the extent of fracture patterns on radiographs. This means that including Computed tomography in the diagnostic workup enhances the interpretation of fracture patterns. This will lead to better decision making for the treatment. We attempted to find the degree of variability in responses on Radiographs and Computed tomography for each subject, but this value couldn't reach statistical significance. Such result provides stimulus for us to find out limitations in the study, and rectify them for the future studies.

The gender-wise distribution shows female preponderance, 55% of the participants were female and 45% are male out of a total of 20 participants. Left sided involvement was more common. 55% of the cases had left side involvement, while for 45% right side was involved. The ages covering a range from 36 to 88 years, the average age being 73.15 years and having standard deviation of 11.477. The X-Ray scores as evaluated by three observers with scores ranging from 1 to 9 and different percentages assigned to each score by the observers. For Observer 1, the most frequent scores were 5 (30%) and 9 (20%). Observer 2's most frequent scores were 5 (35%) and 6 (20%). Observer 3's most frequent scores were 3 (20%) and 5 (20%). All observers evaluated a total of 20 cases. A2.2 was the most common fracture pattern seen. It was also the most common response given by subjects on evaluating Radiographs and Computed tomography.

Inter-observer Reliability

Krippendorff's Alpha is a statistical tool used for assessing the agreement among multiple observers, applicable to different types of data (nominal, ordinal, interval and ratio). It takes into consideration the random conformity which might occur by chance, providing a more accurate measure of inter-rater reliability.

Krippendorff's Alpha formula-

Krippendorff's Alpha is calculated using the following formula:

$\alpha = 1 - (Do / De)$

Where:
Do is the observed disagreement among raters.
De is the expected disagreement by chance.
The observed disagreement Do and the expected disagreement De are calculated as follows:

$Do = (\sum (d\_cc\backslash' * o\_cc\backslash')) / N$
$De = (\sum (d\_cc\backslash' * e\_cc\backslash')) / N$

where:
d_cc' is the difference or distance between categories c and c'.
o_cc' is the observed frequency of pairs in categories c and c'.
e_cc' is the expected frequency of pairs in categories c and c' by chance.
N is the total number of observations.

AO grade on Xray

For AO grade on Xray, the Krippendorff's Alpha alpha value is as given below:
Krippendorff's Alpha (Interval Scale): 0.648
Bootstrap Confidence Interval (95% CI): [0.289, 0.853]
The inter-observer reliability for the AO grade on X-ray among the three observers, measured by Krippendorff's alpha, is 0.648 on an interval scale. This indicates a moderate level of agreement among the observers. The bootstrap confidence interval, at a 95% confidence level, ranges from 0.289 to 0.853 suggests that the true level of agreement is likely to be moderate.

Ao grade on CT

For AO grade on CT, the Krippendorff's Alpha alpha value is as given below:
Krippendorff's Alpha (Interval Scale): 0.426
Bootstrap Confidence Interval (95% CI): [0.186, 0.588]
The inter-rater reliability for the AO grade on CT among the three observers, measured by Krippendorff's alpha, is 0.426 on an interval scale. This indicates a fair level of agreement among the observers. The bootstrap confidence interval, at a 95% confidence level, ranges from 0.186 to 0.588 suggests that the true level of agreement is likely to be fair.

Intra-observer reliability

The intraobserver reliability for the AO grade on X-ray was evaluated by the use of Intraclass Correlation Coefficient (ICC) for three observers. Observer 1 demonstrated moderate reliability with an ICC of 0.647 (95% CI: 0.109 to 0.860) with a p-value of 0.014, indicating statistical significance. Observer 2 showed substantial reliability with an ICC of 0.724 (95% CI: 0.303 to 0.891) and a p-value of 0.004, also statistically significant. Observer 3 exhibited the highest reliability with an ICC of 0.84 (95% CI: 0.596 to 0.937) and a highly significant p-value of 0.000. These results suggest that while all observers demonstrated statistically significant reliability, Observer 3's measurements were the most consistent and reliable over time.

Comparison of AO grade on X-ray and AO grade on CT

For each observer, the AO grades on Radiographs are slightly higher than the AO grades on Tomography. However, the differences are not statistically significant for any observer, as indicated by the p-values (all more than 0.05). It implies that there is absence of significant difference between the AO grades assigned using X-ray and CT methods for these observers.

Paired Samples Correlations of AO grade on X-ray and CT

The correlations between AO grades on X-ray and CT for each observer are all statistically significant, as indicated by the p-values (all less than 0.05). This suggests that there is a significant positive relationship between the AO grades given using the two different methods for each observer.

- **Observer 1** has a moderate positive correlation (0.499) having p-value of 0.025, indicating a substantial relationship.
- **Observer 2** has a stronger positive correlation (0.621) having p-value of 0.003, indicating a more substantial relationship.
- **Observer 3** has the strongest positive correlation (0.732) having p-value of 0.000, indicating a highly substantial relationship.

These correlations imply that the AO grades given on X-ray and CT by each observer are consistent and positively related, with Observer 3 showing the highest consistency between the two methods.

The Tomography scores evaluated by three observers are shown in the table below. Observer 1's most frequent scores were 5 (35%) and 6 (30%). Observer 2's most frequent scores were 5 (35%) and 6 (30%). Observer 3's most frequent scores were 4 (25%) and 5 (25%). All observers evaluated a total of 20 cases.

Discussion

Intertrochanteric femur fractures continue to be a very common fracture which are encountered in medical practice. In cases where the fixation is not adequate there is a significant morbidity and even mortality associated with it.

So appropriate fixation of fractures is paramount to maintaining the quality of life post operatively. Correct choice of surgery and implant selection plays a crucial role in achieving good postoperative outcomes. We rely on imaging to study the fracture patterns which guide the choice of surgery. Radiographs and Computed tomography continue to be the most relevant for this purpose. In general practice, clinicians rely heavily on Radiographs for determining the fracture patterns.

On analysing and interpreting the data from our study, it was found that there was a decrease in the interobsever variability on using Computed tomography. We infer that Computed tomography may have a role in diagnostic workup with the purpose of mitigating the variability due lack of experience of a practioner or preference of one modality over the other by practioners. We could not reach to a statistically significant level upon comparing the response of each observer using Radiographs and Computed tomography. This could be because of various factors discussed later.

Keizo wada *et al* conducted a study of 203 patients evaluated variation in classifying intertrochanteric fractures according to two different classification systems on using radiograph and 3 dimensional computed tomography. Evans-Jensen and AO classification was used. It was concluded that computed tomography based systems for classification had better Interobserver and Intraobserver reliability [5].

Yi-Cheng Cho *et al* concluded from a retrospective study on 60 patients in which they sought to find the Interobserver variability. They concluded that 3 dimensional Computed tomography enhanced the interpretation of stability of a fracture pattern. Preoperative Computed tomography was advised to be added in the diagnostic workup as they provide significant diagnostic benefit. Another goal of the study was to determine the utility of fragment based fracture classifications. High reliability was found for the same [6].

Ronald Isida *et al* concluded from a study in 110 patients that assessment of radiographs undervalued the degree of comminution posteriorly and along the medial wall. They also concluded that complexity of frcature lines was underestimated on radiographs. It was also stated that comminution is the major factor which contributes to fracture instability. AO classification was found to be deficient in classifying fractures with posterior comminution [7].

Etsuo shoda *et al* did a study of 239 patients with two part, three part and four part fractures which involved head, lesser trochanter, greater trochanter and femur shaft in different combinations. Such five groups were made and study was carried out. Aim of the study was to find out the relevance of computed tomography in classifying Intertrochanter fractures in accordance with Evans-Jensen and AO system of classification. It was found that large oblique fragments which might include greater and lesser trochanter were identified easily on computed tomography. This pattern was difficult to appreciate on radiographs [8].

Mohamed Zarie *et al* conducted study on 96 on interobserver and intraobserver variance using radiographs for AO classification. Study showed lack of any acceptable interobserver and intraobserver reliability. It was concluded that AO system is not suitable for classifying fractures for treatment protocols [9].

This might explain the lack of significant intraobserver variability between radiographs and tomography in our study.

There have also been studies in literature stating that Computed tomography brings no added benefit as well.

Embden *et al* concluded from a 30 case study that using Computed tomography did not lead to an enhanced capability of classifying the fractures or deciding the treatment. Data analysis showed significant enhancement of diagnostic accuracy with Computed tomography only for A3 fracture type. According to this study the role of Computed tomography was significant only for fracture patterns belonging to A3 [10].

Masaki *et al* did a retrospective study of 89 cases and came to the conclusion that the AO/OTA revised classification of 2018 was reasonably reliable by itself irrespective of whether classifying was done using Radiograph or Computed tomography. Tomography was useful in accurately classifying the unstable fractures to an extent. It was also noted that use of tomography was significant only in the mid or high level expertise group [11].

From analysis of our study and review of literature we infer that Computed tomography is a potentially useful tool for determining fracture patterns. We suggest including Computed tomography in the diagnostic workup for unstable patterns and fractures with posterior comminution. We could not reach statistical significance for Intraobserver variability with Radiographs and Computed tomography. This prompts further studies on the same with minimisation of factors which we believe might have affected our study.

Limitations of the study

1. Lack of large sample siz.
2. Use of just one system of classification.
3. Excluding lateral wall th ickness and posterior wall comminution from evaluation and analysis

Table 1: Gender-wise distribution

Gender	Frequency	Percent
Female	11	55.0
Male	9	45.0
Total	20	100.0

Table 2: Side involved

Side	Frequency	Percent
Left	11	55.0
Right	9	45.0
Total	20	100.0

Table 3: Descriptive Statistics for Age

	N	Min	Max	Mean	SD
Age	20	36.00	88.00	73.150	11.477

Intra-observer reliability

Table 4: Intraclass Correlation Coefficient

	Alpha	95% CI		p-value
		Lower Limit	Upper Limit	
Observer1	0.647	0.109	0.860	0.014
Observer2	0.724	0.303	0.891	0.004
Observer3	0.84	0.596	0.937	0.000

Table 5: Comparison of AO grade on X-ray and AO grade on CT

		Mean	N	SD	SEM	t-stat	p-value
Observer1	AO grade on X-ray	5.750	20	2.173	0.486	1.027	0.317
	AO grade on CT	5.300	20	1.625	0.363		
Observer2	AO grade on X-ray	5.350	20	2.084	0.466	1.094	0.288
	AO grade on CT	4.950	20	1.356	0.303		
Observer3	AO grade on X-ray	4.900	20	2.360	0.528	1.229	0.234
	AO grade on CT	4.450	20	2.038	0.456		

Table 6: Paired Samples Correlations of AO grade on X-ray and CT

Observer	N	Correlation	Sig.
Observer1	20	0.499	0.025
Observer2	20	0.621	0.003
Observer3	20	0.732	0.000

Table 7: X-Ray

Score	Observer1		Observer2		Observer3	
	n	%	n	%	n	%
1	0	0.0	0	0.0	0	0.0
2	2	10.0	3	15.0	3	15.0
3	0	0.0	0	0.0	4	20.0
4	3	15.0	2	10.0	3	15.0
5	6	30.0	7	35.0	4	20.0
6	3	15.0	4	20.0	0	0.0
7	1	5.0	1	5.0	3	15.0
8	1	5.0	0	0.0	0	0.0
9	4	20.0	3	15.0	3	15.0
Total	20	100.0	20	100.0	20	100.0

Table 8: CT

Score	Observer1		Observer2		Observer3	
	n	%	n	%	n	%
1	0	0.0	1	0.5	1	5.0
2	0	0.0	1	5.0	2	10.0
3	3	15.0	2	10.0	3	15.0
4	2	10.0	3	15.0	5	25.0
5	7	35.0	7	35.0	5	25.0
6	6	30.0	6	30.0	2	10.0
7	0	0.0	0	0.0	0	0.0
8	0	9.0	1	5.0	0	0.0
9	2	10.0	0	0.0	2	10.0
Total	20	100.0	20	100.0	20	100.0

Conclusion

Computed tomography should be included in the workup of Intertrochanteric fractures since studies have indicated to their usefulness in determining accurate fracture morphology. It is especially significant in the unstable fracture patterns. The degree to which Computed tomography is useful has still not been established definitively. This should prompt further research in future

Conflict of Interest

Not available

Financial Support

Not available

Bibliography

1. Avci M, Kozaci N. Comparison of X-ray imaging and computed tomography scan in the evaluation of knee trauma. Medicina (Kaunas). 2019 Sep 23;55(10):623. DOI: 10.3390/medicina55100623. PMID: 31547588; PMCID: PMC6843286.
2. Hecht G, Saiz AM, Shelton TJ, Haffner MR, Delman C, Shieh A, *et al*. CT scans better assess lateral wall morphology of stable appearing intertrochanteric (IT) femur fractures and predict early failure of sliding hip screw (SHS) fixation. OTA Int., 2021 Aug 9, 4(3). DOI: 10.1097/OI9.0000000000000140. PMID: 34746672; PMCID: PMC8568429.
3. Sharma G, Gn KK, Khatri K, Singh R, Gamanagatti S, Sharma V, *et al*. Morphology of the posteromedial fragment in pertrochanteric fractures: A three-dimensional computed tomography analysis. Injury. 2017 Feb;48(2):419-431. DOI: 10.1016/j.injury.2016.11.010. Epub 2016 Nov 17. PMID: 27903406.
4. Li C, Zhao D, Xu X, Ding J, Guo Y, Liao L, *et al*. Three-dimensional computed tomography (CT) mapping of intertrochanteric fractures in elderly patients. Med. Sci. Monit., 2020 Oct 12, 26. DOI: 10.12659/MSM.925452. PMID: 33041321; PMCID: PMC7566228.
5. Wada K, Mikami H, Toki S, Amari R, Takai M, Sairyo K, *et al*. Intra- and inter-rater reliability of a three-dimensional classification system for intertrochanteric fracture using computed tomography. Injury. 2020 Nov;51(11):2682-2685. DOI: 10.1016/j.injury.2020.07.047. Epub 2020 Jul 21. PMID: 32718752.
6. Cho YC, Lee PY, Lee CH, Chen CH, Lin YM. Three-dimensional CT improves the reproducibility of stability evaluation for intertrochanteric fractures. Orthop. Surg. 2018 Aug;10(3):212-217. DOI: 10.1111/os.12396. PMID: 30152606; PMCID: PMC6594481.

7. Isida R, Bariatinsky V, Kern G, Dereudre G, Demondion X, Chantelot C, *et al*. Prospective study of the reproducibility of X-rays and CT scans for assessing trochanteric fracture comminution in the elderly: a series of 110 cases. Eur. J Orthop. Surg. Traumatol. 2015 Oct;25(7):1165-1170. DOI: 10.1007/s00590-015-1666-6. Epub 2015 Jul 4. PMID: 26141046.
8. Shoda E, Kitada S, Sasaki Y, Hirase H, Niikura T, Lee SY, *et al*. Proposal of new classification of femoral trochanteric fracture by three-dimensional computed tomography and relationship to usual plain X-ray classification. J Orthop. Surg. (Hong Kong). 2017 Jan;25(1):2309499017692700. DOI: 10.1177/2309499017692700. PMID: 28211303.
9. Zarie M, Mohamoud MF, Farhoud AR, Bagheri N, Khan FMY, Heshmatifar M, *et al*. Evaluation of the inter- and intra-observer reliability of the AO classification of intertrochanteric fractures and the device choice (DHS, PFNA, and DCS) of fixations. Ethiop J Health Sci. 2020 Sep;30(5):755-760. DOI: 10.4314/ejhs.v30i5.15. PMID: 33911837; PMCID: PMC8047276.
10. van Embden D, Scheurkogel MM, Schipper IB, Rhemrev SJ, Meylaerts SA. The value of CT compared to radiographs in the classification and treatment plan of trochanteric fractures. Arch Orthop. Trauma Surg. 2016 Aug;136(8):1091-1097. DOI: 10.1007/s00402-016-2475-z. Epub 2016 Jun 30. PMID: 27365082.
11. Iguchi M, Takahashi T, Matsumura T, Ae R, Hiyama S, Nakashima M, *et al*. Addition of 3D-CT evaluation to radiographic images and effect on diagnostic reliability of current 2018 AO/OTA classification of femoral trochanteric fractures. Injury. 2021 Nov;52(11):3363-3368. DOI: 10.1016/j.injury.2021.09.031. Epub 2021 Sep 23. PMID: 34598792.

How to Cite This Article
Singh R, Parekh A, Singh SK, Jain D, Velankar A, Singh G, *et al*. A retrospective study to evaluate the effectiveness of radiographs versus computed tomography in determining fracture morphology in intertrochanteric fractures. International Journal of Orthopaedics Sciences. 2024;10(3):174-178.