Author: Embden, Daphne van
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Chapter 6

The value of a CT-scan compared to radiographs in the classification and treatment plan of trochanteric fractures

Daphne van Embden
Merel M. Scheurkogel
Inger B. Schipper
Steven J. Rhemrev
Sven A.G. Meylaerts

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ABSTRACT

Aim

The clinical relevance of classification for trochanteric fractures is limited and little agreement exists on what type of implant should be used. It is unknown whether more advanced radio-diagnostics, such as CT, result in better agreement on the treatment. We assessed the effect of CT on agreement of classification and subsequent treatment for trochanteric fractures.

Methods

Eleven observers (5 radiologists, 4 trauma surgeons and 2 orthopaedic residents) assessed 30 radiographs and CTs of trochanteric fractures. Each rating included an assessment according to the AO-classification, Jensen classification and of the preferred type of implant. The inter-observer agreement of the AO-classification, Jensen classification and on the choice of implant was calculated.

Results

The inter-observer agreement was κ0.70 (SE 0.03) for radiographic assessment of the main groups of the AO-classification and κ0.68 (SE 0.03) for CT assessment. The agreement on choice of implant was κ0.63 (SE 0.05) if the choice was made with radiographs and κ0.69 (SE 0.05) with CTs. Six out of the 13 fractures were classified differently after assessment of the CT. Most corrections in choice of implant occurred for the assessment of A3 fractures.

Conclusions

This study confirmed that trochanteric fractures can be reliably classified on both radiographs and CT, according to the main groups of the AO-classification. The implementation of CT for trochanteric fractures does not lead to higher agreement on fracture classification or choice of treatment. Therefore, the clinical relevance of CT for classification of trochanteric fractures seems low. For specific subgroups such as A3 fractures, CT may be of value for adequate fracture classification and subsequent treatment strategies.

INTRODUCTION

A valid fracture classification system serves as an aid in treatment plan decision making. However, choices in treatment are difficult to make when classification systems are unreliable, leading to disagreement between clinicians on fracture type and possible treatment strategies. Explanations postulated for low reliability of fracture classification include ambiguous classification descriptions and difficulties in interpreting plain radiographs. The relevance of classification systems of trochanteric fractures for determination of preferred type of fracture fixation is low, since little agreement in literature exists on what type of implant to use for the stable and unstable fractures.[1, 2]

The value of computed tomography (CT) for fracture classification has been studied for different types of complicated fracture patterns, such as tibial plateau fractures. CT proved to increase the agreement of surgeons on treatment plan[3] and CT is generally believed to lead to better understanding of the fracture pattern, resulting in improved pre-operative planning and is therefore most likely to ameliorate clinical outcome.[3-6]

In this study, we evaluated and compared the reliability of classification of trochanteric fractures, assessed on both radiographs and CT. We also evaluated the agreement of clinicians on the treatment plan after assessment of these fractures on radiographs and CT.

MATERIAL AND METHODS

Thirty consecutive patients with a fracture in the trochanteric region were prospectively included in a teaching hospital in the period between January 2010 and February 2011. After the patient had signed the informed consent, a standard AP and lateral radiograph and additional CT were performed, according to a standard scanning-protocol of the fractured hip. Patients with a pathological fracture or subtrochanteric extension were excluded.

Four trauma surgeons, 5 radiologists and 2 surgical residents with special interest in orthopaedic trauma were asked to classify these 30 AP- and lateral radiographs and 30 CT-scans.

The observers were asked to classify the fractures both according to the Jensen modification of the Evans' classification[7] and the 31-AO/ASIF classification.[8] (Figure 1) The assessments of the 31-AO/ASIF classification were used to extract the data of the AO-main group classification (fracture types A1, A2 and A3). All observers were familiar with both classifications. During classification sessions, an example of the classifications with a diagram of the different types of fractures was shown on each questionnaire.

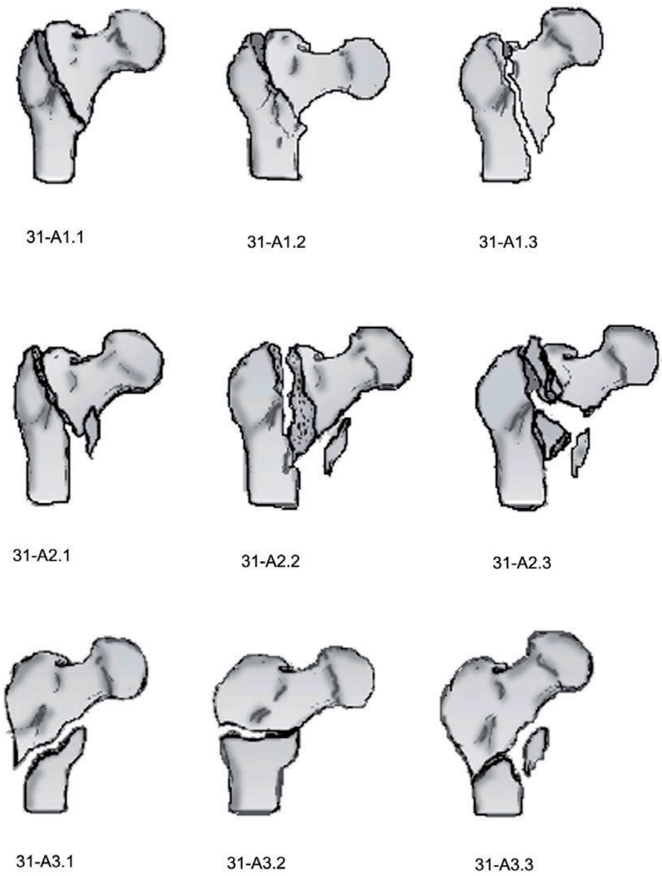

Figure 1

The AO/ASIF classification for trochanteric femur fractures

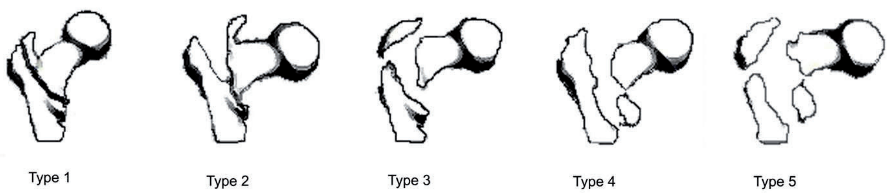

Figure 2

Jensen modification of the Evans classification

The Jensen modification of the Evans' classification (Figure 2) consists of six subtypes: type 1: undisplaced 2-part fracture, type 2: displaced 2-part fracture, type 3: 3-part fracture without posterolateral support due to dislocated of the greater trochanter fragment, type 4: 3-part fracture without medial support due to a dislocated lesser trochanter fragment and type 5: 4-part fracture without posterolateral and medial support. The reversed type of fracture, type R, was included.
The observers were allowed as much time for accurate assessment as needed. They were not allowed to discuss their findings with others. Only the surgeons and residents were asked for their proposed treatment plan after assessing the radiographs and CT-scans. They could choose between the most commonly used implants: the extramedullary implant dynamic hip screw (DHS) and the intramedullary implants: Gamma-nail/ PFNa or long Gamma-nail/PFNa. No additional information was given or asked.
Statistical analysis was performed by calculating the Cohen kappa value using SPSS 18.0 statistical software for intra-observer reliability. In order to calculate an unweighted multi-rater kappa for the inter-observer agreement a SPSS syntax using the statistical method of Fleiss' was used.[9] The number of patients to be included was estimated according to Shoukri.[10]
We interpreted the kappa value coefficient according to the guidelines proposed by Landis and Koch: 0.00 to 0.20 poor reliability, 0.21 to 0.40 fair reliability, 0.41 to 0.60 moderate reliability, 0.61 to 0.80 substantial agreement and 0.81 to 1.00 almost perfect agreement.[11]
The local ethical review board was consulted and approved our study according to their guidelines.

RESULTS

Thirty patients were included with a mean age of 78 years (SD 13.0). Eleven patients were male (37%).
In Table 1 the results of the inter-observer agreement of the AO-main group classification, and the Jensen classification are presented. AO-main group score a K-value of 0.70 (SE 0.03) for radiographs and 0.68 (SE 0.03) for CT, whereas the AO-classification including all subgroups had a kappa value of 0.34 (SE 0.02) and 0.27 (SE 0.02) and the Jensen classification had a kappa value for radiographs of 0.32 (SE 0.02) and 0.24 (SE 0.02) for CT. In Table 2 the results of the intra-observer agreement for the AO-main groups determined on radiographs and CT-scans are presented. The mean intra-observer agreement of the observers for the classification of the same fractures on radiograph and on CT was κ0.76 (SD 0.8).

Table 1

Inter-observer agreement

	Radiographs		CT	
	Kappa	95-CI	Kappa	95-CI
AO-main groups (A1-A2-A3)				
All	0.70	[0.64 - 0.76]	0.68	[0.62 -0.74]
Radiologists	0.61	[0.49 - 0.76]	0.55	[0.42 - 0.68]
Surgeons	0.76	[0.67 - 0.85]	0.77	[0.67 - 0.87]
Jensen				
All	0.32	[0.29 - 0.35]	0.24	[0.21 - 0.27]
Radiologists	0.41	[0.34 - 0.48]	0.25	[0.17 - 0.33]
Surgeons	0.31	[0.26 - 0.36]	0.26	[0.21- 0.31]

Table 2

Intra-observer agreement for the AO-main groups on radiographs and CT scans.

AO-main groups (A1-A2-A3)		**Intra-observer kappa (SE)**	
Observer		**Radiograph vs. CT**	
1	radiologist	0.77	(0.11)
2	radiologist	0.80	(0.11)
3	radiologist	0.76	(0.11)
4	radiologist	0.70	(0.12)
5	radiologist	0.67	(0.13)
6	trauma surgeon	0.94	(0.06)
7	trauma surgeon	0.76	(0.11)
8	trauma surgeon	0.86	(0.09)
9	trauma surgeon	0.69	(0.12)
10	resident	0.71	(0.11)
11	resident	0.69	(0.12)

Table 3

AO-main group ratings based on review of fracture radiographs and CT scans.

		AO-main group clasification on CT-scan			
		A1	A2	A3	Total
AO-main group classification	**A1**	75	10	0	85
on radiographs	**A2**	5	76	1	82
	A3	3	3	7	13
	Total	**83**	**89**	**8**	**180**

Table 4

Non-corresponding ratings

This Table shows the ratings that did not correspondent: the classification of the fractures that were reviewed by radiograph did not match the fracture classification based on the CT images. It concerns 11 different fractures. Furthermore, type of implant suggested by the observers is itemized.

Rating	Fracture	Observer		Radiograph	CT	Radiograph	CT
				AO-main group classification		Choice of implant	
1	1	E	R	A3	A2	long IM-implant	IM-implant
2	2	E	R	A3	A2	IM-implant	IM-implant
3	3	B	TS	A1	A2	DHS	IM-implant
4	3	C	TS	A1	A2	DHS	IM-implant
5	3	D	TS	A1	A2	DHS	IM-implant
6	4	F	R	A2	A3	long IM-implant	IM-implant
7	5	B	TS	A1	A2	DHS	DHS
8	5	D	TS	A1	A2	DHS	DHS
9	6	B	TS	A2	A1	IM-implant	DHS
10	6	D	TS	A2	A1	IM-implant	DHS
11	6	E	R	A2	A1	IM-implant	DHS
12	6	F	R	A2	A1	IM-implant	DHS
13	7	E	R	A3	A2	long IM-implant	IM-implant
14	8	C	TS	A1	A2	DHS	DHS
15	8	D	TS	A1	A2	DHS	IM-implant
16	8	F	R	A1	A2	IM-implant	IM-implant
17	9	A	TS	A1	A2	DHS	long IM-implant
18	10	E	R	A1	A2	DHS	DHS
19	10	F	R	A2	A1	IM-implant	DHS
20	11	B	TS	A3	A1	IM-implant	DHS
21	11	D	TS	A3	A1	IM-implant	IM-implant
22	11	B	TS	A3	A1	IM-implant	DHS

R (Resident); TS (Trauma Surgeon); Observer A to F, the different observers
DHS: dynamic hip screw IM: intramedullary implant

In Table 3 the plain radiograph and CT corresponding and non-corresponding numbers of fractures, classified according to the AO classification, are presented in a crosstab. Six out of the 13 fractures were classified differently after assessment of the CT. Table 4 shows the 22 cases in which the plain radiograph ratings for fracture classification and treatment were adjusted, after reviewing the same fracture on CT. Proportionally, most corrections in choice of implant occurred for the assessment of A3 fractures. Different fracture classifications resulted in a different choice of implant in 18 out of the 22 ratings. The clinicians showed an inter-observer agreement on the choice of implant of κ0.62 (SE 0.05) if radiographs were used for assessment. The agreement based on CT assessment was κ0.69 (SE 0.05). Table 5 shows different ratings of the proposed fracture fixations in regard to the proposed AO-fracture classification.

Table 5

Radiograph and CT based AO-fracture classification vs. choice of implant

		Implant			
		DHS	**Y-nail or PFN**	**Long Y-nail or PFN**	**Total**
AO-main group classification	**A1**	82	3	0	**85**
Radiographs	**A2**	1	70	11	**82**
	A3	1	6	6	**13**
	Total	**84**	**79**	**17**	**180**

		Implant			
		DHS	**Y-nail or PFN**	**Long Y-nail or PFN**	**Total**
AO-main group classification	**A1**	79	4	0	**83**
CT	**A2**	7	75	7	**89**
	A3	0	4	4	**8**
	Total	**86**	**83**	**11**	**180**

DISCUSSION

As the number of hip fracture patients substantially increases over the years, the need for optimal fracture treatment becomes even more important. An increase of agreement on fracture classification and treatment, by surgeons and in literature might lead to an improvement of hip fracture treatment.

It is generally accepted that CT improves the understanding of complex or intra-articular fracture patterns.[3-6] In other common osteoporotic fractures such as the distal radial fracture it was demonstrated that an increase of information gained by CT or 3D CT led to an increase in the quality of preoperative planning.[12, 13]

Because the majority of trochanteric fractures cannot be considered simple fractures requiring standard diagnostic work-up and treatment, this study was designed to evaluate whether preoperative CT increases agreement of fracture classification and improved consensus on the choice of fracture fixation for trochanteric fractures.

In our study the agreement on fracture type according to three classifications were compared after an assessment by radiograph and CT. The 31-AO-main group classification showed to be the most reliable classification, with a 'substantial' agreement. All observers showed an intra-observer κ> 0.65 agreement, which shows that no substantial difference exists between assessment of a trochanteric fracture on radiograph or CT, if

classified according to the AO-main group classification. These results were similar to those found by Chapman et al[14], who also investigated the classification of trochanteric fractures.
Agreement on type of fracture fixation device showed 'substantial' agreement. To date, in literature, trochanteric fracture classification did not influence implant choice, as it remains unclear, especially in the unstable fracture types, what implant is best to use for different type of trochanteric fractures. Currently, sliding hip screw devices are most commonly used for the stable fractures such as the type A1 fractures and intramedullary devices are most commonly used for A3 fractures. The optimal treatment device for the A2 fractures still is topic of debate.[15] Recent studies have showed some advantages of the more expensive intramedullary nails although most of these studies did not analyse for the separate fracture subtypes.[16, 17]
In this study we have decided to simply ask the trauma surgeons and residents what implant they would use based on the fracture they had classified on the radiograph or CT. Our results show that these observers did change their choice of implant depending on whether the fracture was assessed on a radiograph or CT. In most of the cases where the classification of the fracture was changed by the residents and surgeons, this also resulted in a different choice of osteosynthesis (Table 4). Additional information on the fracture pattern and subsequent classification therefor proves to be of major importance for the specific choice of treatment.
Our study also shows that most clinicians consistently propose their implants according to the AO classification. In the majority of the cases, type A1 fractures would be treated with a DHS, type A2 fractures with IM-nailing and a type A3 fracture by regular or long IM-nail depending on the distal extension of the fracture. This classification therefore does what it should do: it has a reasonably high agreement on fracture classification among clinicians and predicts treatment in an acceptable manner. For future studies investigating the subject of trochanteric fracture treatment, we recommend to incorporate this relative reliable fracture classification.
Our results are supported by the findings of Palm et al.[18, 19] who describe in their paper the reliable use of treatment algorithms for hip fracture treatment. By accepting and using a universal treatment algorithm we might improve the applicability of studies regarding hip fracture treatment and improve the quality of care for this very common severe fracture.
As shown in the results, classification of the complex A3 fractures is more challenging. In previous studies the AO 31-A3 fracture has proven to be a different type of fracture as compared to the type A1 and A2, in terms of mechanical stability.[20,21] For instance, treatment of A3 fractures with extramedullary implants may lead to high rates of fixation failure as the hip screw does not cross the primary fracture line and forces that result in varus cannot be withheld by these implants.[20,21] Although our data suggests no general

advantages of preoperative CT scan for trochanteric fractures, an additional CT scan for the more complex A3 fractures might be of value, as these seem to be more difficult to classify and determine the choice of implant (Table 4): most alterations of implant chosen for treatment were made for A3 fractures. The A3 fracture suffers from higher complication rates up to 32%, mostly non-union or fixation failure.[20, 21] Performing a preoperative CT scan in order to gain information on fracture features such fracture line properties and amount of communition, could lead to improved preoperative planning and reduce the chance of malreduction, which is believed to be a major cause of fixation failure in these fractures.[3, 12, 13] Shen et al[22] assessed the influence of a preoperative CT study present during operation, on the length of operative procedure and demonstrated that a preoperative CT resulted in shorter operating times for intramedullary nailing for hip fractures. There was no additional value of performing a preoperative CT if extramedullary fixation was performed. This was explained by the presence of maximal surgical exposure if extramedullary fixation was performed, undoing the effect of the CT. In the A3 fractures, predominantly treated by intramedullary nailing, preoperative planning using a CT could therefore be of value.

One of the limitations of this study is, that we have shown the observers the radiographs and the CT images separately and not as combined sets of radiodiagnostic images. We therefore did not truly investigate the clinical additional value of a CT-scan after a standard radiograph, which might for future studies be the more realistic clinical situation. Furthermore, the surgeons' or residents' reasons for choosing a specific type of osteosynthesis were not specified nor documented in this study.

To conclude, the classification of trochanteric fractures on radiographs according to the AO-main groups is reliable: it has a reasonably high agreement among clinicians and it predicts treatment in an acceptable manner. In general for trochanteric fractures, there seems to be no increase of reliability if additional CT is used and CT scan of the fracture does not lead to better agreement on choice of implant. The clinicians in this study showed good agreement and are consistent regarding the fracture classification according to the AO-main groups and choice of implant, except for the more complex A3 trochanteric fractures. For this specific group of challenging fractures an additional CT may be of value for adequate fracture classification and subsequent treatment strategies.

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