



Original Article

Reproducibility of the Tronzo and AO classifications for transtrochanteric fractures[☆]



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ABSTRACT

Objective: To analyze the reproducibility of the Tronzo and AO classifications for transtrochanteric fractures.

Method: This was a cross-sectional study in which the intraobserver and interobserver concordance between two readings made by 11 observers was analyzed. The analysis of the variations used the kappa statistical method.

Results: Moderate concordance was found in relation to the AO classification, while slight concordance was found for the Tronzo classification.

Conclusion: This study found that the AO/Asif classification for transtrochanteric presented greater intra and interobserver reproducibility and that greater concordance was correlated with greater experience of the observers. Without division into subgroups, the AO/Asif classification was shown, as described in the literature, to be acceptable for clinical use in relation to transtrochanteric fractures of the femur, although it did not show absolute concordance, given that its concordance level was only moderate. Nonetheless, its concordance was better than that of the Tronzo classification.

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Reprodutibilidade das classificações de Tronzo e AO para fraturas transtrocanterianas

RESUMO

Objetivo: Analisar a reprodutibilidade das classificações AO e de Tronzo para fraturas transtrocanterianas.

Método: Estudo transversal que analisou a concordância entre duas leituras feitas por 11 observadores, intraobservadores e interobservadores. A análise das variações usou o método estatístico Kappa.

Palavras-chave:

Fraturas do quadril

Fraturas do colo

femoral/classificação

Reprodutibilidade dos testes

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Resultados: Verificou-se concordância moderada para a classificação AO enquanto a classificação Tronzo mostrou concordância leve.

Conclusão: O trabalho evidenciou maior reprodutibilidade da classificação AO/Asif inter e intraobservador para as fraturas transtrocanterianas de fêmur, o que tem relação com o aumento da predominância de concordância com a experiência dos observadores. A classificação AO/Asif sem divisão em subgrupos mostrou-se, assim como descrito na literatura, aceita para o uso clínico nas fraturas transtrocanterianas de fêmur. No entanto, não mostrou concordância absoluta, uma vez que seu nível de concordância é apenas moderado, mas superior quando comparada com a classificação Tronzo.

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Introduction

Transtrochanteric fractures are extracapsular and are characterized as occurring in the area between the greater and lesser trochanters of the femur.¹ This area of the femur is predominantly spongy and vascularized.

Elderly patients are more vulnerable to this type of fracture because of their bone fragility. In these patients, falling to the ground is a relatively common mechanism.^{1,2} In surveys conducted between 1941 and 1971 that were cited by DeLee,³ it was noted that patients with transtrochanteric fractures were on average 10–12 years older than patients with fractures of the femoral neck (which are intracapsular), with a mean between 66 and 76 years. It was also noted that cases among females predominated over cases among males, with ratios of 2:1–8:1.

Transtrochanteric fractures also affect young adults, especially through mechanisms of high-energy trauma.¹ The incidence of these fractures is increasing, along with the costs involved in treating them. In Brazil, in a survey conducted by the Ministry of Health, it was observed that 90% of the financial resources destined for orthopedic diseases are consumed by nine diseases, and transtrochanteric fractures were one of these.⁴

Another problem that is faced is that one-third of the patients die within the first year after the injury and that approximately 50% of the patients become incapable of walking alone or going up stairs, and 20% require full-time home care.⁵

The principal method for precisely determining the diagnosis of these fractures is radiography, but shortening of the limb and its positioning in external rotation are important clinical findings that corroborate the diagnosis of this type of injury.⁶ The treatment is surgical and involves use of plates with a sliding screw, cephalomedullary nails or fixed-angle plates, with a view to achieving patient rehabilitation as quickly as possible.⁶

There are several classification systems for transtrochanteric fractures. However, the main characteristic of a classification system is that it should contain valid information that helps to describe the nature of the fracture, such as topography, configuration of the fracture, degree of stability and severity. Another characteristic is that it should aid in planning for osteosynthesis and in predicting the prognosis

after definitive synthesis, with the objective of achieving stable anatomical primary reduction.^{2,7} It is also important that any classification system should be reproducible between different observers and also by the same observer on different occasions.⁷

The Tronzo classification for transtrochanteric fractures⁸ was created in 1974 and is still one of the systems most used today. It was based on the classification of Boyd and Griffin,⁹ who classified fractures according to the possibility of achieving and maintaining reduction (four types: I– stable in two parts; II– unstable and comminutive; III– unstable and reverse oblique; and IV – intertrochanteric–subtrochanteric with two fracture planes). In 1949, Evans⁷ classified fractures after surgical treatment as stable or unstable.

Tronzo⁸ (Fig. 1) modified the classification of Boyd and Griffin,⁹ and this resulted in five types. This classification system is greatly used today.

The AO (Arbeitsgemeinschaft für Osteosynthesefragen) classification^{10,11} was initially created by Müller et al.¹⁰ in the 1980s and has periodically undergone updates with the aim of standardizing the classification of fractures for worldwide coverage, through a system for locating the bone and the type of involvement (letter and number), such that an alphanumeric code would make it possible for professionals to promptly know what had happened, which would facilitate communication between orthopedic services. For this reason, this system is the one currently most used in studies. In this system, trochanteric fractures are represented by code 31-A. They are subdivided into three groups based on the obliquity of the fracture line and the degree of damage (bone fragmentation).¹¹

Group 1 presents a fracture line that starts in any region of the greater trochanter and extends as far as a point above or below the lesser trochanter. There are only two fragments and the medial cortex is fractured in only one locality. These fractures are stable after reduction and fixation, since there is good contact between the fragments, without bone loss. The lesser trochanter is intact.¹¹

In group 2, the fractures are multifragmented and the fracture line starts laterally in the greater trochanter and continues to the medial cortical bone, as a two-part fracture. There is then a third fragment, which is the lesser trochanter. In this group, only fractures in subgroup A2.1 are considered to be stable, given that this third fragment is small and the greater trochanter is intact.³

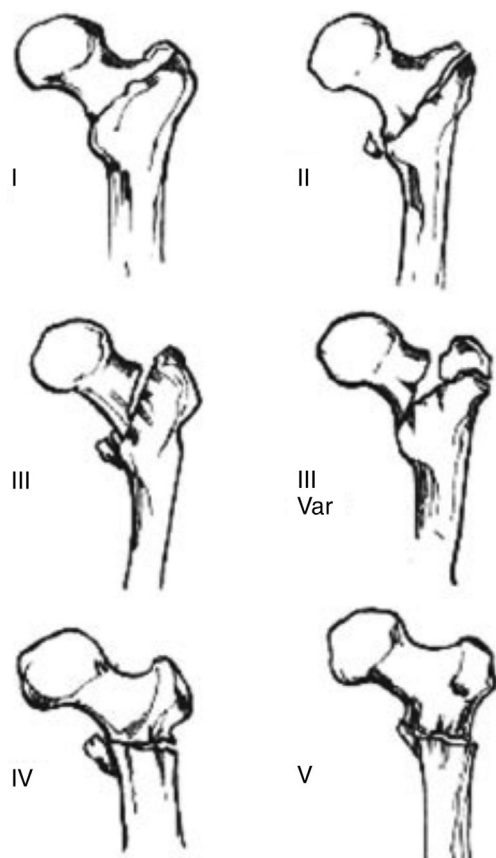


Fig. 1 – Tronzo classification.

Group 3 presents a fracture line that crosses the intertrochanteric region, above the lesser trochanter medially and below the crest of the vastus lateralis in the lateral region. The line affects both cortices and has the characteristics of reverse obliquity.³

This classification also divides the groups into three subgroups, but in the present study, only the groups 31-A1, 31-A2 and 31-A3 (Fig. 2) are used, given that fractures of the same subgroup present similar biomechanical behavior.

The objective of this study was to evaluate the reproducibility of the AO/ASIF classification without division into subgroups and the Tronzo classification, for transtrochanteric fractures, by means of concordance analysis between pairs of readings made by observers at different stages of training.

Materials and methods

Fifty preoperative radiographs in anteroposterior (AP) and lateral views on patients with diagnoses of transtrochanteric fractures of the femur that occurred between January 2012 and December 2012 were selected. All of these individuals were skeletally mature (over the age of 20 years).

Patients with previous pathological conditions in their limbs that possibly modified the normal anatomy, such as previous fractures in the coxofemoral region, malformations, infections and bone tumors were excluded from the case selection. From these data, a multiple-choice questionnaire

Table 1 – Classification of the strength of concordance according to the kappa coefficient.

Kappa coefficient	Strength of concordance
Less than zero	Poor
0.00–0.20	Negligible
0.21–0.40	Low
0.41–0.60	Moderate
0.61–0.80	High
0.81–1.00	Almost perfect

Table 2 – Kappa index, standard error and concordance between the two readings at different times, for the AO classification.

Comparison between the readings	Kappa	SE	Concordance
O1A vs. O1B	0.71	0.09	High
O2A vs. O2B	0.48	0.12	Moderate
O3A vs. O3B	0.13	0.11	Negligible
O4A vs. O4B	0.77	0.08	High
O5A vs. O5B	0.65	0.10	High
O6A vs. O6B	0.24	0.08	Low
O7A vs. O7B	0.71	0.10	High
O8A vs. O8B	0.41	0.11	Moderate
O9A vs. O9B	0.43	0.10	Moderate
O10A vs. O10B	0.71	0.09	High
O11A vs. O11B	0.64	0.10	High

O1 to O11, observers; A, first reading; B, second reading; SE, standard error.

was formulated in order to classify the fractures according to the AO system (31.A1, 31.A2 and 31.A3, without the subgroups of each division) (Table 1) and according to the classification of Tronzo (1973)⁸ (Table 2). A space was provided below each figure and, for each column, only one response was to be indicated.

Eleven physicians were chosen. Among these, three were first-year residents, three were third-year residents of a medical residency program on orthopedics and traumatology, two were orthopedists with specialist titles with up to 5 years of experience and three were orthopedists with specialist titles with more than 5 years of experience. These physicians were identified sequentially with numbers from 1 to 11. All the evaluators worked in the same orthopedics service at a trauma referral hospital. The classifications were reviewed with all the participants individually, before the questionnaire was applied.

The radiographs were analyzed independently, without contact between the evaluators, under identical conditions for all of these observers. There was no time limit for answering the questionnaire.

One month later, the same observers evaluated the same radiographs, without any knowledge of what the responses they made previously were, or any knowledge of the data from the other evaluators. None of the observers had access to the data relating to the surgical treatment on each fracture.

A cross-sectional study was conducted, with analysis on intra and interobserver variations, using the kappa statistical method, which assesses the concordance between the

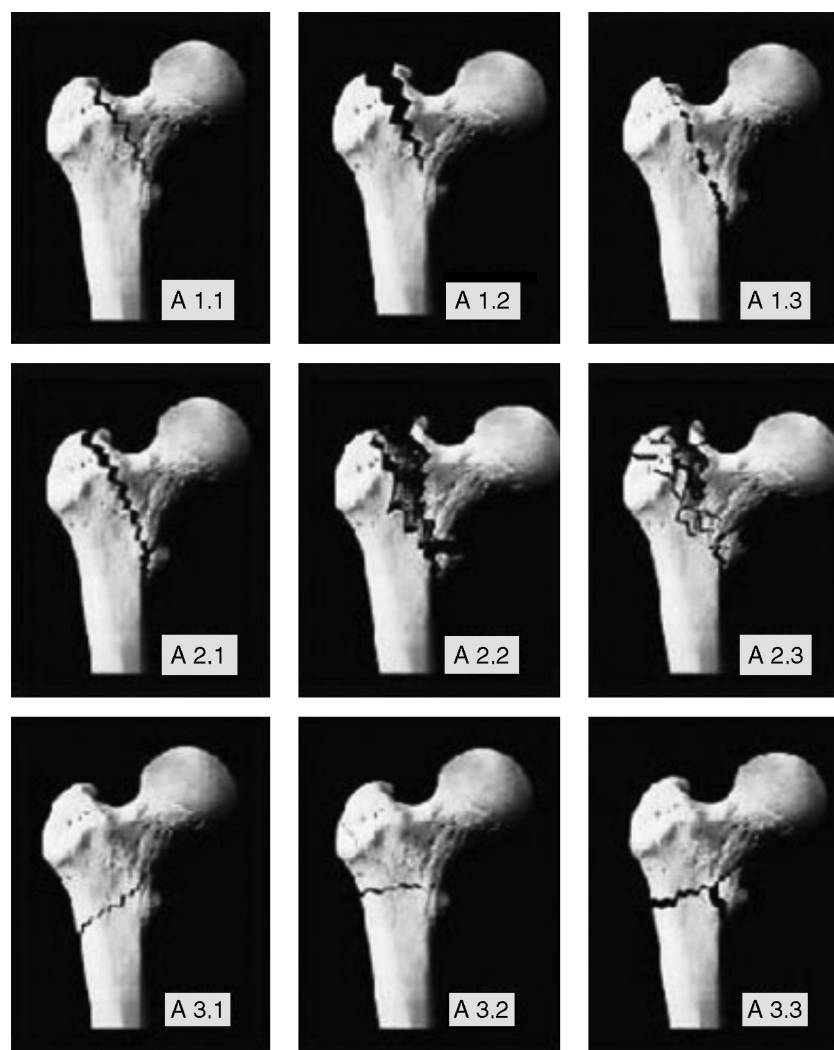


Fig. 2 – AO classification according to subgroups.

observers by means of paired analyses. The observed proportions of concordance between the observers (P_o) and within the observers were compared. These values could vary from a result of less than 0 (poor) to 1 (almost perfect).

Results

The observers analyzed 50 preoperative radiographs in AP and lateral views, on transtrochanteric fractures of the femur and categorized the fractures in accordance with the AO and Tronzo classifications. Each observer made two analyses with a 1-month interval between them, without knowledge of the previous results and without prior contact with the other observers. The results were analyzed by means of the kappa method and the results relating to the strength of the intra and interobserver concordance were subdivided into six levels. Kappa index values less than 0 were classified as presenting poor strength of concordance; values from 0 to 0.2 as negligible; 0.21 to 0.40 as low; 0.41 to 0.60 as moderate; 0.61 to 0.80 as high; and 0.81 to 1.0 as almost perfect.

The presentation of the kappa index, standard error (SE) and concordance between the two readings of the AO/ASIF classification made by the 11 observers at two different times (Table 2) showed that the SE ranged from 0.9 to 1.2 and the kappa index from 0.13 to 0.77, with predominance in the moderate to high group of strength of concordance (Fig. 3).

The presentation of the kappa index, SE and concordance between the two readings of the Tronzo classification made by

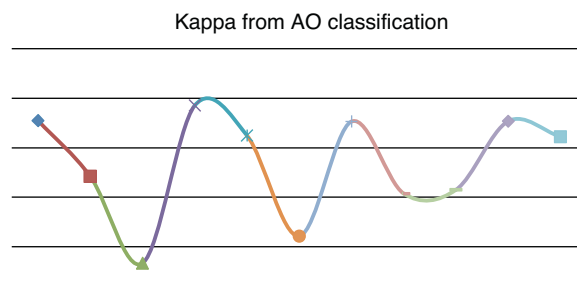


Fig. 3 – Variation in interobserver kappa index from using the AO classification.

Table 3 – Kappa index, standard error and concordance between the two readings at different times, for the Tronzo classification.

Comparison between the readings	Kappa	SE	Concordance
O1A vs. O1B	0.26	0.08	Low
O2A vs. O2B	0.59	0.09	Moderate
O3A vs. O3B	–	–	NA
O4A vs. O4B	0.55	0.08	Moderate
O5A vs. O5B	0.5	0.08	Moderate
O6A vs. O6B	0.24	0.08	Low
O7A vs. O7B	0.51	0.08	Moderate
O8A vs. O8B	0.22	0.08	Low
O9A vs. O9B	–	–	NA
O10A vs. O10B	0.35	0.08	Low
O11A vs. O11B	0.26	0.08	Low

O1 to O11, observers; A, first reading; B, second reading; SE, standard error. NA, not applicable because of the asymmetry of the data.

the 11 observers at two different times (Table 3) showed that the SE ranged from 0.08 to 0.09 and the kappa index from 0.22 to 0.59. Two observers could not be included because of great asymmetry of the data at the two different data-gathering times. The strength of concordance was predominately low to moderate for the Tronzo classification (Fig. 4).

The kappa index analysis comparing the two different readings for the AO and Tronzo classifications, made by the observers at different times, showed that for the AO classification the kappa index was 0.53 with SE of 0.03, i.e. showing moderate concordance. On the other hand, the Tronzo classification showed a kappa index of 0.36 and SE of 0.03, i.e. showing fair concordance.

The analysis and comparison were performed using the same statistical method, which correlated the observers according to their job positions and experience (Table 4). In the analysis on the AO classification, high kappa indexes and concordance were seen among the more experienced observers, i.e. those with more than 5 years since completion of training and those who had completed their training less than 5 years ago. The observers who were medical residents presented lower values (Table 4).

The same analysis on the kappa index, standard error and predominance of concordance according to job position and experience among the observers was performed on the Tronzo classification, as shown in Table 5.

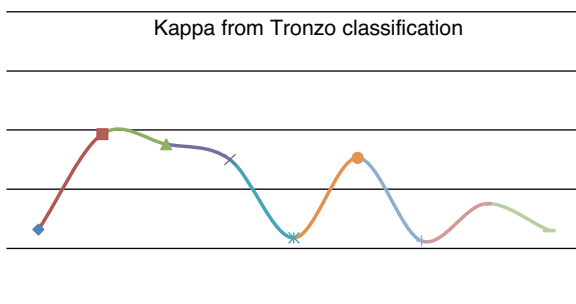


Fig. 4 – Variation in interobserver kappa index from using the Tronzo classification.

Table 4 – AO classification, job position, kappa index, standard error and concordance.

Job position	Comparison between the readings	Kappa	SE	Concordance
S > 5 y	O1A vs. O1B	0.71	0.09	High
S > 5 y	O11A vs. O11B	0.64	0.1	High
S > 5 y	O7A vs. O7B	0.71	0.1	High
S < 5 y	O4A vs. O4B	0.77	0.08	High
S < 5 y	O5A vs. O5B	0.65	0.1	High
R3	O10A vs. O10B	0.71	0.09	High
R3	O2A vs. O2B	0.48	0.12	Moderate
R3	O8A vs. O8B	0.41	0.11	Moderate
R1	O9A vs. O9B	0.43	0.1	Moderate
R1	O6A vs. O6B	0.24	0.08	Low
R1	O3A vs. O3B	0.13	0.11	Negligible

O1 to O11, observers; A, first reading; B, second reading; SE, standard error.
 S > 5 y, specialist with more than 5 years of experience since training; S < 5 y, specialist with less than 5 years of experience since training.
 R3, third-year resident; R1, first-year resident.

Discussion

All fracture classification systems have the objectives of guiding the treatment, aiding in surgical planning and having the capacity to be reproduced with high concordance by different observers in different situations. The kappa statistical system has the capability to numerically transmit the real capacity of fracture classification systems.

Schipper et al.¹² studied the AO classification system for transtrochanteric fractures of the femur using 20 X-ray images that were analyzed by 15 observers. From the AO classification with subgroups, they reported a mean intraobserver kappa

Table 5 – Analysis on the Tronzo classification system in relation to the observers’ experience.

Job position	Comparison between the readings	Kappa	SE	Concordance
S > 5 y	O1A vs. O1B	0.26	0.08	Low
S > 5 y	O11A vs. O11B	0.26	0.08	Low
S > 5 y	O7A vs. O7B	0.51	0.08	Moderate
S < 5 y	O4A vs. O4B	0.55	0.08	Moderate
S < 5 y	O5A vs. O5B	0.5	0.08	Moderate
R3	O10A vs. O10B	0.35	0.08	Low
R3	O2A vs. O2B	0.59	0.09	Moderate
R3	O8A vs. O8B	0.22	0.08	Low
R1	O9A vs. O9B	–	–	NA*
R1	O6A vs. O6B	0.24	0.08	Low
R1	O3A vs. O3B	–	–	NA*
R1	O3A vs. O3B	0.13	0.11	Negligible

O1 to O11, observers; A, first reading; B, second reading; SE, standard error.
 S > 5 y, specialist with more than 5 years of experience since training; S < 5 y, specialist with less than 5 years of experience since training.
 R3, third-year resident; R1, first-year resident.

index value of 0.48 and an interobserver value of 0.33. From the AO system without subgroups, the intraobserver kappa value was 0.78 and the interobserver value was 0.67. A previous study on five patients with transtrochanteric fractures of the femur also concluded that using the AO classification was unreliable.¹³

Newey et al.¹⁴ reported that the alphanumeric system of the AO classification was unnecessarily complicated and that its use in clinical practice fell short of what would be desirable and made little contribution toward surgical planning.

According to Pervez et al.,² the results obtained from their study confirmed that both the AO/ASIF and the Jensen classification system were unacceptable.

However, when the AO/ASIF system was divided into only three groups (31A1, 31A2 and 31A3), it became acceptable. For those who find the alphanumeric terminology confusing, Pervez et al.² recommended that these groups should be named stable trochanteric fracture (31A1), unstable trochanteric fracture (31A2) and trochanteric fracture with reverse line (31A3).

In a study that compared the AO/ASIF and Jensen classifications, Van Embden et al.¹⁵ found that the AO system had poor reliability and the Jensen system had moderate reliability. They concluded that there was a need to create a new classification or to improve the existing classifications in order to achieve better categorization and treatment proposals.

We did not find any studies in the literature that analyzed the reproducibility of the Tronzo classification.

We found that the mean intraobserver kappa index for the AO classification was 0.53 (0.13–0.71), with predominance of moderate to high concordance. There was great inequality in the analysis in relation to the job position and experience of the observer, such that high concordance predominated among the professionals who had already achieved the title of specialist, with a kappa index of 0.696 (range: 0.64–0.77) and standard error of 0.8–1. In our analysis on the residents (both at R1 and at R3 level), there was lower concordance, such that the mean kappa index was 0.4 (range: 0.13–0.71), with predominance of low concordance and a standard error of 0.8–1.2.

The mean intraobserver kappa index for the Tronzo classification was 0.31, with predominance of low to moderate concordance. On the other hand, in relation to the AO/ASIF system, comparison of the job position and experience of the observers showed that the kappa index was 0.416 for the observers who already had specialist titles, with predominance of moderate concordance, while the kappa index was 0.23 for the less experienced observers. In the group of less experienced observers, it should be highlighted that the data gathered in relation to the Tronzo system by two of these observers could not be included in the analysis because of great asymmetry of the data from one reading to the other.

Conclusion

We found that higher concordance predominated in using the AO/ASIF classification, in relation to the Tronzo classification, both in intra and interobserver comparisons. We also observed that in relation to both classifications, there was

higher concordance among the more experienced observers (physicians with specialist titles) than among the less experienced observers (residents).

The predominant concordance level in the AO/ASIF system without divisions was only moderate, and this was compatible with studies found in the literature. In the case of the Tronzo classification, low concordance was found to predominate. The AO/ASIF classification system was characterized as acceptable for clinical practice, albeit imperfect, given the higher concordance among observers with greater experience.

Conflicts of interest

The authors declare no conflicts of interest.

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