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Original Article

Reproducibility of the AO/ASIF and Gartland classifications for supracondylar fractures of the humerus in children☆

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ABSTRACT

Objective: To evaluate the reproducibility of the radiographic classifications of Gartland and the Association for Osteosynthesis/Association for the Study of Internal Fixation (AO/ASIF) for supracondylar fractures of the humerus in children.

Methods: On two occasions, 50 radiographs in anteroposterior and lateral views were evaluated by three pediatric orthopedists in accordance with the Gartland and AO/ASIF pediatric classifications. Their responses were subjected to statistical analysis consisting of calculation of the κ coefficient to assess the intra- and interobserver concordance, in both classifications.

Results: The strength of the intraobserver concordance was high or near perfect for the three examiners in the two classification systems. The strength of the interobserver concordance was high in the two systems, with κ coefficients of 0.756 for the Gartland classification and 0.766 for the AO/ASIF classification.

Conclusion: The Gartland and AO/ASIF classification systems showed similar reproducibility and performance. High strength of concordance was seen in the intra- and interobserver analyses.

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Reprodutibilidade das classificações AO/ASIF e Gartland para fraturas supracondilianas de úmero em crianças

RESUMO

Objetivo: Avaliar a reprodutibilidade das classificações radiográficas de Gartland e Association for Osteosynthesis/Association for the Study of Internal Fixation (AO/ASIF) para fraturas supracondilianas de úmero em crianças.

☆ Work developed in the Discipline of Orthopedics and Traumatology, Universidade Federal do Triângulo Mineiro, Uberaba, MG, Brazil.

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Variações dependentes do observador
Reprodutibilidade dos resultados

Métodos: Em duas ocasiões foram avaliadas por três cirurgiões ortopedistas pediátricos 50 radiografias nas incidências anteroposteriores e perfil de acordo com as classificações de Gartland e AO/ASIF pediátrica. As respostas foram submetidas à análise estatística pelo cálculo do coeficiente κ para avaliar a concordância intra- e interobservador, em ambas as classificações.

Resultados: A força de concordância intraobservador foi grande ou quase perfeita para os três examinadores nos dois sistemas de classificação. A força de concordância interobservador foi grande nos dois sistemas, com coeficiente κ de 0,756 para classificação de Gartland e de 0,766 para classificação AO/ASIF.

Conclusão: Os sistemas de classificação de Gartland e AO/ASIF mostraram reprodutibilidade e desempenho similar. Observou-se grande força de concordância nas análises intra- e interobservador.

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Introduction

Supracondylar fractures are the commonest type of elbow fractures in children and the second commonest type of fracture during childhood, accounting for more than 60% of the cases.[1–4] They occur most frequently between the ages of five and ten years.[5] The various classification systems proposed for these fractures have had the aims of guiding the treatment, estimating the prognosis and enabling standardization and comparison among the many scientific studies. These classifications need to be simple, easy to apply clinically and reproducible, with high concordance between surgeons.[6–8] The Gartland classification for supracondylar fractures of the humerus is the one most used.[9,10] In this classification system, fractures are grouped according to their degree of displacement.

Although the LaGrange[11] classification is more descriptive and detailed in cases of greater displacement, it is not the system most used.

In turn, the system adopted by the AO group[12] for fractures of the long bones in children combines the classification of Muller et al.[13] for adults with an additional description focused on the immature skeleton.[8] This is an alphanumeric system that includes the bone affected, the location and the severity, along with the peculiarities of the growing bone. Thus, supracondylar fractures would be described as 13-/9.1 with an ending of I, II, III or IV, according to whether the fracture was complete or incomplete, and with or without contact between the fragments. In this manner, only the exception component (I–IV) of the morphological segment of the AO/ASIF classification was taken into consideration in the present study.

The objective of this study was to assess the reproducibility of the Gartland and AO/ASIF classifications for supracondylar fractures of the humerus in children, by investigating the levels of intra- and interobserver concordance.

Methods

This study was conducted in a referral hospital that attends orthopedic trauma cases, after receiving approval from the institution's ethics committee. Fifty conventional radiographs (anteroposterior and lateral views) originating from initial attendance of patients with supracondylar fractures of the humerus, produced between January and June 2013, were selected for evaluation.

The radiographic images for the study were obtained by means of high-resolution digital photography, with preservation of the original characteristics of the film.

The selection did not take into consideration the quality of the radiography. Images from patients over the age of 16 years, from those who presented a closed growth plate line and from those presenting multiple fractures on radiographs were excluded. The images were evaluated by three pediatric orthopedists who had had previous access to the classification systems. Seven days of training before the analysis was permitted.

The examiners evaluated the 50 images over a maximum time of two hours and made a second evaluation with the same duration, two weeks later. The order of the 50 images was varied through randomization. The examiners did not have access to the responses of their peers or to their own responses given on the previous occasion.

The responses given by each examiner to the radiographic evaluations were written on a printed chart that was handed out to each participant, together with a free and informed consent statement.

The results were gathered and analyzed with the aid of the SPSS® software, version 12.0 (Chicago, USA), in order to determine the κ coefficient, which inferred the degree of concordance beyond what would be expected only by chance. The strength of the intra- and interobserver concordance of the

Table 1 – Association between the κ coefficient and the strength of concordance.[14]

κ coefficient	Strength of concordance
Less than zero	Poor
0–0.20	Negligible
0.21–0.40	Slight
0.41–0.60	Moderate
0.61–0.80	High
0.81–1.00	Almost perfect

Table 2 – Intraobserver concordance level according to the κ coefficient, in relation to the Gartland and AO classifications for supracondylar fractures of the humerus in children.

	Gartland	AO
Examiner 1	0.781	0.767
Examiner 2	0.859	1
Examiner 3	0.719	0.782

Table 3 – Interobserver analysis on κ coefficient for Gartland classification.

	Gartland I	Gartland II	Gartland III
κ	0.945	0.535	0.677
p-Value of κ	<0.001	<0.001	<0.001
95% confidence interval of κ	Upper: 1.0 Lower: 0.785	Upper: 0.695 Lower: 0.375	Upper: 0.837 Lower: 0.517

two classification systems was then determined, as detained in Table 1.[14]

Results

The intraobserver concordance according to the κ coefficient, relating to the Gartland classification for supracondylar fractures of the humerus in children and the AO/ASIF classification for fractures in children, as presented in Table 2, was high or almost perfect for all the examiners in relation to both classifications. For two of the three examiners, the concordance for the AO/ASIF system was slightly higher.

Tables 3 and 4 present the interobserver analyses for the Gartland and AO classifications, respectively. It can be seen that the interobserver concordance decreased with regard to category II, in both classification systems.

As shown in Table 5, the interobserver evaluation showed κ of 0.756 for the Gartland classification and 0.766 for the AO/ASIF classification, which thus shows high concordance between the two systems.

Discussion

The diversity of classification systems for a group of fractures that is published over the course of time may give rise to interpretational conflicts.

Thus, the validity, reproducibility and correlations of well-established classifications need to be verified, given that comparisons between different evaluations, with exclusion of causality and personal bias, can demonstrate the qualities or weaknesses of a given system under examination. According to Audigé et al.,[6] for these objective to be attained, the classification system needs to go through three research phases before it is validated for clinical use.[6,14]

To know whether a given characterization or classification for an object is reliable, this object needs to be evaluated several times, by more than one examiner. For this, in the present study, the κ coefficient was used. This infers the degree of concordance beyond what would be expected purely by chance. It is based on the number of concordant responses, i.e. the number of cases for which the result is the same among the examiners.[15,16]

In the present study, the examiners seemed to be "well calibrated", both within themselves and with the others. The interobserver concordance values were within the 95% confidence interval, with $p < 0.001$ in both classification systems. Therefore, these values presented statistical significance. As also found by Brandão et al.,[14] our interobserver concordance index was no greater than 0.8, even though the observers were all pediatric orthopedists.

The concordance found between the Gartland and AO/ASIF classification systems was satisfactory (high or almost perfect). These systems had similar performance, despite the greater complexity of the AO/ASIF system and the examiners' lower degree of familiarity with this system.

In the present study, the lowest strength of concordance (moderate) in the interobserver analysis was found in type II of the Gartland and AO/ASIF classifications. However, according to Heal et al.,[10] the lowest level of interobserver concordance for the Gartland classification occurred in type I.

It was observed that variations in the degree of concordance in the interobserver analysis of different studies[10,14] did

Table 4 – Interobserver analysis on κ coefficient for AO classification.

	AO I	AO II	AO III	AO IV
κ	0.865	0.435	0.75	1.0
p-Value of κ	<0.001	<0.001	<0.001	<0.001
95% confidence interval of κ	Upper: 1.0 Lower: 0.705	Upper: 0.595 Lower: 0.275	Upper: 0.91 Lower: 0.59	Upper: 1.0 Lower: 0.84

Table 5 – General κ coefficient for interobserver evaluation, according to classification system.

	Number of radiographs	General κ	General *p*-value	95% confidence interval of κ
Gartland	50	0.756	<0.001	Upper: 0.874 Lower: 0.637
AO/ASIF	50	0.766	<0.001	Upper: 0.868 Lower: 0.665

not invalidate the constant observation that the two classifications have good reproducibility.

Evaluation of the reproducibility of these classifications is of importance insofar as they guide the type of treatment instituted for these fractures (conservative versus surgical). They also enable standardization of the orthopedic language for comparing studies from different centers.

Now that the reproducibility of these classification systems has been verified, it becomes necessary to conduct further studies to ascertain whether one of them might be superior to the other and thus to determine a standard system.

Conclusion

The Gartland and AO/ASIF classification systems showed similar reproducibility and the intra- and interobserver analyses showed high strength of concordance, even though use of the AO/ASIF system remains limited among orthopedists and, consequently, their familiarity with this method is lower.

Conflicts of interest

The authors declare no conflicts of interest.

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