Research article

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Analysis of the risk of a secondary displacement in conservatively treated paediatric distal radius metaphyseal fractures. A multicentric study

P. Persiani[1], L. Martini[1], V. Calogero[1], E. Giannini[1], T. Speziale Varsamis[1], O. Mazza[2], M. Crostelli[2], D. Mascello[3], D. De Meo[1], C. Villani[1]

[1]*Department of Anatomical, Histological, Forensic Medicine and Musculoskeletal System Sciences, Sapienza University of Rome, Italy;* [2]*IRCCS Bambino Gesù Paediatric Hospital, Rome, Italy;* [3]*IRCCS Bambino Gesù Paediatric Hospital, Palidoro, Italy*

Abstract

Objectives. Distal radius fractures represent one of the most frequent injuries in children. The treatment of choice is a closed reduction followed by immobilisation in plaster cast; the immediate recourse to osteosynthesis with Kirschner wires is only reserved for certain cases. The displacement rate reported in the literature is 21-39%. The aim of this study is to retrospectively evaluate the risk factors for a secondary displacement of metaphyseal radius fractures in a paediatric population treated in three different centres.

*Materials and method*s. The initial treatment for all 360 patients examined was a closed reduction under general anaesthesia and immobilisation in an above elbow cast for 4 weeks. The pre-operative displacement, residual post-reduction displacement and possible displacement at 7 and 14 days of follow-up were all assessed clinically and radiographically.

Results. A loss of reduction was reported in 102 cases; 51 underwent an additional reduction procedure - some followed by osteosynthesis - while in the remaining 51 cases, the loss of reduction was acceptable in relation to the expectation of remodelling. The most statistically significant variable for the occurrence of a secondary displacement is a severe primary displacement. The association with the ulna fracture is not significantly correlated. The quality of the plaster cast is important for maintaining the reduction. There are a few things to consider as indicators for a second procedure: age, time elapsed from moment of fracture, fracture site and the absence of an acceptable reduction.

Conclusions. In our experience, a reduction followed by osteosynthesis with Kirschner wires should be considered the treatment of choice in fractures with a high risk of secondary displacement, namely those with severe initial displacement or unsatisfactory reduction. ***Clin Ter 2022; 173 (1):84-87. doi: 10.7417/CT.2022.2397***

Key words: *cast, fracture, injury, redisplacement, remodelling, paediatrics*

Introduction

Distal radius fractures represent one of the most frequent injuries in children (1, 2) namely 15% of all fractures (3). The treatment of choice is a closed reduction, followed by plaster cast immobilisation (2, 4, 5). With regard to secondary displacements of paediatric distal radius fractures in plaster casts, the literature reports a percentages between 21% and 39% (2, 5-9). The factors taken into consideration to identify fractures that are at risk of secondary displacement are: age (8), initial displacement (4-6, 10, 12), isolated radius fracture (13) or in association with an ulna fracture (6,9,14), the obliquity of the fracture line (1), the quality of the reduction obtained (5, 8, 9, 11, 12, 15) , and the quality of the plaster cast (2, 8, 9, 15, 16). The objective of our study was to identify the risk factors responsible for secondary displacements in metaphyseal fractures of the radius, either isolated or associated with ulna fractures, in children after a closed reduction and subsequent immobilisation in a plaster cast.

Materials and methods

Between January 2014 and November 2017, 360 children with displaced metaphyseal fracture of the distal radius were treated at the Department of Orthopaedics and Traumatology of the Sapienza University of Rome and the Paediatric Surgery Departments of the Bambino Gesù IRCSS Hospital in Rome and in Palidoro. These fractures were classified according to the AO criteria (15). The data, collected through a retrospective analysis of the surgical registers, medical records and digital radiographic archives, were related to age, sex, degree of initial displacement and quality of the reduction obtained. The inclusion criteria were: age within adolescence and the presence of a distal radius fracture, either isolated or associated with a distal ulna fracture (Type 23-M / 3.1 and 23-RM / 3.1 AO classification). The following were excluded

Correspondence: Dr. Tommaso Speziale Varsamis, Via Cassia 1042, 00189 Roma, Tel: +39 338 2398489.
E-mail: tommaso.speziale90@gmail.com

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from the study: epiphyseal detachments, refractures, exposed fractures, polytraumas, pathological fractures and, of course, the absence of complete documentation at the follow-up. The adequately moulded plaster cast protection was applied by healthcare professionals with proven experience, using the same methodology for all the patients. The initial treatment for all the patients was a closed reduction under sedation and immobilisation in an above-elbow cast within 36 hours of the trauma. The degree of pre-operative displacement, assessed on radiographs performed in the emergency room, was classified as: minimal, moderate (with contact between the fragments and displacement <50%), severe (displacement > 50% or no contact between the fragments), in accordance to the criteria used by Mani et al.(10) The quality of the reduction was then assessed on post-operative radiographs, classifying it as: anatomical (absence of translation or radial deviation, with angulation on the sagittal plane ≤5°, on the coronal plane ≤3° , primary angulation ≤5°, shortening ≤0.2 mm) good (radial deviation >1° and ≤2°, translation >1 and ≤2 mm, angulation on the sagittal plane > 5° and ≤25°, on the coronal plane >3° and ≤5°, primary angle >5° and ≤10°, shortening >0.2 and ≤0.5 mm) and poor (radial deviation >2° and ≤5°, translation> 2 and ≤3 mm, angulation on the sagittal plane> 25 ° and ≤ 35 °, on the coronal plane >5° and ≤10°, primary angulation >10° and ≤15° , shortening >0.5 mm and ≤1 cm), according to the parameters recommended by Wilkins (17) and Alemdaroglu et al.(2) Radiographs carried out at 7 and 14 days post reduction procedure were used to check for possible loss of reduction; the following were set as tolerance limits (1,2,17,27): 5° of radial deviation, 3mm of translation, 30°-35° of angulation on the sagittal plane, 10° on the coronal plane, 15° of primary angle, 1 cm of shortening for males up to 14 years of age and females up to 12 years of age. These measurements were performed concurrently by three orthopaedic specialists with experience in paediatric traumatology. The continuous variables were analyzed with the t-test, while the Fisher exact-test was used, where applicable, for the categorical variables. A 95% confidence interval and a statistically significant p-value < 0.05 were considered for all these results.

Ethical Standards

The study protocol of this retrospective research has been notified to the Ethics Committee of the same institution where the study was conducted. All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. As this was a retrospective study, formal consent is not required.

Results

The population object of this retrospective analysis consisted of 360 patients (111 females and 249 males) with an average age of 6.9 years (range 4-12 years), diagnosed with type 23-MRI / 3.1 AO isolated distal radius fracture or associated with type 23-M / 3.1 AO distal ulna fracture. At the initial presentation in the emergency room the degree of displacement was mild in 62 patients, moderate in 200, severe in 98 patients. The quality of the reduction obtained after performing the reduction manoeuvre and the plaster cast immobilisation was anatomical in 112 cases, good in 190 and bad in 58 cases. In 258 cases (62 started from a mild initial displacement, 179 from a moderate initial displacement and

17 from a severe initial displacement) there were no secondary loss of reduction events. There were 102 reduction losses (28.3%). The average interval for the loss of reduction was 11 days (IQR: 7 to 14).

In 51 cases (39 of which started from a severe initial situation and 12 from a moderate initial displacement) it was necessary to perform a secondary procedure based on the patient's age and degree of displacement; more specifically: 30 patients underwent a new reduction manoeuvre followed by plaster cast immobilisation, 21 patients underwent a new reduction manoeuvre with percutaneous synthesis, using Kirschner wires followed by plaster cast immobilisation. Of these cases who underwent a second procedure due to secondary displacement, 39 started from a severe initial situation and 12 from a situation of moderate initial displacement. In the other 51 cases (42 of which started from a severe initial situation and 9 from a moderate one), no further manoeuvres were performed since the loss of reduction was considered acceptable in relation to the expectation of remodelling in children (Table 1).

Statistical analysis has shown that the most significant variable for the occurrence of a secondary displacement is a severe primary displacement (odds ratio = 54,68 with

Table 1. Representation of the cases and their treatment.

Degrees of displacement at the initial presentation in the emergency room		Quality of the reduction obtained after the reduction manoeuvre		Secondary displacements at follow up		New reduction manoeuvre + plaster cast immobilisation	New reduction manoeuvre + osteosynthesis with K wires + plaster cast immobilisation
Minimal	62	Anatomical	112	Minimal	0	0	0
Moderate	200	Good	190	Moderate	21	12	0
Severe	98	Poor	58	Severe	81	18	21

Table 2. Risk factors for a secondary displacement

Risk factors	OR	95% CI	P value
Age	0,99	0,88 – 1,1	P=0,83
Sex	1,9	0,83 – 4,34	P = 0,13
Initial displacement	54,68	7.5028 - 108.7155	P <0,0001
Fracture of the ulna	1,44	0,68 – 3,03	P = 0,34
Quality of the reduction	0,017	0.0069 - 0.0452	P <0,0001

95% CI = 7.5028 - 108.7155; p <0,0001) although an anatomical reduction may decrease the risk of a secondary displacement (p = 0,0001; odds ratio = 0,017 with 95% CI = 0.0069 - 0.0452). The association to the age (p = 0,83), sex (p = 0,13), the ulna fracture (p = 0,34) are not correlated in a statistically significant manner with the secondary displacement. (Table 2).

Discussion

The 28.3% displacement rate reported in our study is consistent with that found in the literature (5). Among the parameters analysed to predict the secondary loss of reduction, the one regarding the high degree of initial displacement of the fracture was the most relevant. This parameter is widely accepted in the literature (2, 4, 6, 10, 11). In fact, in severely displaced fractures, the lack of contact between the fragments makes it difficult to obtain an anatomical reduction (12) and decreases stability, thus increasing the risk of a secondary displacement. Another issue to take into account is that once the local swelling goes down there is a decrease in the plaster cast's tight fit, with the consequent possibility of further reduction loss (6). The role of the associated ulna fracture is controversial (6, 8, 13, 14). From our results, an associated ulna fracture does not increase the risk of a secondary displacement. The quality of the plaster cast is another important factor for maintaining the reduction (2, 9, 12, 16, 18, 21-24). As for the type of plaster cast, there is conflicting data present in the literature on whether the cast should or should not include the elbow (16, 18, 21). In our case, all the patients underwent treatment with immobilisation in an above-elbow cast applied by dedicated healthcare professionals with proven experience. Several authors, in fact, have reported that a poorly moulded plaster cast constitutes a risk factor that can lead to a loss of the reduction obtained. Although nearly one third (28.3%) of distal radius metaphyseal fractures have a loss of reduction (8, 9, 11), not all of them required a second procedure. This is consistent with what emerges from the literature, several authors in fact claim that patients aged between 3 and 10 with a partial reduction or a secondary displacement that is considered acceptable achieve good remodelling (19, 20). There is no agreement in the literature regarding the superiority of an immediate reduction combined with a percutaneous osteosynthesis using K wires compared to a closed reduction alone followed by immobilisation in a plaster cast (26). Our study also showed that only 50% of patients who suffered a secondary displacement underwent an additional procedure. The factors to be taken into consideration for a second intervention are: age, time elapsed from the fracture, fracture site and absence of an acceptable reduction (25). In fact, by identifying fractures with a high risk of secondary displacement with those with a high degree of initial displacement and with an anatomically unsatisfactory reduction, we have modified our clinical procedure by opting for an immediate reduction associated with osteosynthesis with K wires in order to minimise the risk of a secondary displacement. Another aspect to keep in mind is that in fractures, as well as in any other type of pathology, the patient's parents play a fundamental role; therefore, it is important to also consider their emotional state, their perception of what happened and their expectations (3) in order to keep them involved throughout the treatment. The patient's age was also inversely proportional to the parents' concerns regarding a possible loss of residual function (3) and the perception of whether the treatment received was good is directly connected to the explanation provided to the parents. When parents doubt the orthopaedist's treatment choices, the patients will be subjected to a greater number of visits by different doctors in different structures, which leads to a greater impact on health care costs, an increase in medical-legal disputes and a greater possibility of an unnecessary second procedure (3). In our study, given its retrospective nature, it was not possible to evaluate non-objective parameters such as the emotional state and concerns of the parents. The limitations of our study are its retrospective nature and the impossibility of evaluating patients from a long-term functional and radiographic point of view.

Conclusions

Severely displaced and partially reduced fractures are at high risk of reduction loss in the plaster cast. If the reduction loss is acceptable, the bone remodelling potential makes a second procedure unnecessary; If the loss of reduction is not acceptable, a second procedure and a possible synthesis with Kirschner wires is necessary. In conclusion, from our experience, the reduction followed by osteosynthesis with Kirschner wires should be considered as the main treatment option in fractures with severe initial displacement or unsatisfactory reduction, which are at high risk of secondary displacement.

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