Functional Outcomes of Displaced Radial Neck Fractures in Children: Correlation Between Patient-reported Outcomes (PROMIS and QuickDASH)

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Introduction: Objectives: 1) to evaluate the subjective outcomes in skeletally immature patients undergoing surgical treatment of displaced radial neck fractures, 2) to compare the performance between PROMIS and QuickDash, 3) to evaluate the floor/ceiling effects of the outcome measurements. We hypothesized that the PROMIS scale would correlate favorably with QuickDash and would demonstrate lower floor or ceiling effects. **Materials and Methods:** Demographic data, associated lesions, fracture type, surgical technique, and complications were evaluated. QuickDash and PROMIS scales (PROMIS Upper Extremity (UE), PROMIS Strength and PROMIS Pain interference) were used for functional assessment. The Shapiro-Wilk test was used to analyze the normal distribution of the data. Metrics correlations were made with Spearman's rho coefficient. Ceiling and floor effects were further assessed. The alpha value was set at 0.05. **Results:** 26 patients were evaluated. Average age: 7.5 years; average follow-up: 31 months. There were significant correlations between the postoperative QuickDash and PROMIS UE metrics (rs = -0.64, p = 0.003). We found no correlation between PROMIS Pain and PROMIS Strength with QuickDash (rs = 0.001, p = 0.966 and rs = -0.39, p = 0.101 respectively). Ceiling or floor effects were observed at all scales. **Conclusion:** We observed a strong correlation between PROMIS UE and QuickDash assessing the results after surgical treatment of radial neck fractures in children. However, all the measures had evident floor/ceiling effects, probably due to the size of the cohort and the fact that a high percentage of these fractures usually present favorable clinical outcomes.
Keywords: Elbow; radial neck fracture; children; PROMIS.
Level of Evidence: IV

Resultados funcionales de las fracturas desplazadas del cuello del radio en niños: correlación entre las medidas de resultado informadas por el paciente (PROMIS y QuickDASH)

RESUMEN
Introducción: Nuestros objetivos fueron: 1) Evaluar los resultados subjetivos en pacientes esqueléticamente inmaduros que habían sido sometidos a una cirugía por fracturas desplazadas del cuello del radio, 2) comparar el desempeño del PROMIS y QuickDASH, y 3) evaluar los efectos de piso y techo de las medidas de resultado. **Materiales y Métodos:** Se evaluaron los datos demográficos, las lesiones asociadas, el tipo de fractura, la técnica quirúrgica y las complicaciones. La evaluación funcional se realizó con las escalas de QuickDASH y el instrumento PROMIS (Upper Extremity/Strength/Pain Interference). Las correlaciones de las escalas se efectuaron con el coeficiente rho de Spearman. El valor alfa se estableció en 0.05. **Resultados:** Se incluyó a 26 pacientes (13 varones) con una edad promedio de 7.5 años. El seguimiento promedio fue de 31 meses. Hubo correlaciones significativas entre las métricas QuickDASH y PROMIS Upper Extremity posoperatorias (rs = -0,64; p = 0,003). No se halló una correlación entre PROMIS Pain Interference y PROMIS Strength con el QuickDASH (rs = 0,001; p = 0,966 y rs = -0,39; p = 0,101, respectivamente). Se observaron efectos de techo o piso en todas las escalas. **Conclusiones:** Hubo una marcada correlación entre el PROMIS Upper Extremity y el QuickDASH para evaluar los resultados después de la cirugía de fracturas del cuello del radio en niños. Sin embargo, todas las medidas tuvieron marcados efectos de piso y techo, probablemente debido al tamaño de la cohorte y a que un alto porcentaje de estas fracturas suelen tener resultados clínicos favorables.
Palabras clave: Codo; fractura; cuello del radio; niños, PROMIS.
Nivel de Evidencia: IV

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INTRODUCTION

In children, radial neck fractures represent 1% of all pediatric fractures[1] and 5-10% of elbow fractures.[2,3] These fractures are more frequent in children because the radial head is largely cartilaginous until the proximal epiphysis begins to close around the age of 14 or 15 in boys and between 12 and 14 years in girls.[4] The main acting force in these injuries is applied to the head of the radius and is transmitted to the neck, which fractures. Many of these injuries are the result of a fall on the hyperextended arm with the elbow extended, associated with a valgus mechanism on the forearm.[5]

The approach to a proximal radius fracture should follow a stepped approach from closed reduction to percutaneous assisted reduction and open treatment.[6] The decision is made based on radiographic (angulation and translation) and clinical (pronosupination range of motion) parameters. Fractures with an angulation <30º and <2-3 mm of translation can be treated conservatively without the need for a reduction, as long as pronation and supination are complete. Fractures with an angulation >30º and translation >3 mm should be treated initially with an attempted closed reduction under sedation or anesthesia. If closed reduction is unsuccessful, percutaneous assisted reduction should be attempted. This can be done by directly manipulating the fragment with a Kirschner wire or a Freer elevator. Another option is the Metaizeau technique, which uses an elastic nail in a retrograde manner, engaging the proximal fragment for manipulation and fixation, or a combination of techniques.[7,8] Finally, irreducible or unstable fractures should be treated with open reduction and internal fixation.

Multiple studies have reported the outcomes of surgical treatment of displaced radial neck fractures in children.[4-8] Functional outcomes are influenced by factors such as age, mechanism of injury, fracture characteristics, and type of treatment. Patient-reported outcomes have become increasingly important in medicine to substantiate the benefits of various treatments.[9] The PROMIS (Patient-Reported Outcomes Measurement Information System) instrument was developed some years ago in the United States by the National Institutes of Health as a means of standardizing patient-reported outcome scores and measuring health-related quality of life. These scoring systems have only recently been implemented, so there are few studies on the patient-reported functional outcomes of surgery for displaced radial neck fractures in this age population.

The objectives of our study are: 1) to evaluate the subjective outcomes in patients who have undergone surgery for a displaced fracture of the radial neck, 2) to compare the performance of the PROMIS scores with that of the QuickDASH, and 3) to evaluate the floor and ceiling effects of the outcome measurements. Our hypothesis is that the PROMIS instrument would correlate favorably with the QuickDASH and demonstrate reduced floor or ceiling effects.

MATERIALS AND METHODS

Selection of patients

After obtaining authorization from the institution's ethics committee, a descriptive, retrospective study was carried out, in which all patients with a radial neck fracture between January 2013 and January 2019 were evaluated. All were treated by four specialists from the Department of Child Traumatology. The patients were skeletally immature when the fracture was diagnosed. Those with a follow-up <6 months were excluded. Demographic and radiographic data, complications, and associated injuries were evaluated. Complications were defined as any alteration in the anticipated course of the local or systemic response of the surgical patient (infection, malunion, nonunion, stiffness, avascular necrosis). The types of radial neck fracture were compared according to the Judet classification and the technique used for the reduction and fixation of the fragment. The functional evaluation was carried out with the QuickDASH questionnaire[10,11] and the PROMIS CAT instrument (PROMIS Upper Extremity, PROMIS Strength, and PROMIS Pain Interference).[12,13] The patients were contacted by phone, they were informed about this study, and—after giving their consent—the forms were sent to them to be completed and monitored.

Imaging evaluation

Kodak Carestream PACS Version 10.2 was used for the storage and analysis of imaging studies. Two observers evaluated the images separately and then defined the measurements by consensus. Angulation and translation were assessed on the anteroposterior and lateral elbow radiographs before treatment and on the first radiograph taken afterward. The Judet[14] classification was used and, finally, it was documented whether the lesion had consolidated or not.

Statistical analysis

The Shapiro-Wilk test was used to analyze the normality of the data. Differences in preoperative and postoperative angulation and translation values were evaluated with Student's t tests. The correlations of the scales were made using Spearman's rho coefficient. In addition, ceiling and floor effects were assessed for these outcome measurements. The alpha value was set at 0.05. All statistical analyzes were performed with the SPSS v.19.0 program.

RESULTS

26 patients (13 children) with 26 fractures underwent surgery. The average age was 7.5 years. According to Judet's classification, five fractures were type II; 14, type III; and seven, type IV. 11% had associated injuries: displaced ulna fracture (No. 1) and olecranon fracture (No. 1). Eleven patients were treated with closed reduction and cast; four, with percutaneous nailing; and eleven, with elastic intramedullary nailing according to the Metaizeau technique (Figure).

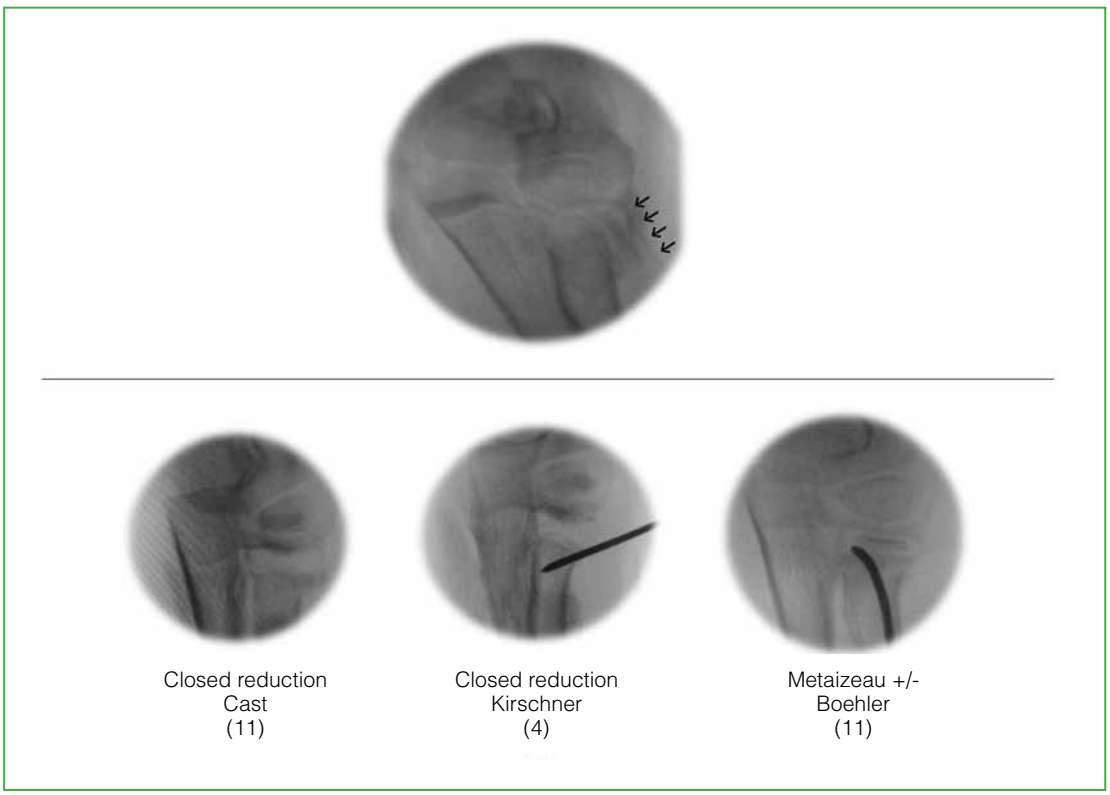

Figure. Distribution of the treatments carried out in our series.

The average follow-up lasted 31 months (range 6–51). The average maximum angulation and translation improved from 47.1° and 4 mm before surgery to 5.5° and 0.3 mm, respectively, on immediate postoperative radiographs (Table 1). All fractures healed in an average of 5.5 weeks (range 4-6). There were no complications. All patients had a full range of motion at the last follow-up. Eleven required a second intervention to remove the osteosynthesis material (elastic nail) and two, a pin extraction at the office.

Table 1. Preoperative and postoperative angulation and translation values.

	Preoperative	Pos-Postoperative	p*
Angulation	47.05°	5.5°	<0.01
Translation (mm)	4	0	<0.01

* Paired t-test.

Nineteen patients were able to complete the functional scales and could be assessed. There were significant correlations between the postoperative QuickDASH and PROMIS Upper Extremity metrics (rs = -0.64, p = 0.003). No correlation was found between the PROMIS Pain Interference and PROMIS Strength metrics and the QuickDASH score (rs = 0.001; p = 0.966 and rs = -0.39; p = 0.101, respectively). Ceiling or floor effects were observed on all scales (Tables 2 and 3).

Table 2. Patient-reported outcomes.

Scale	Total patients	Average	Standard deviation	Minimum	Maximum
PROMIS Upper Extremity	19	37.44	7.03	10	40
PROMIS Pain Interference	19	13.95	2.41	13	22
PROMIS Strength	19	30.13	10.9	8	40
QuickDASH	19	5.94	9.28	0	38.64

PROMIS Upper Extremity vs. QuickDASH: rs = -0.63918, p (two-tailed) = 0.00322
PROMIS Pain Interference vs. QuickDASH: rs = 0.01047, p (two-tailed) = 0.96608
PROMIS Strength vs. QuickDASH: rs = -0.38728, p (two-tailed) = 0.10139

Table 3. Ceiling/floor effects.

Scale	n	Effect	Total number of scales in maximum/minimum values (%)
PROMIS Upper Extremity	19	Ceiling	14 (73%)
PROMIS Pain Interference	19	Floor	15 (78%)
PROMIS Strength	19	Ceiling	8 (42%)
QuickDASH	19	Floor	9 (47%)

DISCUSSION

Patient-reported outcome measures have gained popularity in recent years in both clinical care and research in orthopedic surgery. In pediatric clinical practice, there are multiple frequently used and validated examples, such as the PODCI (Pediatric Outcomes Data Collection Instrument), the CHQ (Child Health Questionnaire), and the PedsQL (Pediatric Quality of Life Inventory). All of these outcome measures contain domains of physical function and there is no consensus on which would be superior. The PROMIS instrument is not used for a specific disease, which improves its applicability and positions it as a possible universal outcome measure. It has been validated in populations of patients with orthopedic disorders of the foot and ankle, upper limbs, and spine.[15-18] PROMIS measures of physical function have proven useful in evaluating orthopedic outcomes and are superior to historical measurements in various populations. Although PROMIS has begun to be used in various areas of general orthopedics, few studies have evaluated its usefulness in pediatric patients. In this series, in which we analyzed a specific group of pediatric upper limb fractures, we observed a significant correlation between the postoperative QuickDASH and PROMIS Upper Extremity metrics, although no correlation was found between the PROMIS Pain Interference and PROMIS Strength metrics, and the QuickDASH score. This could be due to various factors, such as the sample size and the favorable prognosis of the fractures evaluated. On the other hand, floor and ceiling effects were present in all cases. This could be explained because, in the evaluated period, only 15% of our cohort was >10 years old and no case required an open reduction. Previous studies have shown that the outcomes are more favorable when closed or percutaneous reduction techniques are used and when the fracture affects children <10 years of age.[19,20]

This study has certain limitations due to its methodological design and the relatively small sample size. Although the QuickDASH score has been validated in Spanish and previously used in studies involving patients <18 years of age,[21,22] it is a scale originally designed for adults. On the other hand, the PROMIS instrument has been designed for the pediatric population, although it has not been validated in Spanish. In our study, the average age was 7 years, so the anamnesis was indirect in most of the patients included. It is well documented in the literature that, for both adults and children, the information provided by indirect anamnesis is not equivalent to that reported by the patient.[23] The variance between informants (lack of agreement between the self-report and the substitute report) could affect the results obtained in our study,[24,25] mainly in the domains of strength and pain.

In conclusion, we found a strong correlation between PROMIS Upper Extremity and QuickDASH metrics to assess outcomes after radial neck fracture surgery in children. However, all the measures presented marked floor and ceiling effects, probably due to the size of the cohort, since a high percentage of these fractures tend to have favorable clinical outcomes. Future studies will allow us to assess the usefulness of these outcome measures in other diseases of children.

Conflict of interest: The authors declare they do not have any conflict of interest.

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