

Complications associated with Pediatric Supracondylar Humeral Fractures

Ernesto Del Valle-Hernández, MD*; Pablo A. Marrero-Barrera, MD*; David Beaton, MD*;
Dalibel Bravo, MD†; Sergio Santiago, MSPH‡; Humberto Guzmán-Pérez, MD*;
Nestor Ramos-Alconini, MD*

Objective: To measure pediatric supracondylar fracture epidemiology, fracture rate, and complications in the island's pediatric population. The study aims to compare our results to the national rates reported in the literature.

Methods: In this retrospective record review we examined 330 patients who underwent open reduction internal fixation or closed reduction percutaneous pinning in pediatric supracondylar fractures at the University Pediatric Hospital of Puerto Rico Medical Center (HOPU). The study evaluated patients from January 2008 to January 2011 that had completed at least a 1 year follow-up. Measurement of type of fracture, and complications were recorded. Statistical significance was set at a p-value < 0.05

Results: Of the 330 patients, 206 (62%) were male and 127 (38%) were female. The average age was 5.49 years (± 2.43). The vast majority had extension-type fractures (98.2%) and 1.8% had flexion-type fractures. The neurological complication rates were 10% (33 patients). Neurologic complications after distal fragment displacement were 13.5% for posteromedial displacement versus 11.8% for posterolateral displacement, with a p-value of 0.71.

Conclusion: Our results in terms of female-to-male ratio, fracture type and complications (e.g., infection, vascular and neurologic complications) were similar to those reported in the literature. Because significant differences in the rates of posteromedial and posterolateral supracondylar fractures were found, we recommend further research on this subject. Overall, both our findings regarding complications and our results are similar to what has been reported in the literature. We can therefore affirm that our institution provides adequate care and management for this kind of fracture. [*PR Health Sci J* 2017;36:37-40]

Key words: Pediatric supracondylar humerus fractures, Pediatric orthopedics, Supracondylar fracture, Morbidity

Supracondylar fractures of the humerus account for 3% of all pediatric fractures, making them the most common elbow fractures in children (1–3). These fractures occur most commonly in children who are from 5 to 8 years of age (5.9 ± 2.8 years) (4–7). Extension fractures account for approximately 98% of these injuries, and they usually occur as the result of a fall on an outstretched hand with the elbow in full extension (7). Modern techniques for their treatment have dramatically decreased the rates of angular deformities and neurovascular injuries. Still, there is a significant rate of complications reported in the literature. Vascular injury, neurologic injury, compartment syndrome, pin-track infections, and cubitus varus are among the most common complications (9,10). The current treatment for a displaced supracondylar humeral fracture is closed reduction of the fracture with the use of percutaneous skeletal fixation (Figure 1) versus open reduction and internal fixation. Nondisplaced fractures are typically treated with a cast (11,12). The purpose of this study

was to report the complication rates in our practice and to compare them to those reported on the literature.

Methods

This was a retrospective study of pediatric patients with a supracondylar humeral fracture who were seen at University Pediatric Hospital of Puerto Rico (HOPU, by its Spanish acronym) from January 2008 to January 2011 and treated either

*Department of Orthopaedic Surgery, University of Puerto Rico School of Medicine, San Juan, PR; †School of Medicine, University of Puerto Rico School of Medicine, San Juan, PR; ‡Graduate School of Public Health, University of Puerto Rico School of Medicine, San Juan, PR

The author/s has/have no conflict/s of interest to disclose.

Address correspondence to: Pablo A. Marrero-Barrera, MD, University of Puerto Rico, Medical Sciences Campus, Department of Surgery–Orthopaedics, PO Box 365067, San Juan, PR 00936-5067. Email: Pablo.a.marrero@upr.edu



Figure 1. AP radiographs of a type II humerus supracondylar fracture before (A) and after (B) fixation with pinning, after closed reduction.

with closed reduction with percutaneous skeletal fixation or open reduction and internal fixation (ORIF). The inclusion criteria were as follows: being from 1 to 15 years of age, having suffered an isolated humeral supracondylar fracture (treated at HOPU), and having had a minimum of 1 year of follow-up after management. The exclusion criteria were as follows: not being in the age range set by the inclusion criteria, having suffered a concomitant injury or fracture ipsilateral to injured elbow, and not having a supracondylar humeral fracture. Local IRB approval was obtained prior to the beginning of data collection. Lists of the medical records of potential subjects were generated via the analysis of diagnostic codes and procedure codes for pediatric humeral supracondylar fractures. A total of 330 medical records that met the inclusion and exclusion criteria parameters were obtained. We reviewed the medical records prior to data collection, with particular interest in the following variables: the fracture pattern (based on the Gartland classification) described in the operative report and the displacement of the distal fracture fragment, the use of closed reduction via a cast or closed reduction percutaneous pinning, complications, and neurovascular status.

We used the modified Gartland classification and the displacement of the distal fracture fragment to identify fracture patterns. A Gartland type I supracondylar fracture is nondisplaced or minimally displaced (by <2 mm) and is associated with an intact anterior humeral line. A Gartland type II supracondylar fracture is displaced (by >2mm) and has an intact (presumably), yet hinged posterior cortex. A Gartland type III fracture is a displaced supracondylar fracture with no meaningful cortical contact. Type IV fractures are those with instability on both flexion and extension. This multidirectional instability is usually determined at the time

of the operation, with the patient under anesthesia. The distal fracture displacement were reported as either posterolateral or posteromedial and as being either an extension or a flexion-type fracture. Complication rates were calculated for each of the fracture patterns described above, and they were compared to those reported in the medical literature.

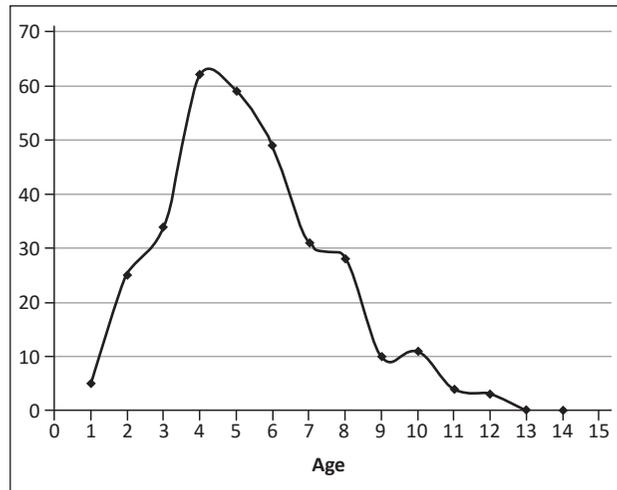


Figure 2. Frequency distribution of supracondylar humerus fractures versus age. We can see a marked increase in the incidence of these fractures after the age of 3, with the majority of cases falling around the ages of 5 to 6 and a sharp decrease occurring in cases over the age of 8 and steadily dropping to 0 cases at 13 years and older.

Results

Out of a total of 330 patients, 205 (62%) were male and 125 (38%) were female, a 1.64:1 male-to-female ratio. The average age of the patients included in the study was 5.49 years (± 2.43 years). The vast majority of fractures were extension-type fractures (98.2%); the remainder (1.8%) were flexion-type fractures. Out of the 251 patients that presented with a distal fragment displacement, 53% had posteromedial displacements and 47% had posterolateral displacements. The complication rate for neurological injury was 10% (33 patients) (Figure 3). Of these, 18 patients resolved on the first post-operative

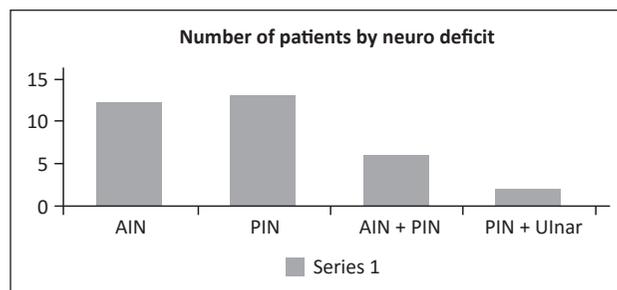


Figure 3. Anterior interosseous nerve (AIN) palsy only, 12 patients; posterior interosseous (PIN) palsy only, 13 patients; ulnar palsy only, 0 patients; AIN+PIN palsies, 6 patients; PIN+ulnar palsies, 2 patients. Total neurological complications: 33, or 10% of the patient population.

day, while 12 patients recovered at 3 months and 2 patients at 6 months follow-up; after a year, 1 persisted with anterior interosseous nerve (AIN) palsy. Neurologic complications after distal fragment displacement were 13.5% for posteromedially displaced versus 11.8% for posterolaterally displaced (Figure 4). Using Fisher's exact test, we determined that there was no statistically significant difference in complication rates between the displacement of distal fracture fragment (posteromedial or posterolateral); the p-value was 0.71.

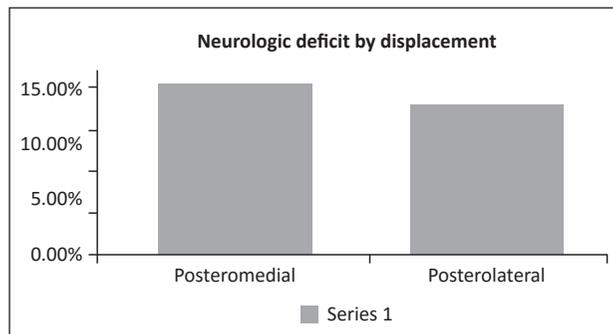


Figure 4. Neurologic deficits associated with posteromedial versus posterolateral fracture displacement: 13.5% for posteromedially displaced versus 11.8% for posterolaterally displaced fractures.

Another reported complication rate was the following: vascular injury, 2.7% (9 patients). Patients with this injury had a pulseless, pale hand that did not recover immediately after reduction. Four recovered on the first post-operative day, and all patients had recovered fully at 3 months follow-up. Pin-tract infection was documented in only 0.3% and was resolved with oral antibiotics. Compartment syndrome was seen in only 1 patient (0.3%); at 6 months follow-up, the patient was found to be neurologically intact, with a full range of motion. Of the 2 patients fixed using the cross K-wire configuration, neither developed ulnar nerve palsy.

Discussion

Currently there are no reported studies on the epidemiology and complications of pediatric humeral supracondylar fractures in the Puerto Rican population. The male-to-female ratio reported in our study was 1.64:1, compared to that in the reported in literature, which is 1.7:1 (7), although the gender gap has been getting narrower in recent years. When we look at Figure 2, we can see that the average gap was 5.49 years, with an increase in the incidence of these fractures at the age of 3. This sharp increase can be attributed to reasons associated with child neuromuscular development and the increase in patient ambulation. Such development can lead children to performing tasks that increase risks associated with such fracture mechanisms as a fall on an outstretched arm. When we examined the mechanisms of injury associated with the different fractures, we found that 98% of fall-related fractures had resulted

in extension-type fractures, a rate that is similar to that reported in the literature (9).

The results for distal fragment displacement showed that 53% were posteromedial and 47% were posterolateral, while other, past studies reported 75% and 25%, respectively (7). Compared to the results of other studies, then, ours are significantly different. Any number of factors could be responsible for these differences: study design, level of evidence, and population size. However our other variables resulted in values similar to those reported in the literature, which could be attributed to another cause or combination of causes, entirely. Regardless such a finding merits further research with a proper study design; it would be beneficial to evaluate the strength of the associations between different fracture mechanisms and the types of fracture displacement that these mechanisms may provoke. Doing so would allow investigators to better assess the incidences of the various fracture types.

The rate of neurologic complications was 10%, which is similar to what has been reported in the literature (between 7% and 15%) (9). When we compared the development of neurologic complications (AIN, PIN, ulnar or mixed palsies) with distal fracture fragment posteromedial or posterolateral, our results showed 13.5% and 11.8%, respectively. However these results proved not to be statistically significant. Another complication that we measured was vascular injury; we report herein a rate of 2.7%, which is similar to the rates that have been reported in the literature (themselves ranging from 4% to 20%) (9).

Pin-site infection occurred in 0.3% of the patients, which again is similar to results reported by others (rates range from <1% to 6.6%) (9). Lastly compartment syndrome occurred in only 1 patient (0.3), a finding that is similar to those reported in the literature (9).

This is the first study on pediatric humerus supracondylar fractures in the Puerto Rican population. Our study shows that there are a vast number of cases at our institution (HOPU), and our conclusions merit being communicated to Puerto Rican health professionals and pediatric physicians. Our reported outcomes and rates of complications are similar to the ones reported in the literature. We can therefore state that the medical service provided at our institution is on par with the national standard of care and that we furnish appropriate management for these fractures. It is important to recall that our study was a retrospective study, level-3 evidence base, and is therefore subject to the many biases and limitations inherent to such a design. Further studies such as a prospective cohort could help in confirming or further evaluating the results in our study and assess patient progression during medical treatment.

Resumen

Objetivo: Evaluar la epidemiología, tasa de fracturas y complicaciones en fracturas supracondilares del codo pediátricas en la isla. El objetivo de este estudio es comparar

nuestros resultados con los reportados en la literatura. Métodos: En este estudio retrospectivo se evaluaron 330 pacientes que se les realizó una fijación interna por medio de reducción abierta o fijación clavos percutáneos por medio de reducción cerrada en pacientes pediátricos del Hospital Pediátrico de Centro Médico (HOPU). El estudio evaluó pacientes desde enero del 2008 hasta enero del 2011 que hubieran completado mínimo un año de seguimiento clínico. Se evaluó el tipo de fractura, y complicaciones. Significado estadístico se estableció a un valor de $p < 0.05$. Resultados: De los 330 pacientes, 206 (62%) eran varones y 127 (38%) eran hembras. El promedio de edad fue 5.49 años (± 2.43). La mayoría de las fracturas fueron tipo extensión (98.2%) y 1.8% en flexión. La tasa de complicaciones para daño neurológico fue de 10% (33 pacientes). Complicaciones neurológicas luego de sufrir una fractura con desplazamiento del fragmento distal fueron 13.5% para desplazamientos posteromediales versus 11.8% para desplazamiento posterolateral con un valor de p de 0.71. Conclusión: Nuestros resultados en términos de razón de varones y hembras, tipo de fractura y complicaciones (infección, daño vascular o neurológico) fue similar a la reportada en la literatura. Se observó diferencia significativa en la tasa de fracturas con fragmento distal posteromedial o posterolateral de fracturas supracondilares, recomendamos más investigación en esta área. En general los hallazgos reportados de nuestras complicaciones y resultados son similares a los de la literatura médica. Podemos afirmar que en nuestra institución se provee un buen cuidado y manejo de este tipo de fracturas.

References

1. Minkowitz B, Busch MT. Supracondylar humerus fractures: Current trends and controversies. *Orthop Clin North Am* 1994;25:581–594.
2. Noonan KJ, Zaltz I, Wenger D. What's new in pediatric orthopaedics. *J Bone Joint Surg Am* 2011;93:597–606.
3. Otsuka NY, Kasser JR. Supracondylar fractures of the humerus in children. *J Am Acad Orthop Surg* 1997;5:19–26.
4. Farnsworth CL, Silva PD, Mubarak SJ. Etiology of supracondylar humerus fractures. *J Pediatr Orthop* 1998;18:38–42.
5. Henrikson B. Supracondylar fracture of the humerus in children: A late review of end-results with special reference to the cause of deformity, disability and complications. *Acta Chir Scand Suppl* 1966;369:1–72.
6. Omid R, Choi PD, Skaggs DL. Supracondylar humeral fractures in children. *J Bone Joint Surg Am* 2008;90:1121–1132.
7. Cheng JC, Lam TP, Maffulli N. Epidemiological features of supracondylar fractures of the humerus in Chinese children. *J Pediatr Orthop B* 2001;10:63–67.
8. Otsuka NY, Kasser JR. Supracondylar fracture of the humerus in children. *J Am Acad Orthop Surg* 1997;5:19–26.
9. Spencer HT, Wong M, Fong Y, Penman A, Silva M. Prospective longitudinal evaluation of elbow motion following pediatric supracondylar humeral fractures. *J Bone Joint Surg Am* 2010;92:904–910.
10. Hanlon CR, Estes WL Jr. Fractures in childhood: A statistical analysis. *Am J Surg* 1954;87:312–323.
11. Howard A, Mulpurik, Abel ME, Braun S. The treatment of pediatric supracondylar humerus fracture. *J Am Acad Orthop Surg* 2012;20:320–327.
12. Skaggs DL, Hale JM, Bassett J, Kaminsky C, Kay RM, Tolo CT. Operative treatment of supracondylar fractures of the humerus in children. *J Bone Joint Surg Am* 2001;83-A:735–740.
13. Meyer CL, Kozin SH, Herman MJ, Safier S, Abzug JM. Complications of pediatric supracondylar humeral fractures. *Instr Course Lect* 2015;64:483–491.
14. Kim TJ, Sponseller PD. Pediatric supracondylar humerus fractures. *J Hand Surg Am* 2014;39:2308–2311.