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THE OUTCOME OF IRREDUCIBLE PULSELESS SUPRACONDYLAR FRACTURE OF HUMERUS TREATED VIA ANTERIOR APPROACH – A CASE SERIES

Orthopaedics

Dr. Zaheer Parveez Islam Assistant Professor, Department of Orthopaedics, Assam Medical College and Hospital, Dibrugarh, India

Dr. Jishnu Prakash Baruah Associate professor, Department of Orthopaedics, Assam Medical College and Hospital, Dibrugarh, India

Dr. Bashab Protim Borah* Post Graduate Trainee, Department of Orthopaedics, Assam Medical College and Hospital, Dibrugarh, India *Corresponding Author

Dr. Kumar Madhurya Pratim Post Graduate Trainee, Department of Orthopaedics, Assam Medical College and Hospital, Dibrugarh, India

Dr. Devesh Pandey Post Graduate Trainee, Department of Orthopaedics, Assam Medical College and Hospital, Dibrugarh, India

ABSTRACT

Background: Treatment of a pulseless pediatric supracondylar humeral fracture is controversial and varies from closed reduction percutaneous pinning to Surgical Exploration. Present study aimed to analyze outcome of Irreducible pulseless supracondylar fractures treated with Open reduction and exploration via anterior approach. **Method:** in this prospective study of 7 patients with pulseless Supracondylar fracture, 2 were treated by Close reduction percutaneous pinning and the other 5, irreducible on table by Open intervention. The later 5 cases were followed up at 3 weeks, 6 weeks, and 3 months and functionally assessed using MEPS. **Results:** 3 cases showed immediate return of pulse, 2 recovered within 6 hours. All cases at 3 months showed MEPS >90. **Conclusion:** Anterior approach is excellent for surgical decompression of the neurovascular bundle.

KEYWORDS

Irreducible, Pulseless, Supracondylar, Humerus.

INTRODUCTION

Supracondylar fractures of the humerus constitutes 55-75 % of all elbow fractures.(Egol et al., 2019) The peak incidence is from 5-8 years.(Egol et al., 2019) They usually result from a fall on an out-stretched arm, forcing the humeral distal metaphysis into extension. These fractures rarely occur from falls with a flexed arm. In such fractures, both primary and secondary iatrogenic neurovascular lesions may occur.(Schoenecker et al., 1996a). Compromised vasculature occurs in 2.6–20% of cases of displaced supracondylar humeral fractures in children(Gosens & Bongers, 2003)(Griffin et al., 2008)(Choi et al., 2010)(Louahem & Cottalorda, 2016), with two kinds of brachial artery injuries reported to be associated: those presenting with a pale pulseless hand and those with a pink pulseless hand (PPH) which is well perfused without a palpable radial pulse.(Louahem & Cottalorda, 2016)(Badkoobehi et al., 2014)(Saglam et al., 2014)Brachial artery lesion may be secondary to various insults, such as entrapment, division, spasm of the vessel, the presence of an intimal tear or thrombus formation. On the other hand, the relative incidence of nerve injuries has been reported as being 12–20%(Campbell et al., 1995)(W et al., 1990)and they mainly (86–100%) consist of neurapraxias, which usually resolve spontaneously.(Brown & Zinar, 1995)(Campbell et al., 1995)(Ristic et al., 2000) In pediatric patients, urgent closed reduction and percutaneous pinning is the primary treatment in both situation, and vascular exploration is often required in the case of a pale pulseless hand.(Louahem & Cottalorda, 2016)(Badkoobehi et al., 2014)(Saglam et al., 2014)(Luria et al., 2007)(White et al., 2010). Yet there is no standard recommendations regarding the management of irreducible fractures at this phase i.e the ideal approach, the ideal method of reduction and regarding the definite surety of decompression of neurovascular bundle. Various approaches advocated for open reduction are the medial (Kumar & Malhotra, 2000), lateral (Weiland et al., 1978), combined medial and lateral (Davis et al., 2000), posterior (Sibly et al., 1991), antero-medial and the anterior transverse. Most surgeons have given up the posterior approach due to the high incidence of elbow stiffness.

Out of the all the approaches, anterior approach provides the best access to the neurovascular structures and the fracture site. (Azar & Beaty, 2021) Also it is considered as a safe and reliable method with very good end results.(Ersan et al., 2009) So we have undertaken this study to analyze the outcome of irreducible pulseless supracondylar fractures of humerus treated via anterior approach. We hypothesized that the anterior approach is the best approach for the management of irreducible pulseless supracondylar fracture in achieving a pre injury status with few complications.

MATERIALS AND METHOD

This is a prospective study of 7 children of mean age of 7 years, who presented with pulseless supracondylar humeral fracture from January 2021 to June 2022 at the Department of Orthopaedics, Assam Medical College and Hospital. The study was undertaken with the following objectives: 1) To evaluate the neurovascular recovery. 2) To evaluate the clinical outcome.3) To evaluate the complications associated with the anterior approach. All the patients underwent a thorough clinical examination for the neurovascular injury and all had pink pulseless hands. After initial stabilization of the elbow in semi extended position with a slab the patients were prepared for emergency operation. A routine USG colour Doppler was performed immediately in all cases to evaluate the extent of avascularity. All the cases showed a monophasic flow for the radial and ulnar artery. Operative procedure was performed within 6 hours of presentation along with the presence of a vascular surgeon by side. In 2 cases Close reduction was possible and so pinning was done percutaneously, after which immediate return of pulse was seen. In the other 5 cases, the fractures were irreducible on table and an open procedure through anterior approach was opted for immediately. Strictly, in these cases only a single attempt at close reduction was done. Moreover, in 2 of the included cases Anterior Interosseous Nerve injury was seen. In all the cases an Above Elbow slab was applied in 45° elbow flexion post-operatively. The patients were followed up at 3 weeks, 6 weeks and 3 months period with evaluation of the elbow performance using the Mayo Elbow performance score (MEPS).

The Procedure of anterior approach –

The transverse skin incision was on the anterior skin crease of the elbow starting from the lateral end and extending 3–4 cm medially. In Superficial dissection the subcutaneous layer was dissected and crossing veins were coagulated / ligated. In Deep dissection the biceps tendon was identified first and dissection proceeded from lateral to medial side. The Spike of the proximal fragment was found at subcutaneous level in between the tendon and vessel or vessel and nerve. The Vessels and median nerve are carefully dissected out and protected. The Lassertus fibrosus was carefully released and fracture

was reduced under direct vision through the torn Brachialis muscle and fixed with K Wires of adequate size. The wound was closed in layers thereafter.

RESULTS AND OBSERVATIONS

All the pulseless supracondylar humeral fractures included in our study had pink hands and had monophasic flow on Doppler study. Brachialis sign or the ecchymosis over anterior skin were observed in almost all cases. The cause of pulselessness was found to be kinking of the Brachial artery by the proximal spike in all cases. Whereas the fractures were irreducible because of entrapment of either the Neurovascular bundle or the Median Nerve alone or due to tethering of the spike to the Lassertus fibrosus / Vascular sheath. The Return of Pulse in 3 cases was immediate and in 2 cases within 6 hours of operative intervention. All cases maintained vascularity post- surgery without the evidence of Compartment Syndrome. In clinical outcome during the follow up period it was seen that Range of motion (ROM) was full within 6 weeks and Mayo Elbow Performance Scoring was >90 for all cases at 6 months. In the 2 cases with median nerve injury recovery was seen within 6 weeks post operatively. Post-operative complications was seen in 2 cases in which incision was given directly over elbow crease, which showed initial wound dehiscence and later delayed healing.

Table 1: Results and Observations

Sl. No.	Age in Years	Sex	Type of Fracture	Direction of Distal Fragment	Nerve Injury	Time from Injury to Procedure	Cause of Irreducibility	Post-operative Vascular Status	MEPS at 6 Months	Complications
1	6.5	M	Gartland III(Extension)	Posteromedial	No	9 hours	NV bundle	Immediate return of pulse	99	Delayed wound healing
2	7.5	M	Gartland III(Extension)	Posteromedial	No	10 hours	Tethering of proximal spike to lassertus fibrosus	Return of pulse within 6 hours	100	Delayed wound healing
3	7	M	Gartland III(Extension)	Posteromedial	Yes	8 hours	Median Nerve	Immediate return of pulse	98	None
4	6	M	Gartland III(Extension)	Posteromedial	No	10 hours	NV bundle	Immediate return of pulse	100	None
5	8	M	Gartland III(Extension)	Posteromedial	Yes	7 hours	Median Nerve	Return of pulse within 6 hours	98	None

Fig1: Fracture Irreducible on table under Fluoroscopy

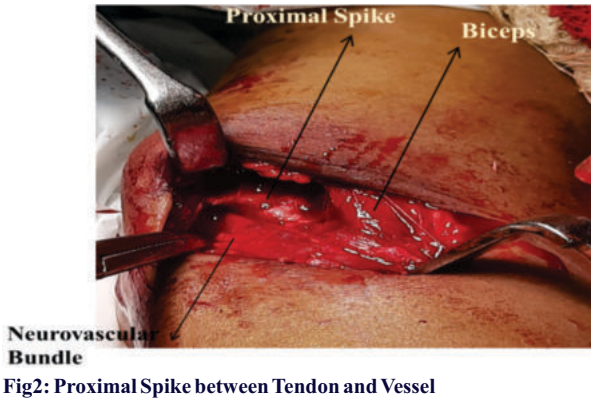
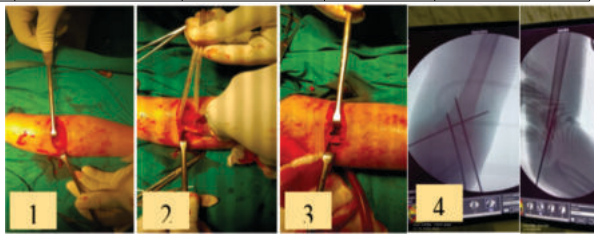


Fig2: Proximal Spike between Tendon and Vessel

Fig3: Proximal Spike between Nerve and Vessel



Pic 1: Proximal spike (impinging on the neurovascular bundle) protruding through the interval between biceps and the neurovascular bundle.
Pic 2: The neurovascular bundle tethered to the spike is being released.
Pic 3: After complete decompression of the neurovascular bundle.
Pic 4: Fixation of the fracture with K wires.

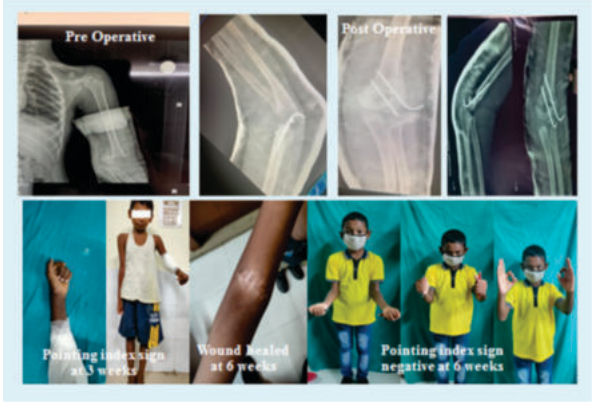


Fig4: Intraoperative Images

Fig5: Radiological and clinical images after Operation and at follow up

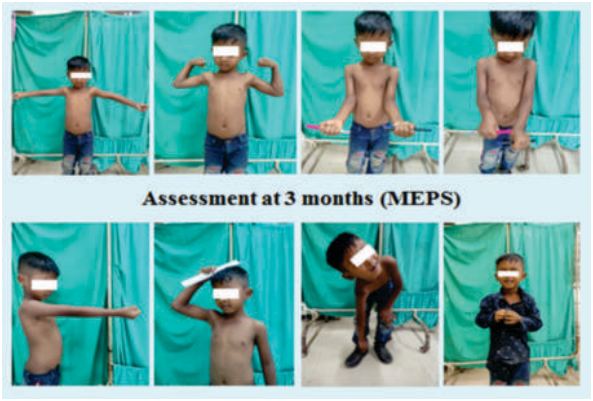


Fig6: Mayo Elbow Performance scoring at 6 months follow up

DISCUSSION

The treatment of supracondylar fractures of the humerus in children should focus on exact anatomical reduction, full range of motion at the end of treatment as well as good cosmesis. The decision of whether to undertake surgical exploration for supracondylar fractures in a Pink Pulseless limb is a subject of some debate.(White et al., 2010)(Delniotis et al., 2019) Some clinicians recommend aggressive exploration and vascular reconstruction(Gosens & Bongers, 2003)(Saglam et al., 2014)(White et al., 2010)(Schoenecker et al., 1996b)(Noaman, 2006)(S et al., 2017)while others recommend close observation after urgent Close reduction and percutaneous pinning.(Griffin et al., 2008)(Choi et al., 2010)(Louahem & Cottalorda, 2016)(Badkoobehi et al., 2014)(Delniotis et al., 2019)(Scannell et al., 2013)(Weller et al., 2013)(Wolfswinkel et al., 2014)(Tomaszewski et al., 2017)(Cambon-Binder et al., 2018)(Delniotis & Ktenidis, 2018) Yet at this point there is no standard recommendations regarding the management of Irreducible Pulseless fractures i.e the approach, the method of reduction, the procedure that would have definite surety of decompression of NV bundle. So our study was to analyze the Outcome of Irreducible Pulseless supracondylar fracture that has been operated via Open reduction via the anterior approach, which has been considered as the approach that provides us the best access to the neurovascular structures and the fracture site, according to various available standard textbooks.

Open reduction and pinning have also been recommended by several authors for severe supracondylar fractures.(Furrer et al., 1991)(Kekomäki et al., 1984)(Weiland et al., 1978)(*Ramsey, R.H. and Griz, J. (1973) Immediate Open Reduction and Internal Fixation of Severely Displaced Supracondylar Fractures of the Humerus in Children. Clinical Orthopaedics and Related Research, 90, 131-132. - References - Scientific Research Publishin*, n.d.)However, most pediatric orthopedic surgeons would reserve this approach for open fractures or for those associated with vascular injury.(Millis et al., 1984)(Morrissy & Wilkins, 1984)(Mehserle & Meehan, 1991)Although we agree that closed reduction should remain the first line of treatment, we believe that open reduction with internal or percutaneous pinning should be seriously considered when closed reduction is unattainable after a single attempt.

In the study of **Mcintyre et al**(Fleuriau-Chateau et al., 1998) where in 25 children, the humerus was found to have "buttonholed" through the brachialis muscle; 1 had entrapment of the common flexor muscle at its origin and 1 had entrapment of the triceps. In 15 children there was entrapment or tethering of the median nerve and radial nerve or brachial artery, or both, but this was not predictive of preoperative neurovascular deficit, which was recorded in 21 patients (fully recovered). At follow-up, the Baumann angle and the humerocapitellar angle differed by an average of 2° and 5.3° respectively compared with the unaffected arm. Range of motion was satisfactory in 94% of patients, and there was no significant cubitus varus.

Our results are comparable to those of Mcintyre's as in our study the proximal fragment was found to have “buttonholed” through the brachialis and along with the Lassertus fibrosis resulted in a pinching effect to the brachial artery. Also the culprit structures of irreducibility was either the Neurovascular bundle or the median nerve, also in 1 case it was tethering of the spike to the Lassertus fibrosus that lead to irreducibility of the fracture. 2 cases that had evidence of AIN injury in our study recovered fully within 6 week time. During the final follow up at 6 months all the cases showed a MEPS of >90 and as post-operative complications one complication of initial wound dehiscence and later delayed healing was seen in 2 cases in which incision was given directly over elbow crease.

Luria et al(Luria et al., 2007) in their study of Vascular complications of supracondylar humeral fractures in 24 children found a statistically significant correlation between the median nerve injury and the brachial artery lesion. However, they did not notice a correlation between the type of a vascular lesion and nerve injury. Also in their research, reduction in the fracture was followed by a return of the pulse in 58 % of the cases.

Similarly in our study 2 patients (40%) had an associated AIN injury. All injuries seemed to occur due to tenting or entrapment of the nerve on the sharp dislocated proximal humeral fragment. Also in our study immediate return of pulse was seen in 3 cases (60%), and in the other 2 it was seen with 6 hours, which makes our study comparable to that of Luria's as well.

CONCLUSION

An Irreducible fracture in a pulseless hand should arouse the suspicion of entrapment of NV bundle at fracture site. In such cases one must have lower threshold for open reduction to avoid complications. Open reduction via anterior approach is the best available option in such cases due to the following advantages: 1) It is an excellent window for surgical exploration of the Neurovascular bundle 2) It is an extensile approach if at all vascular repair is required. 3) It Provides a definite surety of decompression of the neurovascular bundle.

Consent

Written informed consent was taken from all the patients under this study for this publication carrying all the clinical data and images.

Limitations

1) The small number of cases in our study
2) Routine CT angiography to evaluate the pattern of vascular injury was not done in our cases due to unavailability of the procedure on emergency basis.

Recommendation

An Irreducible Pulseless Supracondylar fracture of the humerus should arouse the suspicion of entrapment of NV bundle at fracture site. If so, open reduction via anterior approach is the best available surgical option.

Conflict Of Interest

There is no conflict of interest.

REFERENCES

1. Azar, F., & Beaty, J. (2021). Supracondylar Humeral Fractures. In K. Daugherty & L. Jones (Eds.), *Campbell's Operative Orthopaedics* (14th ED, p. 1504). Elsevier.
2. Badkoobehi, H., Choi, P. D., Skaggs, D. L., & Bae, D. S. (2014). Current concepts review: Management of the pulseless pediatric supracondylar humeral fracture. In *Journal of Bone and Joint Surgery - American Volume* (Vol. 97, Issue 11, pp. 937–943). Lippincott Williams and Wilkins.
3. Brown, I. C., & Zinar, D. M. (1995). Traumatic and iatrogenic neurological complications after supracondylar humerus fractures in children. *Journal of Pediatric Orthopaedics*, *15*(4), 440–443.
4. Cambon-Binder, A., Jehanno, P., Tribout, L., Valenti, P., Simon, A. L., Ilharreborde, B., & Mazda, K. (2018). Pulseless supracondylar humeral fractures in children: vascular complications in a ten year series. *International Orthopaedics*, *42*(4), 891–899.
5. Campbell, C. C., Waters, P. M., Emans, J. B., Kasser, J. R., & Millis, M. B. (1995). Neurovascular injury and displacement in type III supracondylar humerus fractures. *Journal of Pediatric Orthopedics*, *15*(1), 47–52.
6. Choi, P. D., Melikian, R., & Skaggs, D. L. (2010). Risk factors for vascular repair and compartment syndrome in the pulseless supracondylar humerus fracture in children. *Journal of Pediatric Orthopaedics*, *30*(1), 50–56.
7. Davis, R. T., Gorczyca, J. T., & Pugh, K. (2000). Supracondylar humerus fractures in children. Comparison of operative treatment methods. *Clinical Orthopaedics and Related Research*, *376*, 49–55.
8. Delniotis, I., Delniotis, A., Saloupis, P., Gavriilidou, A., Galanis, N., Kyriakou, A., Potoupnis, M., Tsiridis, E., & Ktenidis, K. (2019). Management of the Pediatric Pulseless Supracondylar Humeral Fracture: A Systematic Review and Comparison Study of “Watchful Expectancy Strategy” Versus Surgical Exploration of the Brachial Artery. *Annals of Vascular Surgery*, *55*, 260–271.
9. Delniotis, I., & Ktenidis, K. (2018). The pulseless supracondylar humeral fracture: Our experience and a 1-year follow-up. *Journal of Trauma and Acute Care Surgery*, *85*(4), 711–716.
10. Egol, K., Koval, J., & Zuckerman, J. (2019). Supracondylar Humerus Fractures. In K. Egol, K. Koval, & J. Zuckerman (Eds.), *Handbook of Fractures* (6th ED, pp. 606–609). Wolters Kluwer.
11. Ersan, O., Gonen, E., Arik, A., Dasar, U., & Ates, Y. (2009). Treatment of supracondylar fractures of the humerus in children through an anterior approach is a safe and effective method. *International Orthopaedics*, *33*(5), 1371.
12. Fleuriau-Chateau, P., McIntyre, W., & Letts, M. (1998). An analysis of open reduction of

irreducible supracondylar fractures of the humerus in children. *Canadian Journal of Surgery*, *41*(2), 112–118.
13. Furrer, M., Mark, G., & Rüedi, T. (1991). Management of displaced supracondylar fractures of the humerus in children. *Injury*, *22*(4), 259–262.
14. Gosens, T., & Bongers, K. J. (2003). Neurovascular complications and functional outcome in displaced supracondylar fractures of the humerus in children. *Injury*, *34*(4), 267–273.
15. Griffin, K. J., Walsh, S. R., Markar, S., Tang, T. Y., Boyle, J. R., & Hayes, P. D. (2008). The Pink Pulseless Hand: A Review of the Literature Regarding Management of Vascular Complications of Supracondylar Humeral Fractures in Children. In *European Journal of Vascular and Endovascular Surgery* (Vol. 36, Issue 6, pp. 697–702). Eur J Vasc Endovasc Surg.
16. Kekomäki, M., Luoma, R., Rikalainen, H., & Vilkki, P. (1984). Operative reduction and fixation of a difficult supracondylar extension fracture of the humerus. *Journal of Pediatric Orthopaedics*, *4*(1), 13–15.
17. Kumar, R., & Malhotra, R. (2000). Medial approach for operative treatment of the widely displaced supracondylar fractures of the humerus in childre. *Journal of Orthopaedic Surgery (Hong Kong)*, *8*(2), 13–18.
18. Louahem, D., & Cottalorda, J. (2016). Acute ischemia and pink pulseless hand in 68 of 404 gartland type III supracondylar humeral fractures in children: Urgent management and therapeutic consensus. *Injury*, *47*(4), 848–852.
19. Luria, S., Sucar, A., Eylon, S., Pinchas-Mizrachi, R., Berlatzky, Y., Anner, H., Liebergall, M., & Porat, S. (2007). Vascular complications of supracondylar humeral fractures in children. *Journal of Pediatric Orthopaedics Part B*, *16*(2), 133–143.
20. Mehserle, W. L., & Meehan, P. L. (1991). Treatment of the displaced supracondylar fracture of the humerus (Type III) with closed reduction and percutaneous cross-pin fixation. *Journal of Pediatric Orthopaedics*, *11*(6), 705–711.
21. Millis, M. B., Singer, I. R., & Hall, J. E. (1984). Supracondylar fracture of the humerus in children. Further experience with a study in orthopaedic decision-making. *Clinical Orthopaedics and Related Research*, *188*, 90–97.
22. Morrissy, R. T., & Wilkins, K. E. (1984). Deformity following distal humeral fracture in childhood. *Journal of Bone and Joint Surgery - Series A*, *66*(4), 557–562.
23. Noaman, H. H. (2006). Microsurgical reconstruction of brachial artery injuries in displaced supracondylar fracture humerus in children. *Microsurgery*, *26*(7), 498–505.
24. *Ramsey, R.H. and Griz, J. (1973) Immediate Open Reduction and Internal Fixation of Severely Displaced Supracondylar Fractures of the Humerus in Children. Clinical Orthopaedics and Related Research, 90, 131-132. - References - Scientific Research Publishin*. (n.d.).
25. Ristic, S., Strauch, R. J., & Rosenwasser, M. P. (2000). The assessment and treatment of nerve dysfunction after trauma around the elbow. *Clinical Orthopaedics and Related Research*, *370*(370), 138–153.
26. S, S., AM, S., D, B., R, D., D, M., C, C., P, R., & P, S. (2017). Vascular Injury Due to Humerus Fracture in Pediatric Age: When the Treatment Is Mandatory. *Annals of Vascular Surgery*, *44*.
27. Saglam, Y., Tunali, O., Akgul, T., Dikmen, G., Aksoy, M., & Dikici, F. (2014). Mid-term results of pediatric vascular injured supracondylar humerus fractures and surgical approach. *Journal of Pediatric Orthopaedics Part B*, *23*(6), 572–578.
28. Scannell, B. P., Jackson, J. B., Bray, C., Roush, T. S., Brighton, B. K., & Frick, S. L. (2013). The perfused, pulseless supracondylar humeral fracture: Intermediate-term follow-up of vascular status and function. *Journal of Bone and Joint Surgery*, *95*(21), 1913–1919.
29. Schoenecker, P. L., Delgado, E., Rotman, M., Sicard, G. A., & Capelli, A. M. (1996a). Pulseless arm in association with totally displaced supracondylar fracture. *Journal of Orthopaedic Trauma*, *10*(6), 410–415.
30. Schoenecker, P. L., Delgado, E., Rotman, M., Sicard, G. A., & Capelli, A. M. (1996b). Pulseless Arm in Association with Totally Displaced Supracondylar Fracture. *Journal of Orthopaedic Trauma*, *10*(6), 410–415.
31. Sibly, T. F., Briggs, P. J., & Gibson, M. J. (1991). Supracondylar fractures of the humerus in childhood: range of movement following the posterior approach to open reduction. *Injury*, *22*(6), 456–458.
32. Tomaszewski, R., Wozowicz, A., & Wysocka-Wojakiewicz, P. (2017). Analysis of Early Neurovascular Complications of Pediatric Supracondylar Humerus Fractures: A Long-Term Observation. *BioMed Research International*, *2017*.
33. W, C. R., Osterman, A. L., Davidson, R. S., Skirven, T., & Bora jr, F. W. (1990). Neural injuries associated with supracondylar fractures of the humerus in children - PubMed. *Journal of Bone and Joint Surgery*, *72*(8), 1211–1215.
34. Weiland, A. J., Meyer, S., Tolo, V. T., Berg, H. L., & Mueller, J. (1978). Surgical treatment of displaced supracondylar fractures of the humerus in children. Analysis of fifty-two cases followed for five to fifteen years. *The Journal of Bone and Joint Surgery. American Volume*, *60*(5), 657–661.
35. Weller, A., Garg, S., Larson, A. N., Fletcher, N. D., Schiller, J. R., Kwon, M., Copley, L. A. B., Browne, R., & Ho, C. A. (2013). Management of the pediatric pulseless supracondylar humeral fracture: Is vascular exploration necessary? *Journal of Bone and Joint Surgery*, *95*(21), 1906–1912.
36. White, L., Mehlman, C. T., & Crawford, A. H. (2010). Perfused, pulseless, and puzzling: A systematic review of vascular injuries in pediatric supracondylar humerus fractures and results of a POSNA questionnaire. *Journal of Pediatric Orthopaedics*, *30*(4), 328–335.
37. Wolfswinkel, E. M., Weathers, W. M., Siy, R. W., Horowitz, K. S., & Hollier, L. H. (2014). Less is more in the nonoperative management of complete brachial artery transection after supracondylar humeral fracture. *Annals of Vascular Surgery*, *28*(3), 739.e11-739.e16.