



Research Article

A CONTEMPORARY APPROACH TO MANAGEMENT OF THE META-DIAPHYSEAL DISTAL RADIUS FRACTURES IN PEDIATRIC POPULATION: A CASE SERIES

Ali Redha Gerashi., Sadaf Mohammed Basheer., Mohammed AbdulBasith and Ahmed Al-Aradi

Department of Orthopaedics, Salmaniya Medical Complex, Ministry of Health, Bahrain

ARTICLE INFO

Article History:

Received 10th April, 2021

Received in revised form 2nd

May, 2021

Accepted 26th June, 2021

Published online 28th July, 2021

Key Words:

Distal radius meta-diaphyseal, pronator quadratus, retrograde elastic nail.

ABSTRACT

Introduction: The subset of Pediatrics distal radius fractures involving the dia-metaphyseal junction presents a significant challenge to the orthopaedic community in terms of standard treatment protocol. Their distinctive feature stems from the fact that they are usually located too distally to be treated with classic ESIN and too proximally to be treated with conventional K wire fixation.

Case-Series: In our case series involving 6 patients, we would like to introduce our modified ESIN technique in which a single ESIN is introduced in a retrograde fashion proximal to the fracture site and advanced distally to just above the growth plate for the treatment of quadratus fractures.

Conclusion: Our technique has been demonstrated to be an effective alternative to the usual ESIN or K wire fixation with no notable complications during follow-up

Copyright©2021 Ali Redha Gerashi et al. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

INTRODUCTION

One of the most common injuries that a pediatrictraumatologist comes across is the forearm fractures. 75-80% of these fractures involve the distal 3rd, 15-30% middle 3rd and 1-7% occur in the proximal 3rd(1) however there is a subset of pediatrics distal radius fractures involving the dia-metaphyseal junction commonly known as the quadratus fractures(2) that present a significant challenge to the orthopaedic community in terms of standard treatment protocol. These fractures account for 10-25% of pediatric population(2).

Unlike majority of pediatrics forearm fractures that can be managed conservatively, these fractures are associated with a 7-32% failure(2,3) rate if managed with closed reduction and cast immobilization alone owing to the unstable nature of the fracture and pronator quadratus muscle interposition. Their distinctive feature stems from the fact that they are usually located too distally to be treated with classic ESIN and too proximally to be treated with conventional K wire fixations(4,5,6). These obstacles has led to a failure of standardized treatment protocol for such fractures. Numerous surgical techniques has been described including trans-epiphyseal intramedullary K wire fixation, short double ESIN fixation as well as intramedullary rush pin insertion(1,7-10).

In our case series involving 6 patients, we would like to introduce our modified ESIN technique in which a single ESIN is introduced in a retrograde fashion proximal to the fracture site and advanced distally to just above the growth plate for the treatment of quadratus fractures. This method achieves appropriate stability and eliminates the need for prolonged casting. Also since the growth plate is not violated the possibility of physeal arrest due to iatrogenic cause has been eliminated. We were able to achieve full ROM of the wrist joint without causing any significant complication in all our cases. The hospital stay was notably reduced to less than 48 hrs along with less operative time, less chance of infection and early union.

Operative Technique

Our indication for open reduction and retrograde ESIN fixation were unstable, displaced quadratus fractures with angulation >10 degrees in children < 10 years and angulation <10 years in children > 10 yrs. Also any grossly rotated radius fractures were considered for retrograde ESIN fixation.

Patients were given general anesthesia as per department protocol. Our standard approach to these patients involve the following steps:

1. Patients are placed in supine position with arm in extension and pronation on a radiolucent arm table
2. Standard aseptic prepping and draping is then utilized.

*Corresponding author: Ali Redha Gerashi

Department of Orthopaedics, Salmaniya Medical Complex, Ministry of Health, Bahrain

3. A Gentle attempt at closed reduction is attempted in all patients.
4. Under image intensifier, the ESIN insertion site is localized which is around 5-8 cm proximal to the fracture site, this decision is based upon the distance of the fracture from the distal physis.
5. A small incision around 3-4 cm in length is then made at the purposed entry site. An important landmark is the bare area that is localized in the palpable interval between brachioradials and extensor carpi radialis insertion. Care has to be taken through the procedure to protect the superficial radial and lateral antebrachial cutaneous nerves.
6. After adequate exposure and visualization of the periosteum, a 2mm K wire is placed at the outer cortex of the bone to make insertion site.
7. The cortex is then drilled using 2-2.5 mm drill bit to create an entry site for ESIN, the ESIN is then advanced in radio dorsal to ulnar volar direction in a controlled manner.

An important precaution with this technique is to reduce the fracture adequately in AP and lateral views before advancing the ESIN. The ESIN is hammered and not rotated till it is 5mm short of the growth plate. The placement and depth of the pin are checked fluoroscopically.

Post-op care: The patient is kept on above elbow slab for 4 weeks followed by a below elbow cast for 2 weeks after which the patient is allowed for full ROM and light sport activities.

Case- Series

The index case involves a 10 years old boy who presented with a history of fall from a tree landing directly on his out stretched wrist sustaining a right sided meta-diaphyseal quadratus fracture (fig 1 & 2).



FIG 1&2 Pre-op Imaging depicting AP and lateral views of the meta-diaphyseal fracture in our index case.

The patient was initially splinted in the ER with an above elbow slab and was admitted for closed reduction and ESIN fixation. He was taken to OR and underwent retrograde ESIN fixation (fig 3) which was supplemented with an above elbow splint. The patient was discharged on post op day 1, he was comfortable with not much pain and minimal soft tissue swelling. Post-op patient was followed in the OPD with serial radiographs at 1 week, 3 weeks and 6 weeks respectively (fig 4&5).

At 4 weeks, the splint was changed from above elbow to below elbow, the fracture showed adequate callus formation (fig 4,5) and was consolidated by 6 weeks. The slab was removed and patient was examined clinically. He demonstrated full ROM with no deformity clinically. The ESIN was removed in OPD at 6 weeks under LAA follow up xrays taken at 3 months demonstrated complete healing with no residual deformity and full ROM at wrist joint. The patient was followed to 1 yr post fixation and was doing well in terms of having full range of motion at the wrist joint.

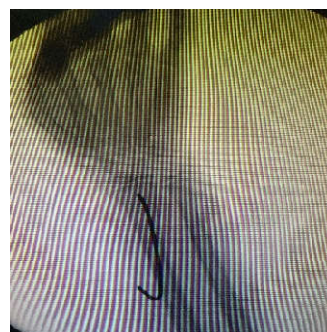


Fig 3 Intra-op imaging showing ESIN insertion.

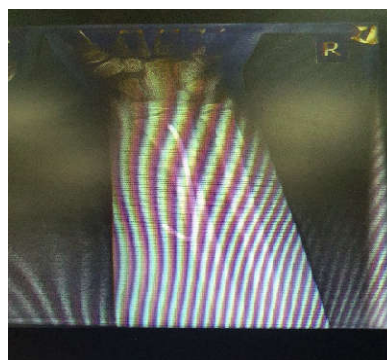


Fig 4 AP view showing adequate callus at 6 weeks



Fig 5 Lateral View at 6 weeks with adequate callus.

Case 2

Similar technique for fixation was adapted in another 12 years old child who presented with left meta-diaphyseal fracture post falling on outstretched hand (fig 6&7). He was operated upon the following day with our methodology of retrograde nancy nailing (fig 8 & 9). Upon follow-up the fracture went on to heal completely without any residual deformity or functional deficits till the last follow up of 4 weeks (fig 10,11).

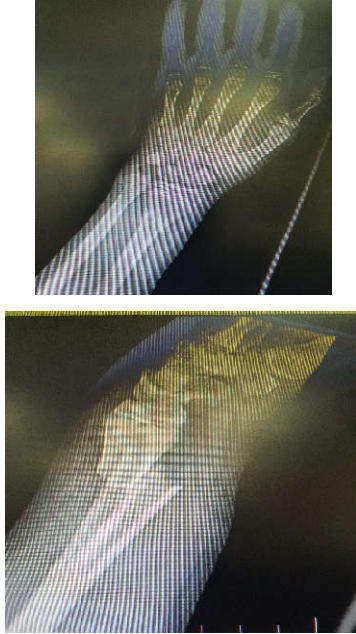


Fig 6,7 Pre-op AP and lateral view depicting typical pronator quadratus fracture subtype.



Fig 10,11 AP and lateral view at 4 weeks with adequate callus formation

Case 3

Our 3rd case also involves a 12 years old patient with history of fall while playing, sustained a closed fracture at the meta-diaphyseal junction of left distal radius with no neurovascular deficits (fig 12,13). He was managed as per our standard protocol and went on to have good callus by 6 weeks with complete ROM at the wrist joint (fig 15).



Fig 8,9 Intra-op AP and lateral view post ESIN insertion.

Fig 12,13 Pre-op imaging of case 3.





Fig 14 Intra-op imaging of the ESIN nailing.



Fig 15 Fracture at 6 weeks

We have utilized this technique of fixation in a total of 6 patients, unfortunately 2 of which were lost to long term follow-up, up to the minimum period of follow up (mean 6 weeks), all of our cases went on to heal uneventfully. We observed no evidence of infection, tendon or nerve injury or growth disturbance during the follow-up period. No cases of mal-union or non-union were reported and all patients had full ROM at 6 weeks post-op.

DISCUSSION

Pediatric traumatologists are well aware of the challenges faced in treating pronator quadratus subset of meta-diaphyseal fractures. The various options of management for such fractures represent the paucity and lack of sufficient literature in this regards.

Quadratus fractures results in total disruption of periosteum and as such are considered highly unstable⁽¹¹⁾. As such these fractures can be regarded as articular fractures as minimal

spatial deviation in the distal radius may affect the forearm rotation significantly.

Pediatric radius fractures are known for their ability to remodel and therefore have been historically treated by closed reduction and casting⁽⁷⁾ in majority of the cases nevertheless this subtype of fracture is associated with 5-7% loss of reduction and poor functional outcomes with conservative treatment. There has recently been a trend towards operative fixation of the fracture in a bid to improve functional outcomes^(7,12,13). Shoemaker *et al*⁽¹⁴⁾ suggested that the ideal operative osteosynthesis technique for pediatric wrist fractures should be minimally invasive, maintain alignment, physal sparing and should have an acceptable risk profile^(2,14).

Current available techniques involve K wire fixation of such fractures. In addition to difficulty in maintaining reduction with various modifications of K wires described, they have complications of pin migration, superficial infection and potential damage to growth plate. K-wire construct for such fractures is not biomechanically stiff and needs to be augmented using an above elbow cast for a minimal of 6 weeks post-operatively. This accounts for the major disadvantage of such technique.

Meta-diaphyseal distal radius fractures are usually located too distally to be treated by conventional ESIN. Lieber *et al*⁽¹⁰⁾ described trans epiphyseal pinning in such cases, other suggest a pre-bent physal sparing elastic nail to eliminate chance of iatrogenic physal injury.

Shoemaker *et al*⁽¹⁴⁾ and Flynn *et al*⁽³⁾ considered using a standard rush pin and found it to be a reasonable treatment option. Difficulty in insertion of rush pin along with limited malleability has led to this technique falling out of favor.

Intramedullary nailing offers advantage over cross K wire configuration in terms of both performance and stability. The main advantage includes maintenance of reduction, minimally invasive, relatively easy application and acceleration of healing by micro motion that leads to bridging callus and rapid bone healing^(15,16,17). In modern day settings, titanium is being used due to its elastic properties that allows for improved insertion and rotation.

However, the treatment of such distal radius fractures with traditional entry portals may push the distal fragment to the opposite side due to short distal fragment resulting in instability and malalignment.

Through this case series we would also like to highlight our own experience with conventional entry ESIN that though was well reduced intra-op (fig17,18) but during the course of healing displaced and the final outcome was a mal-united distal radius fracture with significant volar angulation (fig19,20).

Post the complication that occurred during the above mentioned case and to address the technical difficulties in fixation of distal meta-diaphyseal fractures, we have developed a new approach that involves retrograde insertion of ESIN from proximal fragment, this method avoids repeated entry attempts that may damage the physal plate leading to potential growth arrest. Our technique involved closed or open reduction of the fracture before ESIN insertion both of which have yielded similar functional results with a similar complication profile as evident in a study by Lachman *et al*. He has advocated the use of open reduction to decrease the

trauma to the soft tissues caused by multiple reduction attempts. The average operative time was 23 mins for our technique that is comparable to conventional ESIN fixation.

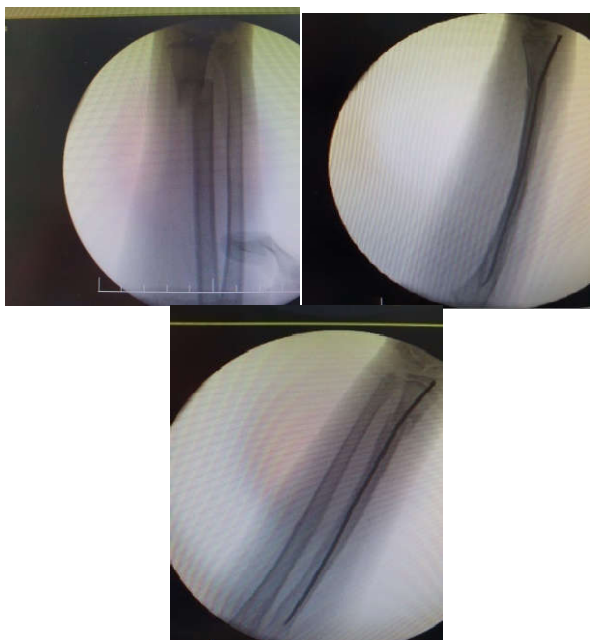


Fig 16 Pre-op images.

Fig 17,18 Intra-op imaging showing acceptable reduction immediate post ESIN insert



Fig 19, 20 Final outcome at 6 weeks depicting significant volar and radial angulation resulting in a maluniting fracture.

Our approach yielded satisfactory outcomes along with increased fracture stability and decrease migration. The main complication associated with our technique was skin irritation that can be minimized by ESIN removal at 6 weeks in contrast to conventional ESIN that need to be left in situ for a minimum of 4 months.

CONCLUSION

In conclusion, our technique is an easy, reliable, safe and minimally invasive alternative to treating pediatric quadratus fractures that has demonstrated a good functional outcome with an acceptable complication profile.

References

1. MarcellVarga, Gergo Jozsa,Balas Fadgyas *et al.*, Short double elastic nailing of severely displaced paedric radial fracture. *Medicine*(2017) 96:14(e6532).
2. DhanpalSingh, AManikandarajan and T Sathish Kumar. Prospective study on functional outcome of management of pediatricquadratus fractures with rush pins. *National Journal of ClinicalOrthopedics* 2018:2(2):24-29.
3. Flynn JM, Jones KJ,Garner MR, Goebel J.Eleven years of expirience in operative management of peadtrics forearm fracture. *J JPediatr orthop.*2010;30:313-19.
4. Mengmeng Du, Jiuhui Han. Antegrade Elastic stable IM nail fixation for pediatricdistal radius diaphyseal-metaphyseal junction fractures.*Injury ,Int J CareInjured* 50(2019) 598-601.
5. Lieber J, Schmid E, Schmittenbecher PP. Unstable diametaphyseal forearm fractures:transphysealintrameduallryKrischner-wire fixation as a treatment option in children.*Eur J PeditarSurg* 2010;20(Nov(6)):395-98.
6. Kim Bs, Lee YS,ParkSY,Nho JH, Lee SG,Kim YH. Flexible intramedullary Nailing of forearm Fractures at the DistaldiaMetadiaphyseal Junction in Adolescents. *ClinOrthopSurg* 2017:9 (March(1)):101-8.
7. Rainer Kubaik,DevrimAksakai,ChristelWeiss,LucasM.Wessei. Is there a standard treatment for displaced pediatricdiametaphyseal forearm fractures?. *Medicine* (2019) 98:28(e16353).
8. KruppaC,BungeP,SchildhauerTA,*et al.* Low complication rates of elastic nailing of peadtric forearm farctures: a reteroprospective study of 202 cases. *Medicine (Baltimore)* 2017;96:e6669.
9. Tisosky AJ, Werger MM, McPartland TG *etal.* The factors influencing the refracture of pediatricforearm . *J PeadiatrOrthop* 2015;35:677-81.
10. Lieber J, Sommerfiled DW. Diametaphyseal forearm fractures in childhood .Pitfalls and recommendations for treatment .*Unfallchirug* 2011;114:292-9.
11. Zu-Jie Hu, Ming Li,Xing Liu, Chang-Kang Liu.Chinese Journal of Traumatology 21(2018);301-303.
12. Kosuge D, Barry M. Changing trends in the management of children's fractures. *Bone Joint J* 2015;97-B:442-8.
13. Schmittenbecher PP. State-of-the-art of the forearm shaft fractures. *Injury* (2005);36(supple):A25-34.
14. Shoemaker S. Comstock C,Mubarak S, Wegner DR, Chambers HG. Intramedullary Krischner wire fixation of open or unstable forearm fractures in children . *J PeadiatricOrthop.* 1999;19:329-37.
15. Haider Mohammed, FareedSallom. Flexible Intramedullary Fixation of Pediatric Forearm Fractures- Report on twenty-one Patients, *Bahrain Medical Bulletin*,2009,31(1).

16. Yalcinkaya M, Dogan A, Ozkaya V, *et al.* Clinical results of intramedullary nailing following closed or mini-open reduction in pediatric unstable diaphyseal forearm fractures. *Acta Orthop Traumatol Turc.* 2010; 44(1):7-13.
17. Joulie S, Laville JM, Salmeron F. Posteromedial elastic stable intramedullary nailing (ESIN) in volarly displaced metaphyseal-diaphyseal distal radius fractures in child. *Orthop Traumatol Surg Res.* 2011; 97 (May(3)):330-4.

How to cite this article:

Ali Redha Gerashi *et al* (2021) 'A Contemporary Approach To Management of The Meta-Diaphyseal Distal Radius Fractures In Pediatric Population: A Case Series', *International Journal of Current Advanced Research*, 10(07), pp. 24821-24826. DOI: <http://dx.doi.org/10.24327/ijcar.2021.4949.24826>
