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Prospective study on functional outcome of management of pediatric quadratus fractures with rush pins

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Abstract
Pediatric quadratus fracture can be treated with closed manipulation, reduction and cast application. Indications for operative intervention in pediatric quadratus fractures include open fractures, irreducible fractures, maluniting and unstable fractures. Varied options for intramedullary fixation include Steinmann pins, Kirschner-wires, Rush pins, and elastic titanium nails. The aim of this study is to access the functional outcome in the treatment of Pediatric quadratus fracture managed with intramedullary rush pin by closed or open reduction which was done at the Department of Orthopaedics, Rajah Muthiah Medical College & Hospital, Annamalai University, Chidambaram included 5 CHILDREN (Age between 5 to 12years) with QUADRATUS fracture treated with intramedullary stainless steel rush pin. Patient's age, sex, side, mode of injury, fracture type, fixation indication and method, time of clinical and radiological union, complication rate and final range of motion were evaluated at subsequent follow up. Mean hospital stay was 7 days (range 5 to 9 days). Clinical evaluation was done as per Price's criteria - followed up for minimum 3 months for radiological and functional outcome. Overall mean time of clinical functional outcome 50 days. All fractures maintained good alignment post operatively. All had excellent results with normal elbow range of motion and normal forearm rotation. In all patients good radiological union was seen in three months time. To conclude fixation with intramedullary stainless steel rush pin produces good to excellent results in quadratus fractures in children. It is an effective, simple, cheap, and convenient way for treatment in pediatric age group.

Keywords: Pediatric quadratus fracture, rush pin

Introduction
Pediatric fractures present significant challenges to the orthopedic community. Distal diaphyseal fractures of the radius & ulna, commonly referred to as Quadratus fractures, are the common fracture in the pediatric population and account for 10 to 25% of all pediatric fractures. Unlike distal radius fractures in adults, which are generally treated by open reduction and osteosynthesis with plate and screw fixation, 90% of pediatric forearm fractures are successfully treated conservatively by closed reduction and casting.

But a recognized failure rate has been reported up to 7%-32% and some of the indications for operative intervention are open fractures, irreducible fractures, unstable fractures, pathological fractures, fractures with neurovascular compromise, malunions, and refractures managed by fixation with pins and plaster, closed or open reduction with a mini incision and intramedullary nailing, open reduction and osteosynthesis with plate and screw fixation, and external fixators. Quadratus fractures can be regarded as articular fractures as slight deviations in the spatial orientation of the radius may significantly decrease the forearm's rotational amplitude and thereby impair the positioning and function of the hand.

The basic principle is to accurately align the fracture fragments and to maintain this position until the fracture is united using intramedullary stainless steel Rush pins. Closed reduction and internal fixation with Rush pins is an easy and fast method for treating Quadratus fractures with minimal blood loss and scar. Full range of movements was achieved without any significant complication. As the cost of implant is very less and hospital stay is reduced to an average of 5 days, with less operative time, less chance of infection, early union rush pin is an effective method for treating quadrates fractures.

Aim & Objective
This study was carried out to evaluate the clinical and radiological outcome of pediatric quadrates fractures treated with intramedullary stainless steel Rush pins & conservative management for ulna.

Materials and Methods

This study was done at the Department of Orthopaedics, Rajah Muthiah Medical College & Hospital, Annamalai University, Chidambaram from May 2016 to November 2016 included 10 CHILDREN (Mean age of the patients 5 to 14years) with QUADRATUS fracture treated with intramedullary stainless steel rush pin & distal ulna by conservative means which were followed for 6 months.

Patients' age, sex, side, mode of injury, fracture type, fixation indication and method, time of clinical and radiological union, complication rate and final range of motion were evaluated at subsequent follow up.

Inclusion criteria

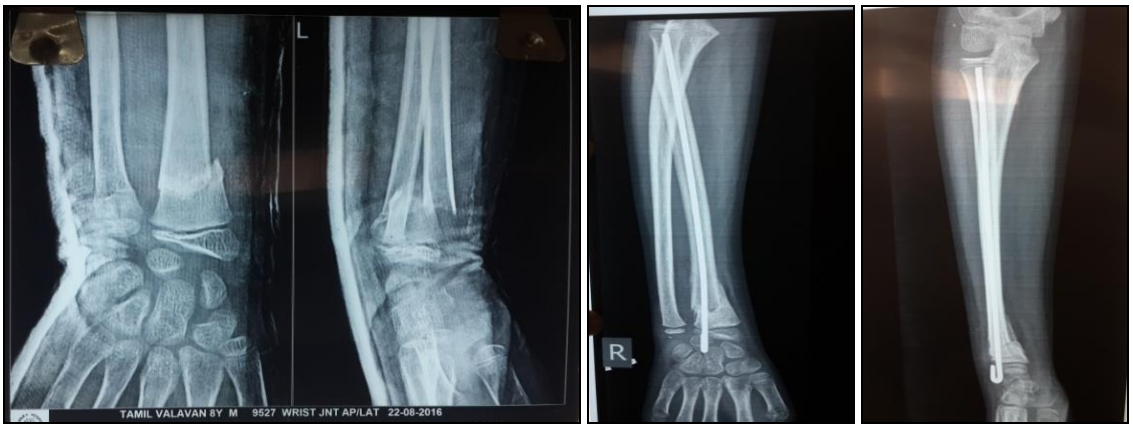
1. Age >4 <15 years
2. Closed Quadratus fractures of radius with undisplaced /minimally displaced ulna

Exclusion criteria

1. Open fracture
2. Pathological fractures
3. Associated with polytrauma
4. Fracture with neurovascular injury
5. Fractures >6 weeks old.
6. Patients with underlying neuromuscular disease & metabolic bone disorder.

Indication for closed reduction and fixation with rush pin:

1. Displaced Quadratus fractures of radius with Angulations >20 degrees in children <10 years, and angulations >10 degrees in children >10 years
2. Fresh fractures <5 days



Indication for open reduction and fixation with rush pin

1. Displaced Quadratus fractures of radius with Rotational deformities
2. Grossly rotated fractures
3. Failed closed manipulation
4. Fracture more than 3 weeks old
5. H/O native treatment

Implant Used

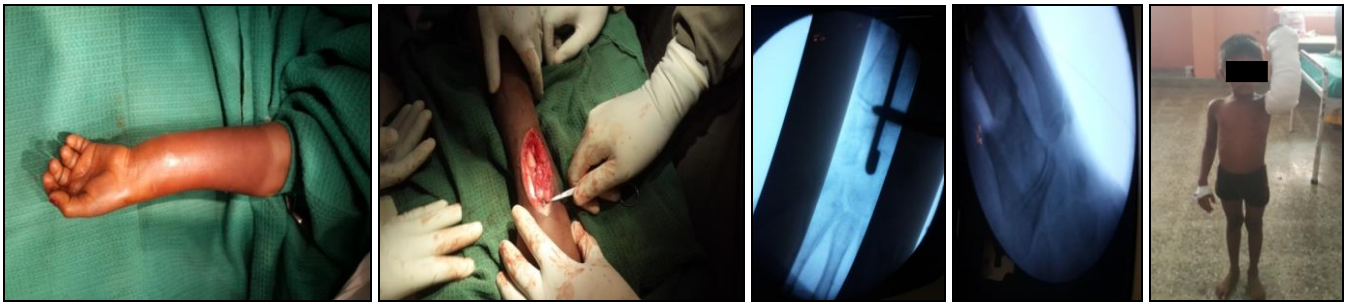
Rush pins made of stainless steel

Rush pins are available in different sizes of length and diameter.

Operative Procedure: Patients were taken for surgery within 1 to 3 days after pre-anesthetic check-up and valid informed written consent. Under general or regional anesthesia the procedure was done. A pneumatic tourniquet was used in all patients.

Position: Patient was placed supine on the table with a side arm board. An optimal closed fracture reduction was achieved under biplanar fluoroscopic control, prior to preparation and draping.

Procedure: Standard aseptic precaution and draping was used.



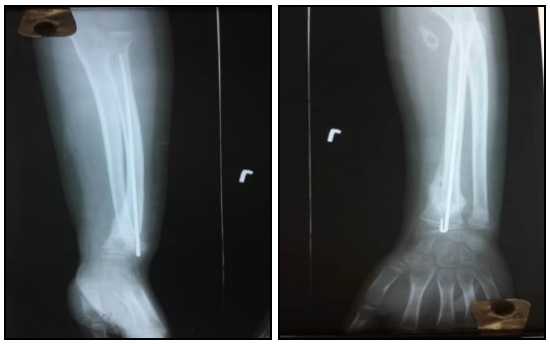
Entry Point
Approach to Radius
Lister Tubercle Approach
For closed pinning Rush pin was advanced through a dorsal stab entry point 2-3 cms proximal to the distal radial epiphyses. For open pinning 2 to 2.5 cm longitudinal incision made over distal radius on radial side of Lister's tubercle starting at the level of wrist joint. Blunt dissection of subcutaneous tissues to avoid injury to superficial radial nerve branches. The second extensor compartment Opened through a longitudinal incision on the extensor retinaculum radial to Lister's tubercle leaving proximal third intact. Retract extensor carpi radialis longus and brevis tendon to radial side. Entry point should be 5 to 10 cm proximal to articular surface.
Dissection is carried out between the second and third extensor compartments to cortical bone. Under C-arm confirmation that the approach has been made from proximal to distal, a small awl is used on the dorsal surface directing the drill bit slightly proximal and volar allows easier passage of the intramedullary rush pin through the radius The extensor pollicis tendon must be protected during drilling and nail passage. Awl is advanced into the medullary canal at a low angle (30 degree) to prevent engaging the palmar cortex. Flexion of wrist over a stack of towel helps in preventing penetration of volar cortex. Diameter of pin used varied from two to three mm depending upon the diameter of medullary cavity at the level of isthmus. The nail length was measured from distal to the proximal growth plate under image intensifier. After the nail has been passed across the fracture site and reduction has been confirmed with C-arm in both planes, the distal bent tip is kept under the skin. The extremity is then placed in well-padded long arm slab.

Approach to Ulna
Managed conservatively with BE slab

Postoperative management: In the postoperative period, immobilization with long arm slab was given. Active finger movements were encouraged after operation. Wrist and finger mobilization was done early according to general condition and co-operation of the patient. Suture removal was done at 7 to 10 days after surgery, following which slab was removed and immobilization was done with above elbow cast for additional 4 to 6 weeks. Supination and pronation of forearm was allowed after removal of splint at six weeks. Patients were followed up at regular intervals of 6 weeks, 12 weeks and 6 months.

Observations & Results
In our study 10 fractures of quadrates fractures of forearm. 6 cases were fresh fractures, 4 patients took native treatment and presented to us after 3 weeks. All patients were boys (males). The median age was 12 years ranging from 5 to 14 years? 5 of the fractures were caused by direct blow, 3were by fall on outstretched hand and 2 were due to road traffic accidents. 2 patients had fractures on right side and 8 on left side.

All patients were operated within 24-72 hours on admission. Duration of surgery was 30-45 minutes. Closed reduction and nailing with Rush pin was successful in 6 cases whereas 4 patients required mini open reduction due to soft tissue interposition or presented to use after 3 weeks of native treatment.
Out of the 10 patients, 8 patients showed radiological signs of Union in a mean of 6±2 weeks (range six to nine weeks). According to the criteria of Price *et al*. [7] an excellent result was achieved in 8 patients (80%) and a good result was achieved in 2 patients (20%) & complete union within 16-20 weeks. We encountered 1 superficial infection which was treated with local debridement and antibiotics as warranted by culture report. However fractures went on to heal uneventfully in 80% of patients had excellent results with good range of motion (supination and pronation) along with wrist dorsiflexion and palmar flexion. There were no cases of malunion and nonunion in our study. The duration of follow up ranged from 3months to 6 months.



Radiological union was defined as presence of bridging callus across three cortex of 10 patients, 8 patients (80%) showed radiological signs of union within 16 weeks.

Table 1: Radiological Union

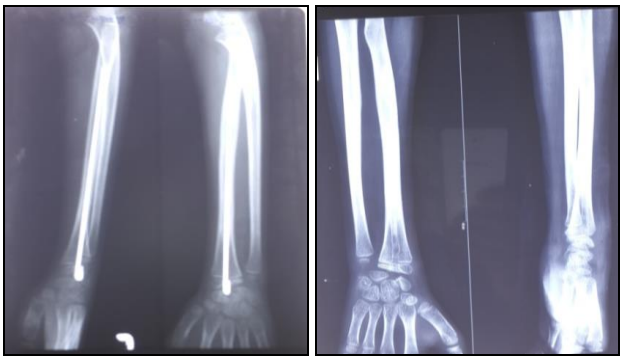
Union (Weeks	No. Of cases	Percentage
< 12 wks.	2	20
12-16 wks.	6	60
16-20 wks.	1	10
Delayed union	1	10
Nonunion	0	0.00

Table 2: Range of Pronation/Supination

Percentage loss of Pronation/supination	No. of cases
<25%	7
25- 50%	2
>50%	1

Functional outcome was assessed using standard Grace and Eversman scoring system & Price criteria according to which absence of complaints with strenuous activity or loss of forearm rotation of less than 10 degrees or both showed an excellent result; the presence of mild complaints with strenuous activity or a rotational loss of 11 to 30 degrees showed a good result; subjective complaints during daily activities or rotational loss of 31 to 90 degrees showed a fair result. All other conditions were considered to be a poor outcome. As per Grace and Eversman scoring system Excellent rating meant there was union of fracture with at least 90% of normal rotation arc of the forearm.

None of the patients had complications such as limb-length discrepancy affecting the upper extremity functions, epiphyseal damage, angular or rotational deformity, synostosis or limited elbow or forearm range of motion. No cases of nonunion or malunion were reported. The implants were removed under appropriate anesthesia at an average of six months following primary fixation



Discussion

Historically, the majority of pediatric distal diaphyseal forearm bone (Qudratus fractures with distal ulna) have been treated with non-operative management relying on closed reduction and casting. This treatment is associated with loss of reduction and poor functional results in five to seven percent of the patients. Recently there has been a trend towards increased surgical management of these fractures in an effort to improve clinical outcomes. The clinical results of pediatric forearm fractures mainly rely on residual angulations at the fracture site, the presence of a rotational deformity, remodeling potential of the bone, the age of the patient, and the location of the fracture.

Our study comprised of 10 patients with quadratus fractures with distal ulna fracture of forearm who were treated by rush pins. Overall final outcome was assessed by Grace and Eversman scoring system & & Price criteria.

Shoemaker SD *et al*. suggested that the ideal mode of fixation of pediatric forearm fractures should maintain alignment, be minimally invasive and inexpensive, and carry an acceptable risk profile.

The main advantages of intramedullary nailing include maintenance of reduction, provision of an inexpensive, minimally invasive, relatively easy application, protection of bone alignment by three point contact, acceleration of bridging callus formation through micro movements at the fracture site, and thus contribution to rapid bony healing. Intramedullary fixation materials include Steinmann pins, Kirschner-wires, Rush pins, and elastic titanium nails. In the clinical setting, titanium is being used more often than stainless steel because of the elastic properties which allow for improved insertion and rotation but it may be expensive and not easily available in many hospitals in rural set up.

Outcome of treatment with intramedullary stainless steel rush pin in diaphyseal forearm bone fracture was excellent in 25(83.3%) patients and good in five (16.6%) patients in this study which is similar to study done by Yalcinkaya *et al*. [2], Shoemaker SD *et al*. [11] and Flynn JM *et al*. [13] (table 1). Stainless steel rush pin is a reasonable option and it can be used like titanium elastic nails in peripheral orthopedic setup for managing pediatric diaphyseal forearm bone fractures. Though insertion of Rush pin may be difficult as it is less malleable it offers various potential benefits likes cosmetics, easy removal after treatment and decreased chances of neurovascular injuries.

A modification of rush pin was used to treated acute fractures of diaphysis of ulna and radius in adults by intramedullary fixation in standard studies by J Moerman, A Lenaert, DE Coninck**.** Union occurred in 66 fractures (94%). No failure of fixation or material breakage was seen in the study.They concluded that closed nailing does have many advantages, including early union, low incidence of infection, small scars, less blood loss and short operating time with minimal surgical trauma.

Close reduction or open reduction before intramedullary nailing yield similar functional results, with similar complication profile in pediatric diaphyseal forearm bone fracture. Luhmann *et al*. [15] advocated that open reduction with a small incision would cause much less trauma to tissues than that caused by multiple reduction maneuvers. In or study 4 patients had undergone mini open reduction due to soft tissue interposition and their outcome

was similar to patients treated with closed reduction and intramedullary nailing.

In our study, 0ne (10%) patient developed minor complications most of which resolved after adequate antibiotic therapy. Cullen *et al*. [16] reported complications as high as 50% following intramedullary fixation of pediatric forearm bone fractures. Yalcinkaya *et al*. [2] reported complications rate ranged from four to 38% in patients treated with intramedullary nailing. The cause of these complications is difficult to determine, it is due to the surgeon's inexperience with the technique or the surgery itself.

Haider Mohammed, Fareed Salloom *et al*, retrospective Study, twenty one pediatric patients with displaced forearm fractures were treated with flexible intramedullary nails. The study group included 19 boys and 2 girls aged 6 and 14 years (mean 9.3). Closed reduction and percutaneous introduction of nails was tried in all patients.

Closed reduction and percutaneous introduction of the nails was possible in 9 patients. In 8 patients, a mini incision was needed for either the radius or the ulna. In 4 patients, both the radius and ulna needed exposure through mini incision. The patients were followed- up for a period between 6.7 to 35.7 weeks (mean 18.7 weeks). All fractures were united in acceptable alignment and nails were removed at a mean interval of 18.7 weeks However, the functional outcome was excellent.

Our study also produced similar results where closed reduction and percutaneous introduction of nails was tried in 6 patients. In 4 patients, a mini incision was needed for the radius The patients were followed- up for a period between 16-36 weeks. All fractures were united in acceptable alignment and nails were removed after clinical & radiological union & the functional outcome was excellent.

Advantages of Rush Pins

1. Benefits of Closed technique

A. Reduced surgical exposure & decreased periosteal stripping.
B. Avoids big skin incision and subsequent scar with less cosmetic concerns.
C. Decreased chances of infection.
D. Early union.
E. Useful in patients with poor fragile skin conditions.

2. Better anatomical- axial reduction and dynamic stabilization
3. Less refracture after nail removal.
4. Decreased incidence of non-union.
5. Cost is cheaper.
6. Possibility to use in children with small diameter nails by making an entry point without crossing open growth plates.

Sample size, study duration and non-comparative nature of the present study are the limitations of our study. However this study will serve as a baseline data in future in demonstrating the differences between the results of elastic nails versus rush pin or closed versus mini open intramedullary nailing for pediatric distal diaphyseal forearm both bone fractures (Quadratus fracture with ulna fracture).

Conclusion: Closed Reduction and Internal Fixation with Intramedullary Rush Pin is an easy and fast method for treating forearm fractures with minimal blood loss and scar. Full range of movements was achieved without any significant complication. As the cost of implant is very less and hospital stay is reduced to an average of 5 days, Intramedullary rush pin fixation for radius and conservative management of ulna is an effective method of treating these fractures.

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