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Radioulnar derotational osteotomy and internal fixation of radius and ulna with plate and screws distal to fusion site for congenital radioulnar synostosis-A case series

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Abstract
The purpose of this study was to determine the functional outcome of radioulnarderotational osteotomy with internal fixation for the treatment of congenital radioulnar synostosis (CRUS). The forearm was derotated to the desired position (20 degrees of supination to 10 degrees of pronation) utilising plates for internal fixation and plaster splints for external immobilisation in the event of a congenital radioulnar synostosis. The pre- and postoperative locations of the forearm were recorded, and forearm function was assessed using Failla *et al* classification. 's system. The average follow-up period was 6 months to a year. The average adjustment was 50 to 90 degrees. As a result, the correction has been made from 20 degrees of supination to 10 degrees of pronation. At the final follow-up, the forearm was assessed as excellent using the Failla grading system. After 2 to 3 months, the patients' bones were healed. There were no complications discovered.
Conclusions: Proximal radioulnar derotational osteotomy followed by plate fixation is a safe and complication-free operation. The approach can significantly enhance forearm function.

Keywords: radioulnar derotational osteotomy, congenital radioulnar synostosis

Introduction
Congenital radioulnar synostosis (CRUS) is an uncommon congenital upper-limb skeletal deformity that can be severely debilitating, especially when it occurs bilaterally or when severe hyperpronation is present [1, 2].
The forearm is locked in the pronation posture, which is the major feature of this deformity subtype. The absence of forearm rotation makes it difficult to perform movements that need this motion. Mild deformities can be compensated for by the ipsilateral shoulder and wrist [2, 10]. Daily activities such as eating, cleaning, dressing, engaging in personal hygiene care, and accepting objects in the palm of the hand can be severely hampered when pronation abnormalities are severe. Because of the small patient groups reported, differences in the duration of follow-up, and surgical techniques selected at the proximal ends of the radius and ulna, many surgeons have performed proximal radioulnar derotational osteotomy [6, 7] to improve results. Pronation greater than 60 degrees is indicated for surgical treatment. Surgical separation and reconstruction approaches were once thought to be the best treatment because they addressed both the deformity and the rebuilding of forearm rotational function, but the end results were not sufficient. Derotational osteotomy, which changes the posture of the forearm from hyperpronation to a more functional position to lessen supination limits and allow patients to conduct everyday tasks more readily, is still the most routinely performed treatment in patients with CRUS [3, 4]. Derotational osteotomy at the synostosis site with K-wire fixation, one-stage or two-stage double-level derotational osteotomy of the ulna and radius fixed with plaster casts, one-stage double-level derotational osteotomy of the ulna and radius fixed with K-wire fixation, and single osteotomy of the radial diaphysis fixed with plaster casts are some of the osteotomy and fixation methods Nerve palsy, compartment syndrome, loss of correction, residual angulation, delayed union, and nonunion have all been recorded as side effects of the aforesaid techniques [8, 9].
The goal of this retrospective study was to see how well proximal radioulnar derotational osteotomy followed by plate fixation worked for 10 patients with CRUS (10 forearms). The surgical correction's outcomes might be effectively understood based on this sample.

Materials and Methods
From May 2019 till the present, our institute has treated CRUS patients with surgical procedures. Proximal radioulnar synostosis derotational osteotomy and plate fixation distal to the synostosis site were used to treat all ten patients. Out of the patients ten patients (four boys and six girls) who underwent surgery between May 2019 and May 2020 matched the inclusion criteria and were assessed. Children with unilateral or bilateral CRUS, skeletally immature children with open growth plates, forearm pronation of 55 degrees, and a score of 10 points on the Failla classification[9] system were all included in the study. Children with insufficient clinical or

radiographic data, other combined ipsilateral upperlimb abnormalities, and a follow-up time of less than two years were excluded.

The left elbow was affected in six of our cases, while the right elbow was involved in four. At the time of operation, the average age was 9.45(range: 6 to 13). The Cleary and Omer methods of X-ray classification were used to all patients based on the form and position of the radial head [2]. There were no type I cases (fibrous synostosis with a normal-appearing radial head and normal radiocapitellar alignment), however all were type II cases (25%) were found (bony synostosis with a normal-appearing radial head and normal radiocapitellar alignment) [1].

Fig 1

Surgical Technique

The patient was placed in the supine position while under general anaesthesia. To provide a bloodless operating field, a tourniquet was applied to the upper arm. Over the middle ulnar ridge, a 5-cm longitudinal incision was created. The periosteum was incised, and the incision was taken distal to the synostosis location over the ulna, as is the normal subcutaneous approach. Over the distal one-third of the forearm, the radius was exposed more distally. The forearm was gradually derotated to the goal position after a transverse osteotomy was performed distal to the synostosis on both the radius and ulna (20 degrees of supination to 10 degrees of pronation). The radial nerve and its branches were carefully protected during surgery. Derotational osteotomy is also more prone to nerve and blood vessel torsion injury; as a result, the osteotomy must be conducted under the periosteum and treated softly, with no hard peeling. The osteotomy site was temporarily supported with an oblique 2.0-mm K-wire. A 2.7-mm recon plate for the radius and a dcp for the ulna were used to secure the osteotomy site. The elbow joint's full flexion and extension were checked to rule out any impingement. With the shoulder adducted and the elbow flexed at 90 degrees, acceptable forearm rotation was confirmed. The wound was layered closed.

Postoperative Care

The elbow was protected for 4 weeks after surgery with an above-elbow plaster splint, with the elbow joint at 90 degrees of flexion and the forearm in the neutral position. During the early postoperative phase, close surveillance for symptoms of edema and altered peripheral circulation, such as severe pain, numbness, and pale or blue colouring of the affected limb, was conducted, and over tightening of the plaster splint was avoided. For the first three days after surgery, the afflicted limb was elevated above the heart on a cushion. To avoid the occurrence of compartment syndrome, emergency release components were installed. 4 weeks after surgery, an X-ray of the forearm was taken to check for consolidation of the osteotomy. Because the implants may interfere with the growth of the children's ulna and radius, we normally removed the plate and screw system 3–6 months following surgery.

Fig 2: Post op image (before suture removal)

Fig 3: Post op radiography

Outcome Assessments

Postoperative X-rays were used to assess bone union at the osteotomy site, and the incidence of complications was determined. The surgical result was initially assessed by measuring the axial position of the forearm before and after surgery to see if there were any improvements in forearm function. The angle between the longitudinal axis of the humerus and the line of the radial and ulnar styloid processes was measured with a goniometer while the patient's elbow was fixed to the side of the chest and the forearm was in 90 degrees of flexion. The children's forearm function was also evaluated using the classification method developed by Failla *et al*.[9] for 15 tasks specified by Morrey *et al.*

Table 1

Quantity	Daily activities	Complete:1 point/ cannot complete:0 point
1	Touch hand to the vertex (head)	1/0
2	Touch hand to the occiput	1/0
3	Touch hand to the neck	1/0
4	Touch hand to the chest	1/0
5	Touch hand to the waist	1/0
6	Touch hand to the sacrum	1/0
7	Touch hand to the shoe	1/0
8	Pour from a pitcher	1/0
9	Put glass to the mouth	1/0
10	Cut with a knife	1/0
11	Put fork to the mouth	1/0
12	Use a telephone	1/0
13	Read a newspaper	1/0
14	Rise from a chair	1/0
15	Open a door	1/0
	Total score	0–15

Excellent, 15 points; good, 10–14 points; fair, 6–9 points; and poor, < 6 points

Fig 4: Functional outcome Post surgery within 2 months

Fig 5

The preoperative examination of the forearms was as follows: the rate of excellent forearm function increased from 5.6 percent preoperatively to 100 percent postoperatively, according to the Failla classification system [9]. After two months, all of the patients' bones had fused together. There were no instances of plate breakage, infection, or corrective loss.

An example from our research

A 9-year-old girl appeared to our department with her palm set downward and inability to supinate, according to her parents. She complained of difficulty doing things like cleaning, dressing, holding a bowl in her palm, and taking care of her personal hygiene. The patient had type III right CRUS, according to radiological testing. A physical examination indicated a permanent pronation deformity of 70 degrees in the right forearm, but no restrictions in extension or flexion of the right elbow joint. Only seven jobs could be completed preoperatively, according to the Failla classification system [9]. Touching the vertex (head), chest, neck, waist, sacrum, or shoe; lifting a glass to the mouth; and using a telephone were all prohibited. The forearm was placed at 20 degrees of supination and fixed with a plate, and derotational osteotomy was performed distal to the radioulnar fusion site without disturbing the fusion site. The osteotomy site was mending well at 4 months after surgery, and the plate and screw system was removed within a year. The child's right forearm was set in a position of 20 degrees supination at the 2-year follow-up with no problems, and the right elbow's flexion and extension activities were not limited. Her forearm function had greatly improved, allowing her to execute 15 exercises, including holding a bowl in her palm. The rating went from fair (preoperative) to exceptional (postoperative). Although several reports on the dissociation of synostosis and the interposition of fat or muscle (or some other material) have been published, recurrence of ankylosis has been reported [7, 10]. At an average of 3.67 years of follow-up, Kanaya *et al* [6]. Reported bone excision of synostosis with free vascularized tissue interposition in seven cases, and all patients had no fusion recurrence and gained forearm rotation. Separation and reconstruction surgery, on the other hand, has not acquired widespread approval, and derotational osteotomy is still the most routinely done procedure in patients with CRUS [12, 13, 14, 15]. For 34 patients, Hung [15] performed derotational osteotomy at the shafts of the proximal radius and distal ulna, followed by K-wire fixation and cast immobilisation (52 forearms). Twenty-seven patients (78.8%) had outstanding or excellent results, whereas five individuals experienced corrective loss. In 26 patients (31 forearms), Simcock [14] demonstrated derotational osteotomy at the synostosis site followed by fixation with crossing K-wires, resulting in an average final position of 8 degrees of pronation. There was one case of symptomatic muscle herniation in that series, as well as three occurrences of transitory nerve paralysis, two of which were transient anterior interosseous nerve palsies with rotational corrections exceeding 80 degrees. The other osteotomy technique is at the radial diaphysis and is solely fixed with a cast, which has shown satisfactory outcomes and few problems, but it requires a cast change 2 weeks following surgery [10]. All patients in our study had a derotational osteotomy distal to the synostosis site, followed by a plate for rigid internal fixation in the event of correction loss, and a plaster splint for external immobilisation, allowing for easy monitoring of edema and peripheral circulation as well as ease of release. In our investigation, utilising plate fixation did not result in an increase in the incidence of problems when compared to other fixation methods such as K-wires and/or casts, as described by other authors [7, 14, 3].

There is also no absolute consensus on the best posture for the forearm after derotation. Supination of 0 to 20 degrees in the nondominant forearm and pronation of 0 to 20 degrees in the dominant forearm has been recommended by several surgeons [5, 4]. In bilateral situations, Green *et al.* [13] stated that 30 to 45 degrees of pronation in the dominant forearm and 20 to 35 degrees of supination in the nondominant forearm are the optimal positions. Green *et al.* [6] discovered that if one forearm is supinated, it complements the other at 30 to 45 degrees of pronation, allowing the patient to easily perform tasks requiring supination and pronation. As a result, they suggested that the ideal position in unilateral cases is 10 to 20 degrees of supination.

The dominant and nondominant forearms had the best function, i.e., the highest score of 15 points based on the Failla classification system[9], in the range of 0 (neutral) to 20 degrees of supination. Patients with forearms in this position could complete movements requiring forearm pronation, such as using a computer mouse and keyboard and touching the back of the head, as well as movements requiring forearm supination, such as holding a bowl in the palm, washing, touching the waist with the palm of the hand, and performing personal hygiene care.

Transient nerve palsy, loss of correction, residual angulation at the osteotomy site, delayed union, and compartment syndrome are just a few of the significant consequences of derotational osteotomy that have been recorded by many researchers [7, 15, 3, 4]. The consequence compartment syndrome necessitates special measures [9, 14, 3]. In our study, there were no cases of compartment syndrome. With derotational osteotomy of the ulnar and radial shaft fastened with K-wire and cast immobilisation, Murase [4]reported a 20-degree loss of correction in 1 of 4 instances, while Hung [15] reported 15–20 degrees of loss of correction in 5 of 52 forearms. Derotational osteotomy with only cast immobilisation and no internal fixation has also been studied [7, 2]. Because the forearm's rotation is regulated only by the cast in these series, surgeons must be cautious with the forearm's position in the cast and may replace the patient's castings until bone fusion is accomplished. In this study, we used plate and plaster splint immobilisation to fix the osteotomy of the radius and ulna distal to the synostosis site, and there were no cases of corrective loss, residual angulation, delayed union, nonunion, or broken plate among the 10 forearms ranging in age from 6 to 13 years. The downsides include a large amount of exposure and the need for a second procedure to remove the implants. Because the study's follow-up periods are limited, its findings must be evaluated with caution and confirmed in a broader patient population.

Conclusion

In individuals with CRUS, proximal radioulnar synostosis with derotational osteotomy distal to the fusion site followed by plate fixation is a safe and viable procedure. The procedure has a low complication risk and can significantly improve forearm function as well as the patient's quality of life.

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