SVOA Orthopaedics

ISSN: 2752-9576



Research

# Evaluating Outcome of Surgical Centralization for Radial Club Hand in Children

**Nguyen Ngoc Hung, MD[1]*, Hoang Hai Duc,MD, PhD[2], Le Tuan Anh, MD[2] and Phung Cong Sang, MD[2]**

[1] *Professor, Hong Phat General Hospital, 219 Le Duan Street, Hai Ba Trung District, Hanoi city, Vietnam.*

[2] *National Hospital for Pediatrics, Hanoi city, Vietnam.*

***Corresponding Author:** Nguyen Ngoc Hung, MD, Professor, Hong Phat General Hospital, 219 Le Duan Street, Hai Ba Trung District, Hanoi city, Vietnam.*

DOI: https://doi.org/10.58624/SVOAOR.2023.03.053

***Received:** August 30, 2023* ***Published:** September 15, 2023*

## Abstract

**Background**: Various types of osteotomy have been proposed to treat Radial club hand. We reviewed the results of Ulnar osteotomy, Centralization, and tendon transfer.

**Methods**: Between 2000 and 2011, we treated 32 cases of Radial club hand with two Variants Variation 1 (n= 23): ulnar osteotomy; Variation 2 (n=9): without osteotomy; There were 23 patients. Male 10 and Female: 13. Unilateral: 14. Bilateral: 9. Mean age at Operation: 33 months and Follow Up: 56 months. We compared Wrist-Forearm, Hand-Forearm angles before and after surgery, range of motion for all patients.

**Results**: Surgical Centralization on all patients, and Ulnar Osteotomy on 23 forearms. The Patients was Operated according to separated two Variants; there were 23 Variant 1, mean Ulnar bow: 38.68° ±3.583 (33.6° – 45.2°); and there were 9 Variant 2. mean Ulnar bow: 28.15° ± 3.176 (25.7°—28.4°)without ulnar osteotomy. There were 14 patients with unilateral: 8 (57.1%) in V1, and 6 (42.9%) in V2. There were 9 patients with bilateral (18 radial club hand): 15 (83.3%) in V1, and 3 (16.7%) in V2. Compared results on V1 and V 2 with P-values are not significant.

**Conclusion**: Centralization and Ulnar osteotomy technique for operative treatment of the radial club hand is presented. The improved mechanical forces are further stabilized by transposition of the radial wrist extensor and flexor; this favors a better muscle balance.

***Keywords:*** *Radial longitudinal deficiency, Centralization, Osteotomy, Masurement angle, Radial Club Hand.*

## Introduction

Congenital radial deficiency is characterized by varying degrees of hypoplasia of the radial bone or its complete absence, often associated with hypoplasia or absence of the thumb. Clinically, the hand is completely deviated at the wrist. In more obvious cases, the wrist is completely displaced and may align with the radial facet of the ulna; In such cases, there is a prominent knob on the ulnar side of the wrist, representing the distal end of the ulna.

Deformation correction was performed by lengthening the hypoplastic radius in types I and II and by centralizing the wrist in types III and IV [1]. In some cases of mildly shortened radius (class I), the deviation of the wrist is negligible, and surgery is not indicated. In cases of more pronounced deformities, mobility of the hand should be initiated at an early age, preferably with a corrective brace. Concentration is then performed by transferring the carpal bone over the distal ulna. In patients whose wrist is immobilized by preoperative splints and whose deformity is fixed, wrist focus is technically difficult and can only be achieved by extensive soft tissue release. extensive, sometimes accompanied by shortening of the ulna and central resection. hand bone.

This report describes the results of Radial Club Hand (RCH) surgery at the National Children's Hospital.

## Patients and Methods

Between 2000 to 2100, there were 23 patients with 23 rotational absences (14 unilateral and 9 bilateral) under senior authorship (DWL) supervision. Thirty-two people were treated by focusing the hand on the ulna, and indicated ulnar resection and tendon transfer. At the preliminary stage of the study, notes and X-rays were evaluated and it was found that the records of 23 parents were sufficient for analysis. Many of these patients were severely deformed before surgery. They were treated at an older age than is expected today. Median age at surgery was 33 months (range 24-68 months). The surgical treatment has been described previously [2].

All members have confirmed the consensus. The study was approved by the Ethics Review Committee of our Institute and was conducted in accordance with the tenets of the Declaration of Helsinki.

The ulnar correction osteotomy was combined with RCH correction over 23 ulnas. All contactable persons are invited to return for a review in a special clinic, where they are evaluated by a surgeon, senior occupational therapist (HS) and a medical student (WLL) is working on a special research project. All patients were reviewed at this clinic. Nine patients with bilateral radial absence were available for review. Thirty-two polls were taken. At the clinic, take X-rays and take pictures.

Upper limb function was assessed using the Moberg 'pickup' test [3] and the Jebsen hand test. Severe preoperative deformity, typical of many in the series. Function [4]. Although the Moberg test was originally described for sensory impairment, in the current study it was used as a non-timed test of the ability to pick up 18 different objects and hit the target. price kind of ability to grasp. The Jebsen test consists of a standard set of seven tasks of writing, flipping cards, manipulating small objects, simulating feeding, stacking drafts, and moving light and heavy cans. Grip was measured with a Jamar dynamometer and grip with a B&L caliper. Movement of the upper limb joint was measured with a potentiometer. Patients are asked if they have any pain or discomfort.

All patients were asked to fill out a questionnaire about family life, education, employment, recreation, transportation, and self-care activities.

**Functional assessments**

***The Moberg test***

All the reviewed patients could complete the activities required in this test. Those who had pollicization made use of the reconstructed thumb but sometimes used ulnar prehension as well.

***The Jebsen test***

All the reviewed patients could complete this test.

***Grip strengths***

Patients with short forearms and limited elbow movements had difficulty in gripping the Jamar dynamometer. Grasp strength was considerably diminished from the normal range of 25 to 35 kg. The average grip strength in the hands with a pollicized index was 5.5 kg and 4.5 kg in the non-pollicized hands.

The pinch grip was difficult to perform due to lack of active forearm rotation and insufficient data could be obtained for any conclusions to be drawn.

**Questionnaire**

This was completed by the twenty three patients who attended the long-term review clinic.

***Schooling*** Fifteen had attended normal schools. Two, one of whom had associated bilateral absence of the tibiae, had gone to special schools.

***Work.*** All 32 had been in full-time employment of many different kinds and 11 remained in remunerative work. Five were registered as disabled.

***Marital status***. Ten were currently married, two divorced and five single. The group had twenty three children. One, the child of a mother with thrombocytopenia/absent radius (TAR) syndrome had bilateral radial absence but no other child had an upper limb abnormality.

***Driving***. Sixteen were currently driving. Eight used an automatic, five a manual and three an adapted manual gear change in their cars.

***Dressing / undressing***. All were able to do these activities independently, although slowly in some.

***Washing / grooming*** No difficulties were reported.

***Toilet***. All could manage independently.

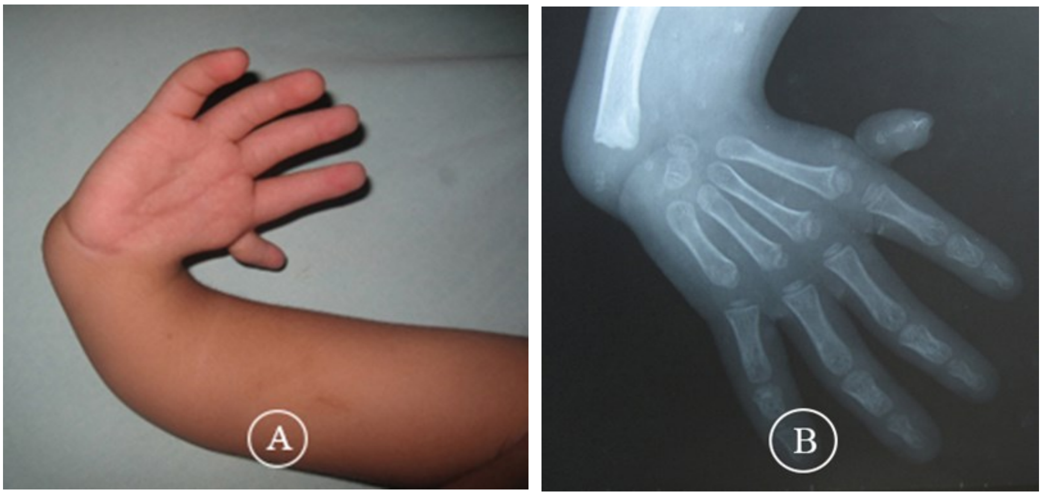
***Recreation***. All had various recreational activities, the most common of which was swimming. A few regretted that they could not play musical instruments or racquet sports.

***Pain***. Seven stated that they had an occasional dull ache in an affected arm. One had an ill-localized persistent aching discomfort for which no cause could be found.

***Surgical scars***. Only one patient complained about scaring on the arm.

The charts and x-rays of patients diagnosed with dysplasia or aplasia of the radius or thumb were reviewed. Patients with thumb hypoplasia but no dysplasia of the radius were included in this study.

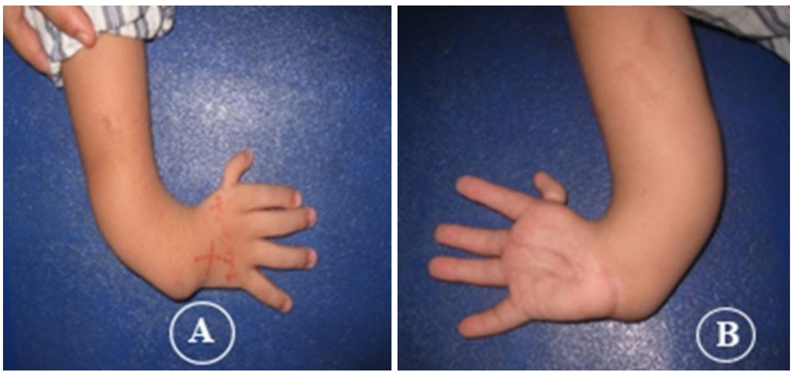
The classification of thumb hypoplasia is based on a modification of the criteria by Blauth and Schneider-Sickert [5]. Six patients with non-thrombotic radius syndrome (TAR) had 12 slightly stiff thumbs, were of normal size and shape, and could not be classified using the modified Blauth–Schneider–Sickert diagram (Pig) . These patients were excluded from this study based on their phenotype and known genetic defect associated with TAR syndrome.




***Figures 1:*** *Thumb and Carpal deficiency.* ***A.*** *Clinical;* ***B.*** *Radiographic.*

Radial dysplasia was classified on the basis of radiographic findings according to Bayne and Klug's classification [6] (Table 1). Bayne and Klug call the type 2 radius the shrink radius because it reduces plasticity over the entire length. If the radius is partially missing (usually in the distal part) then it is classified as type 3. Missing radius in the proximal part is not a useful finding for classification because the missing radius in the proximal part in young children often develops develop to a normal diameter as adults.

If the radius is absent at all, it is classified as type 4. The classification of short distal radius (type 1) is more difficult because Bayne and Klug provide no criteria for the degree of reduction required. However, cylindrical variance was studied in normal children and children with skeletal disorders (Figure 2). In normal children, the mean longitudinal difference between the radial and ulna is 2.3 to 2.8 mm, where the position of the radial bone is more distal to that of the ulna. Radius diameters greater than 2 mm near the ulnar body are outside the 95% confidence interval. Accordingly, we determined the distal shape of the class 1 radius to be 2 mm larger than the distal shape of the ipsilateral ulna, using the described measurement technique. [5]





***Figures 2:  A-C. A-B****. Clinical, and* ***C****. Radiographic Radial Club Hand.*

The classification was modified with the following additions (Table 6): patients with a normal length radius, normal rotator cuff, and only humb deficiency [7] were classified as type N ; and patients with a normal length radius (ie, the distal end of the radial bone, 2 mm shorter than the distal end of the ulna) but abnormal growth on the radial side of the wrist bone (absence, decreased hyperplasia, conjoined) and hypoplasia of the thumb [7] are classified as type 0.

**Carpal Anomalies**

X-rays were carefully examined to detect abnormalities in the wrist, including absence and hypoplasia of the carpal bones and carpal connections. Because ossification of the radial side of the right carpal bone begins at 8 years of age, [8] patients who did not undergo radiography after 7 years of age were not included in the analysis of wrist malformations. Centralization interferes with carpal tunnel development, so children who underwent centralization before age 8 were also excluded from this analysis. These limitations make 19 limbs available for analysis of wrist anomalies. Proximal radius X-ray deficiency is also examined for abnormalities in the proximal radius, including proximal radial synapse (PRUS) and congenital dislocation of the radial head (CDRH). These abnormalities were probably underreported in this study because some limbs had reduced forearm rotation without radiographic evidence of PRUS or CDRH. In fact, these genera may already have PRUS, but the skeletal linkage in PRUS may be.

**Measurements**

**Hand-forearm angle**.

In an attempt to determine the degree of angle between the hand and forearm before and after surgery, the acute angle of intersection between the longitudinal axis of the long metatarsal and the longitudinal axis of the distal ulna was recorded. It is important to note that clinically apparent radial rotator cuff deformities may in part be secondary to forearm flexion (Figures 2, A and B).

***Performing measurement of hand-forearm angle***.


***Figure 3:*** *Measurement of hand-forearm angle on preoperation.*

The presence of a curved ulna requires establishing a standard technique for determining the distal ulnar axis.

Using standard anteroposterior radiographs of the forearm and hand (Fig 3), a construction line was drawn across the face of the distal ulnar head plate. A line perpendicular at the midpoint of the head plate is designated as the longitudinal axis of the distal ulna. The acute angle at which this perpendicular intersects a longitudinal line drawn through the medial axis of the long metaphysis is recorded as the hand-forearm angle.

**Hand-forearm position**.

Since the hand was displaced radially in addition to being angled in the radial direction, a second measurement was used to determine the position of the hand relative to the distal ulna. This measurement is particularly useful in patients with very small preoperative hand-forearm angles but unstable wrists.

Using standard anteroposterior radiographs of the forearm and hand (Figure 4), the longitudinal axis of the distal ulna was plotted as described above. A line from the proximal pole of the little finger bone is drawn perpendicular to the longitudinal axis of the distal ulna and the distance measured.

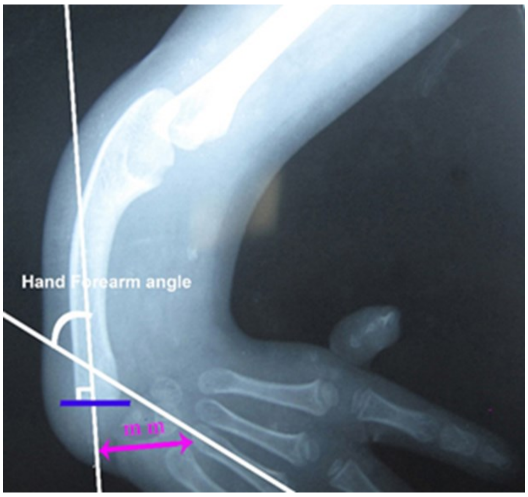



***Figure 4:*** *Hand Forearm position.*

If the proximal pole of the little finger metaphysis lies on the axis of the distal ulna, the position is recorded as negative millimeters (-mm). If the proximal pole of the little finger metaphysis is ulnar side relative to the distal ulnar axis, the position is recorded as positive millimeters (+ mm). Postoperative change in axial orientation is considered an improvement in position.

**Ulnar bow**

With the use of standard anteroposterior radiographs of the anterior region (Figure 5), the longitudinal axis of the distal ulna was recorded as previously described. Similarly, the longitudinal axis of the proximal ulnar head is drawn perpendicular to the midpoint of the construction line across the proximal ulnar head plate. The angle at the intersection of the two lines is recorded as a cylindrical arc (0 degrees is no bow).

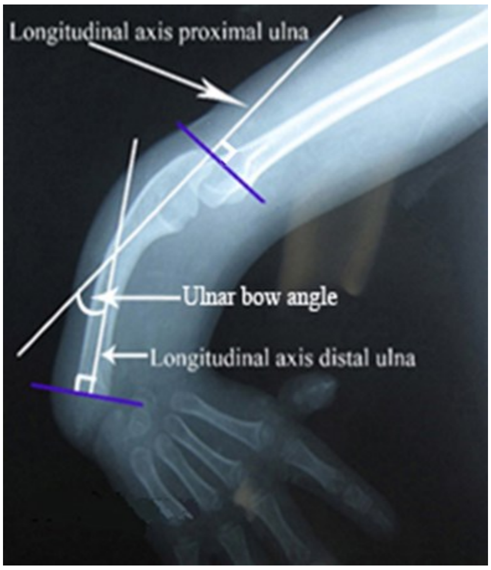



***Figure 5:*** *Bowing Ulna.*

**Classification**

We have divided radiographic radial dysplasia into four categories (Figures 6). There is a direct relationship between the degree of rotational deficiency and the degree of clinical deformity of the crank shaft.

Type I (A). Short far radius. The distal radial head is present but appears late. The growth of the distal radial head is reduced resulting in a normal image but a short radius. There is very little radial deviation of the hand due to the full radial support of the hand. Radius of near-normal bony head growth. Thumb hypoplasia is almost always present.

Type II (B). Hypoplastic radius. Radius has both proximal and distal bony ends but growth is defective in both. This type is basically a miniature radius. The growth of the radius proceeds at a decreasing rate.

Type III (C). Partial absence of radius. The radius is partially absent. The defect may be in the proximal midsection or the distal third. All have been reported, but most often the absence of one or two-thirds distal. The hand is displaced in the radial direction. The ulna is thickened, shortened, and completely curved; the wrist is not supported.

Type IV (D). Completely absent. This represents the most common type of radial deficiency. The hand is unsupported and often severely displaced.


***Figures 6 A-D:** Radial deficiencies. **A.** Type I radial deficiency. **B.** Type II radial deficiency. C. Type III radial deficiency. D. Type IV radial deficiency.*

**Table 1:** Classification of Radial Longitudinal Deficiency [6].

| Type | Definition | Description |
|---|---|---|
| 1 | Short distal radius | Distal radial epiphysis present but delayed, little radial deviation, thumb hypoplasia almost always present |
| 2 | Hypoplastic radius | Growth defective in proximal and distal radial epiphyses, radius in miniature |
| 3 | Partial absence of the radius | Defect can be proximal, middle, or distal third, but most frequently proximal; hand is radially displaced, wrist is unsupported |
| 4 | Total absence of the radius | Most common type, hand is usually severely radially displaced |

**Operative technique**

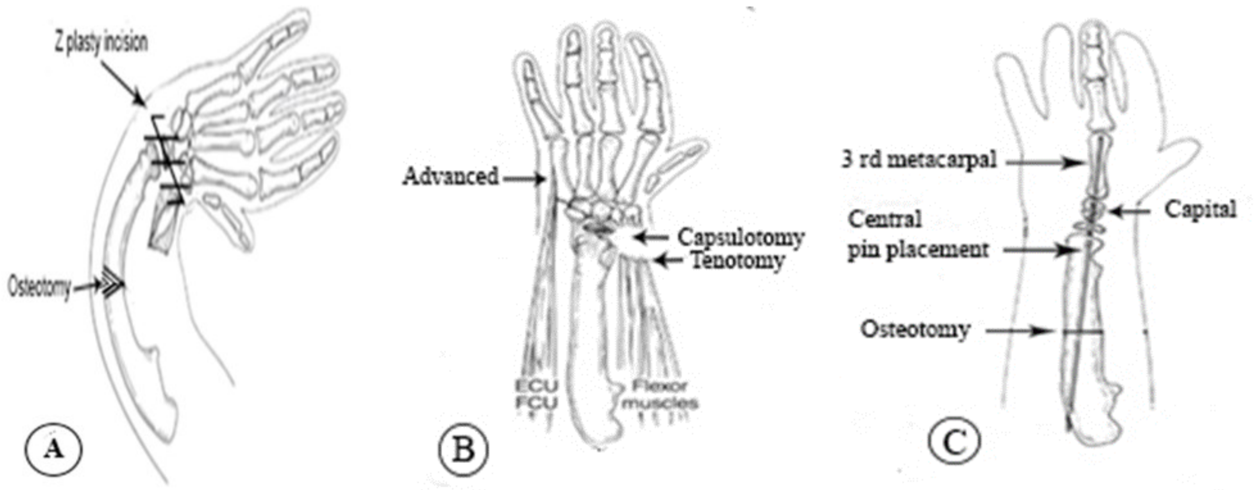
The goal of surgery is to stabilize the wrist, focusing on the distal ulna while maintaining functional wrist movement.

The procedure is performed under general anesthesia in a bloodless field. A Z-plasty incision may also be needed on the radial surface of the forearm and wrist. This will add length to the taut skin on the radial side and make the wrist flexors and tight sheath attachments more accessible. A Z-plasty incision may not be necessary if rotator cuff contracture has been corrected preoperatively (Fig. 7A).

Superficial blood vessels and nerves, especially the most radial branch of the median nerve and its artery, are well preserved. The extensor retinal muscle is incised from the radial side in the ulnar direction. The extensor tendons are identified and preserved. In most cases, the extensor and rotator cuff muscles share a common muscle mass that is virtually tendonless and is separated from the radial carpal bone; In some cases, they have separate masses and a true tendon and are separated from the attachment to the bones of the hand.

The dorsal and palmar fascia are slit horizontally; one or two flaps have been prepared, which can later be placed in the new joint. Well-developed ulnar collateral ligaments are saved. Most fibrotic and often contractile tissues and muscles are excised because they interfere with the much-needed extensive mobility of the hand. Fibrochondral dilatation of the distal radius is found only in patients with partial rotator cuff deficiency and not in most patients with aplastic (complete lack) radius. If present, this angle should be excised because it interferes with distal and ulnar motion of the hand (Fig. 7B).

The distal end of the ulna is freed, carefully preserving the cartilage and all the arteries supplying the bony head. The hand can now be easily positioned with the radial carpal bone above the ulnar head. A Kirschner wire is threaded counter currently through the entire length of the ulna and under radiographic control, then it is passed remotely through the radial carpal bone and obliquely through the second carpal bone. two (Fig. 7C). The hand is placed in a slightly off-axis position.




***Figures 7:  A-C:*** *Surgical procedures.* ***A*** *Z-plasty incision.* ***B****. Balance hand.* ***C****. Pin fixation.*

The ulna will be greatly curved, and a closed wedge osteotomy will be required at the time of centralization. Bows greater than 30° should be osteotomy (fig. 8); The osteotomy should be performed at the apex of the ulna, and bowing ulnar smaller 30° without osteotomy (fig. 9)

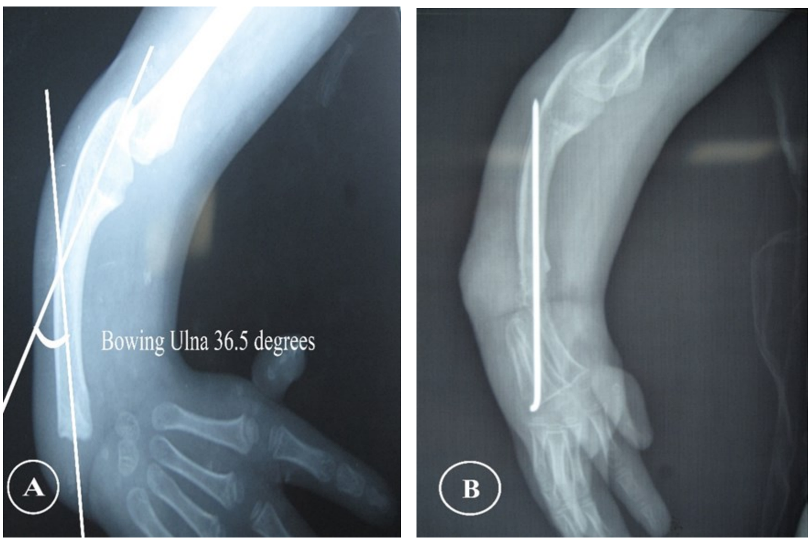



***Figure 8 : A-B: A****. Bowing Ulnar 36.5°.* ***B****. Osteotomy and Kirschner wire have fixated Ulna and carpal.*

The fixation of the cord will usually provide a firm fixation to the two ulnar segments. Depending on the age of the patient, a Kirschner wire with a diameter of 1 or 2 mm was used (Fig. 8). The ulnar and capsular ligaments are sutured to the periosteum as a new lateral ligament.

Strengthening of the ulnar muscles is achieved through displacement of as many rotator cuff muscles as possible, including the ECR, which is common with the FCR or other muscles other than the extensors of the finger and insertion of the carpal bone. or bones of the hand. Their anatomical identification and labeling are often difficult and uncertain. These muscles are threaded between the ulnar and extensor tendons toward the ulnar and end-to-end sutured to the carpi ulnaris extensor tendon, which is also shortened by stretching. The retinaculum is returned to the radial carpal bone and placed between the joint and tendon to prevent adhesions.

After careful hemostasis, excess skin on the ulnar side of the wrist is removed. The dorsal branch of the ulnar nerve should be preserved during this procedure.

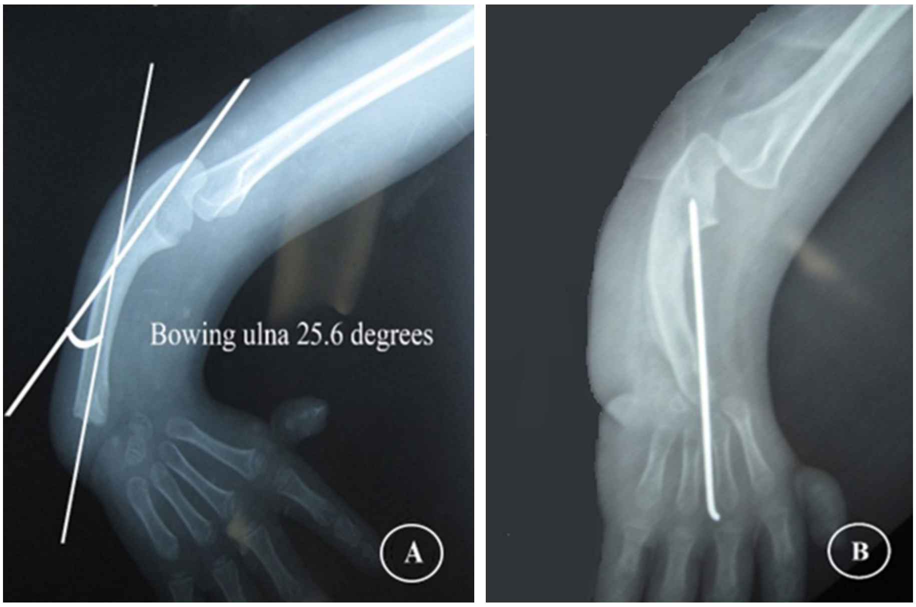



***Figure : 9:*** *A-B.* ***A****. Bowing Ulnar 25.6°'* ***B****. Surgical RCH without osteotomy.*

The incisions are closed. The hand is placed in a neutral position between supine and pronation. A long arm plaster splint is applied, and the arm is raised; This is usually removed after 3 weeks. Kirschner cords are usually removed at the time of pollination. In our series, the earliest resection was performed 4 weeks after surgery without compromising the outcome. After the Kirschner is removed, the night brace will be worn for several months; When removing the post-operative fixation for pollination after 3 weeks, still wearing the night brace. In some cases, the Kirschner strings are left in place longer; In these three cases, a wire break occurred.

Intraoperative radiographs should be obtained to ensure correct position on the distal ulna. Failure to achieve a perfect reduction is a common cause of decentralization later on. Damage to the epithelium is caused by the use of too large fixing pins.

A pediatrician (referring pediatrician or staff pediatrician) and a hand surgeon evaluated all patients. Medical records were reviewed to identify a variety of demographic data including patient gender, race, unilateral and bilateral involvement, RLD type, and thumb involvement. Records are specifically evaluated for any associated medical or musculoskeletal diagnoses including the presence of syndromes, associations, and medical conditions. Preoperative examination included complete blood count and upper extremity X-ray in all patients, but other tests were performed at the discretion of the surgeon or pediatrician. Additional testing is done if physical examination reveals abnormalities. All available data including echocardiography, renal echocardiography, laboratory data and spinal evaluation results were reviewed. Physical examination was considered, especially cardiac and musculoskeletal examination. When applicable, preoperative anesthetic cardiac evaluation is also evaluated.

**Evaluating result**

Outcomes were classified as good, satisfactory, or unsatisfactory based on clinical, radiological, and subjective criteria. Forearm angle was assessed clinically by standard methods. Radiographically, the angle between the ulna and the third metatarsal is used to measure alignment. Wrist range of motion was measured using standard methods. A questionnaire was used to subjectively assess patient outcomes. Questionnaires were given to patients or their parents to assess improvement in appearance, function, and overall satisfaction. The questionnaire included questions related to fine motor movement, strength, and personal activities related to daily living.

Other questions were directed at comparing function before and after surgery and whether parents felt the child was using the hand more efficiently or whether the procedure reduced function.

A good outcome is a centered hand, with the following features: (I) Clinical and radiographic forearm angle less than 30°. (2) The ROM of the wrist is greater than 40°, the functional range includes 20° when flexed to 20° when extended. (3) Overall positive response from patient or parent regarding functional enhancement and cosmetic improvement.

A positive result is a centered hand, with the following characteristics: (l) Forearm angle less than 30°. (2) Wrist with an angle of inclination less than 40°. (3) A positive answer to the question regarding functional and aesthetic enhancement.

Unsatisfactory results include all patients who did not fully meet any of the above criteria.

The vertical growth of the pillar continued after centralization. Cylinder length on the affected side is 2/3 of the normal cylinder length. This ratio persists both before and after centralization, unless severe head injury occurs.

**Statistical analysis**

Statistical analysis was performed using the SPSS statistical package program (SPSS version 19.0; SPSS Inc., Chicago, Illinois, USA). The t-test was performed to compare injured and uninjured elbows. The null hypothesis was that the mean extension and angle of inclination in the injured elbow after fixation would be the same as in the uninjured elbow (control). We used a P value of less than 0.05 to determine the statistical significance of the respective variables.

## Results

All the previously accepted methods of treatment for radial club hands stress centralization without regard for wrist motion. We believed that our best results included a centralized hand, as well as one that had functional wrist motion.

There 23 patients in this study. Male 10 and Female: 13. Unilateral: 14. Bilateral: 9. Age at Operation: 33 months and Follow Up: 56 months. Surgical Centralization on all patients, and Ulna Osteotomy on 23 forearms.

The Patients was Operated according to separated two Variants, 23 Forearms was operated Variant 1, Ulnar osteotomy; and 9 forearms remaining was operated Variant 2. Without ulnar osteotomy.

**Table 2:** Patient's data with Ulnar osteotomy (V1).

| Patients | Age at Operation (mo) | Follow Up (mo) | Hand –Forearm angle ($^0$) | | | Hand-Forearm position (mm) | | | Unlar Bow (°) | Result. |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | PreO. | PostO | Correction | PreO | Post O | Correction | | |
| 1 | 24 | 38 | 65 | 22 | 43 | -13 | +3 | 10 | 33.6 | Satisfa. |
| 2 | 29 | 42 | 90 | 62 | 18 | -12 | +14 | 2 | 35.8 | Unsatisfa |
| 3 | 68 | 56 | 105 | 12 | 93 | -19 | +1 | 18 | 40.3 | Good |
| 4 | 24 | 68 | 40 | 26 | 14 | -9 | +4 | 5 | 42.6 | Satisfa |
| 5 | 32 | 66 | 94 | 15 | 79 | -8 | +10 | 2 | 39.5 | Satisfa |
| 6 | 48 | 48 | 50 | 27 | 23 | -7 | +6 | 3 | 35.8 | Good. |
| 7 | 27 | 44 | 75 | 16 | 59 | -2 | +8 | 6 | 45.2 | Satisfa |
| 8 | 37 | 68 | 64 | 0 | 64 | -9 | +11 | 8 | 36.8 | Satisfa |
| 9 | 22 | 52 | 49 | 40 | 9 | -12 | +2 | 10 | 34.3 | Unsatisfa |
| 10 | 25 | 48 | 60 | 0 | 60 | -18 | +4 | 6 | 32.8 | Satisfa |
| 11 | 28 | 51 | 55 | 22 | 33 | -5 | +8 | 13 | 41.8 | Good. |
| 12 | 38 | 62 | 75 | 24 | 51 | -8 | +6 | 8 | 44.2 | Good. |
| 13 | 26 | 48 | 64 | 0 | 64 | -8 | +4 | 6 | 36.9 | Good |
| 14 | 29 | 55 | 32 | 26 | 6 | -8 | +7 | 9 | 38.5 | Unsatisfa |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 15 | 26 | 42 | 46 | 22 | 23 | -6 | +10 | 14 | 42.1 | Good. |
| 16 | 36 | 38 | 64 | 26 | 28 | -8 | +8 | 18 | 36.6 | Good. |
| 17 | 35 | 54 | 62 | 25 | 27 | -12 | +10 | 12 | 39.5 | Satisfa |
| 18 | 28 | 48 | 48 | 20 | 28 | -16 | +8 | 12 | 41.2 | Unsatisfa |
| 19 | 21 | 46 | 45 | 18 | 27 | -8 | +6 | 10 | 36.4 | Satisfa |
| 20 | 28 | 50 | 63 | 22 | 41 | -6 | +8 | 12 | 34.5. | Unsatisfa |
| 21 | 26 | 46 | 42 | 28 | 14 | -16 | +10 | 12 | 41.2 | Good. |
| 22 | 32 | 62 | 54 | 26 | 28 | -6 | +6 | 10 | 34.4 | Satisfa |
| 23 | 24 | 52 | 62 | 24 | 38 | 8 | +8 | 19 | 41.6 | Satisfa |
| Mean | 31 | 51.478 | 61.04 | 21.86 | 37.826 | -9.73 | 7.04 | 9.782 | 38.68 | |
| STD | 10.171 | 8.861 | 17.77 | 13.00 | 22.176 | 4.32 | 3.12 | 4.804 | 3.583 | |

PreO.: Preoperation; PostO.: Post Operation; Satisfa.: Satisfactory; Unsatisfa: Unsatisfa: UnSatisfaration; (mo): Month.

Age at Operation: 31.00 mo (± 10.171); Follow Up: 51.478 (± 8.861); Hand – Forearm ($^0$). Pre/Post Operation: 61.043$^0$ (±17,775) / 21.86$^0$ (±13.00); Correction: 37.826 (±22.176); Hand-Forearm position (mm). Pre/Post Operation: -9.739 (±4.329) / 7.043 (±3.125); Correction: 9.782 (±4.894); Mean Ulnar bow: 38.68° ±3.583 (33.6° – 45.2°). Results. Good: 8 (34.8%) Satisfactory: 10 (43.5%), Unsatisfactory 5 (21.7%).

**Table 3:** Patient's data without Ulnar osteotomy (V2).

| Pa-tients | Age at Opera-tion (mo) | Follow Up (mo) | Hand –Forearm angle ($^0$) | | | Hand-Forearm position (mm) | | | Ulnar Bow ($^0$) | Result. |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | PreO | Post O | Correc-tion | PreO | PostO | Correc-tion | | |
| 1 | 29 | 42 | 68 | 62 | 6 | -14 | +16 | 2 | 27.6 | Satisfa. |
| 2 | 24 | 56 | 108 | 22 | 86 | -12 | +4 | 12 | 25.7 | Unsatisfa |
| 3 | 32 | 68 | 48 | 26 | 42 | -19 | +2 | 17 | 28.4 | Unsatisfa |
| 4 | 68 | 66 | 94 | 18 | 76 | -9 | +6 | 7 | 25.9 | Good. |
| 5 | 48 | 48 | 56 | 20 | 32 | -10 | +10 | 20 | 26.2 | Good |
| 6 | 27 | 72 | 78 | 27 | 51 | -9 | +8 | 9 | 27.8 | Good. |
| 7 | 26 | 68 | 64 | 0 | 64 | -5 | +6 | 11 | 26.5 | Good. |
| 8 | 38 | 68 | 52 | 0 | 52 | -10 | +12 | 22 | 28.4 | Good |
| 9 | 26 | 52 | 56 | 44 | 12 | -14 | +2 | 8 | 26.9 | Satisfa. |
| Mean | 35.333 | 60 | 69.33 | 24.33 | 45.777 | 11.33 | 7.333 | 12.000 | 27.04 | |
| STD | 14.396 | 10.723 | 20.37 | 19.57 | 27.035 | 4.000 | 4.690 | 6.519 | 1.042 | |

PreO.: PreOperation; PostO.: Post Operation; Satisfa.: Satisfactory; Unsatisfa.: Unsatisfa: Unsatisfaction; (mo): Month.

Age at Operation: 35.333 mo (± 14.396); Follow Up: 60.00 (± 10.723); Hand – Forearm ($^0$). Pre/post Operation: 69.333$^0$ (±20.375) / 24.33$^0$ (±19.75); Correction: 45.777 (±27.035); Hand-Forearm position (mm). Pre/Post Operation: -11.333 (±4,000) / 7.333 (±4.690); Correction: 12.000 (±6.519); there were 9 Variant 2. mean Ulnar bow: 28.15° ± 3.176 (25.7°—28.4°. Results. Good: 5 (55.6%), Satisfactory: 2 (22.2%), Unsatisfactory 2 (22.2%).

Compared result V1 and V 2: On Satisfactory result with *Valuate* P: 0.131908 and on good result with *Valuate* P: 0.136422. Both methods with and without ulnar resection give P-values the results are not significant.

**Table 4:** Patient's data.

| No of Patients | | No of extremities | |
|---|---|---|---|
| Male | 10 | Unilateral | 14 |
| Female | 13 | Bilateral | 9 |
| | | Right | 17 |
| | | Left | 15 |
| Total | 23 | | 32 |

Male: 10 (43.5%), Female 13 (56.5%), Unilateral: 14 (60.9%), Bilateral 9 (39.1%),

Right: 17 (53.1%), Left: 15 (46.9%)

**Table 5:** Type of deficiencies.

| Types of deficiencies | No. of cases |
|---|---|
| Type I | 0 |
| Type II | 0 |
| Type III | 6 |
| Type IV | 26 |
| | 32 |

Type of deficiencies: Type III: 6 (18.7%), Type IV: 26 (81.3%)

**Table 6:** Ulnar osteotomy in variants.

| Patients number (%) | RCH (%) | V1 (Osteotomy) (%) | V2 (Without osteotomy) (%) | Total |
|---|---|---|---|---|
| 14 (Unilateral) (60.9%) | 14 (43.8%) | 8 (34.8%) | 6 (66.7%) | 14 |
| 9 (bilateral) (39.1%) | 18 (56.2%) | 15 (65.2%) | 3 (33.3%) | 18 |
| Total | 32 | 23 | 9 | 32 |

14 patients with RCH unilateral: 8 (57.1%) in V1, and 6 (42.9%) in V2.

9 patients with bilateral RCH (18 RCH): 15 (83.3%) in V1, and 3 (16.7%) in V2

**Table 7:** Latest operative result.

| | V 1 – Ulmar Osteotomy (23 RCH) 23 | | | | V 2 – Without Ulnar Osteotomy (9 RCH) | | | |
|---|---|---|---|---|---|---|---|---|
| Bilateral 9 Patients – 18 RCH | 15 (RCH) | | | | 3 (RCH) | | | |
| | Satisfactory | Unsatisfactory | Good | Poor | Satisfactory | Unsatisfactory | Good | Poor |
| | 10 | 5 | 11 | 4 | 2 | 1 | 2 | 1 |
| Unilateral 14 Patients -14 RCH | 8 (RCH) | | | | 6 (RCH) | | | |
| | Satisfactory | Unsatisfactory | Good | Poor | Satisfactory | Unsatisfactory | Good | Poor |
| | 6 | 2 | 5 | 3 | 4 | 2 | 5 | 1 |
| Total | 16 | 7 | 16 | 7 | 6 | 3 | 7 | 2 |

Ulnar osteotomy with Satisfactory 16, Unsatisfactory 5, Good 16, Poor 7; Without Ulnar osteotomy with Satisfactory 6, Unsatisfactory 3, Good 7, Poor 2. Total latest Operative Satisfactory 22 (68.8%), Unsatisfactory 10 (31.2%); Good 23 (71.9%), Poor 9 (28.1%).

**Complications**

**Table 8:** Some Complications Post-operative Radial Club Hand.

| Injury | Patients (n) | Percent (%) |
|---|---|---|
| Necrosis of margin Z Plasty | 4 | 12.5 |
| Ulnar fracture | 1 | 3.1 |
| Kirschner was migration | 1 | 3.1 |
| Kirschner wire were broken | 3 | 9.4 |
| Metacarpal was shortened | 1 | 3.1 |

Necrosis of margin Z plasty, remove the necrotic part of the skin, use antibiotics, heal skin lesions. Broken bones, but not broken Kichner wire. Powder reinforcement. After 4 months, the bones are solid. Kirschner wire migration, Replace the Kirschner wire and use the antibiotic, stabilize the ulna cut site. Kirschner wire broken, don't break ulnar. Do not replace the Kirschner wire, strengthen the cast. The bone is connected to the place where the bone is cut. Long-lasting battery One metacarpal was shortened by epiphyseal damage from too large Kirschner wire used in centralization.

## Discussion

The goals of surgical treatment are to achieve the desired length of the upper limb, correct the deviation of the forearm, reconstruct the thumb, and pollinate. The wrist realignment consisted of centralization and radial with a similar degree of surgical exposure in both methods. During rotation of the ulna, excessive correction of the ulnar deformity was attempted to align the ulna with the index finger, and all the force of the extrinsic muscles (rotator cuff flexors, rotator cuff muscles, rotator cuff muscles). wrist extensor (long radialis and short muscle) will move towards the ulnar.

During centralization, the ulnar axis is aligned with the third metatarsal bone. Regarding the condition of the thumb, it must be said that in grade I hypoplasia usually no surgery is needed. In hypoplasia II, treatment includes contralateral arthroplasty, knuckle immobilization, and first membrane deepening. In severity grades III, IV, and V, pollination is often used to improve grip and grip. Other treatments for hypoplasia IV and V include microvascular transfer using the second toe of the left foot. In 1998, Vilkki et al. introduced this method and reported positive results in 9 patients with grade IV RCH [10]. In 2008, Vilkki et al increased the number of patients and reported the treatment of 19 hands in 18 patients. The researchers found that at the final visit, the average forearm-hand angle was 28∘ radial deviations, the mean wrist joint range of motion was 83∘, and the average bony growth. ulnar was 15.4 cm and the mean relative length of the ulna relative to the other was 67% [11].

Several scholars, in addition to favorable treatment outcomes, have evaluated the rate of deformity recurrence in RCH after centralization and have achieved significant results. Shariat Zadeh and colleagues examined the recurrence of deformation after centralization. In this study, 11 hands were centralised. Patients were followed up for 90 months. The mean preoperative hand-forearm angle was 75∘, reaching 25∘ immediately after surgery and 52∘ at the final visit. Thus, the correction rate is 66% and the correction loss rate is 54%. However, the researchers did not specify how many patients experienced re-deformation [12]. Damore and colleagues treated 19 cases of RCH with a focused approach in 2000 and observed a decrease in the angle from 83∘ to 25∘ immediately after surgery (58∘ improvement). However, at the last visit after 3.3 years, it reached 63∘ (38∘ out of correction) [13]. Lamb et al also reported that there were 7 patients with recurrent deformity (46.7%) [3]. Our recurrence in 4 hands (26.7%) seems to be acceptable and lower than in other studies compared with previous studies.

The most important finding of this study was the two-step treatment of RCH, which involved focusing with a rotator cuff and transferring the carpal tendon, followed by an attempt to create a functional thumb with pollination by means of a rotator cuff. The use of Second or Third Rays or tendon transfer is clinically relevant. outcome and function in most patients.

RCH is a longitudinal defect that can cause a wide range of upper limb deformities and its etiology may be sporadic, unknown, or associated with clinical syndromes such as Holt-Oram syndrome, Radius of absence thrombocytopenia (TAR), VACTERL and Fanconi anemia [14]. This disease can range in severity, from mild disease requiring nonsurgical treatment to severe disease requiring multistage surgical treatment. In this disease, the radial column of the forearm is hypoplastic, so the thumb is often inoperable and, if left untreated, the disability will remain. On the other hand, due to the low incidence of this deformity, the number of relevant studies is limited and mainly case series. Therefore, we have very little information and the appropriate treatment and prognosis are not clear to us.

Because of the problems associated with these patients, regardless of the severity of the abnormality, an initial assessment of general health such as heart, kidney, gastrointestinal, and blood disease is necessary. . Therefore, electrocardiogram, renal ultrasound, blood analysis and chromosomal disruption must be performed for all patients.

In previous studies, different surgical and non-surgical treatments were suggested. The patient can be splinted and stretched in series, in order to maintain passive correction of wrist deformity [14, 15].

## Classifications

Radial longitudinal deficiency is defined as underdevelopment, abnormal development, or absence of radial structure of the forearm. It covers a wide range of defects involving the radial, radial, and thumb bones.

Classifications based on severity of deformity have been described for both radial and thumb defects.1–3 However, there is no classification scheme that incorporates all defects in radial (eg, radius, wrist, and thumb). Furthermore, no previous classification scheme fully identifies radial abnormalities associated with radial deficiencies. The most comprehensive scheme, reported by Bayne and Klug, [6] includes 4 categories based on radiographic progression severity of radius deficiency. It fully identifies type 2 (radial hypoplasia), type 3 (radial partial dysplasia) and type 4 (complete radius dysplasia). However, this classification does not explicitly define type 1 (short distal radius) in that it does not indicate the degree of radius shortening required to qualify as type 1 dysplasia of the radius. Importantly, Bayne and Klug's diagrams did not include patients who were missing a thumb or wrist but had a normal length radius. It is important to do so, as the term dysplasia or radial deficiency refers to abnormalities of the entire radial aspect of the forearm, as opposed to dysplasia or radial deficiency, which involves only the radial aspect. related to abnormalities of the radial bone itself.

The aim of this study is to develop a global classification system of radial defects, more fully define radius abnormalities and include thumb and wrist defects (Figure 1). In addition, we determined the incidence of thumb, wrist, and radial malformations in a large number of patients with radial muscle deficiency (Table 9).

**Table 9:** Modified Classification of Radial Longitudinal Deficiency [5, 7, 15].

| Type | Thumb | Carpus | Distal Radius | Proximal Radius |
|---|---|---|---|---|
| N | Hypoplastic or absent | Normal | Normal | Normal |
| 0 | Hypoplastic or absent | Absence, hypoplasia, or coalition | Normal | Normal, radioulnar synostosis, or congenital dislocation of the radial head |
| 1 | Hypoplastic or absent | Absence, hypoplasia, or coalition | >2mm horter than ulna | Normal, radioulnar synostosis, or congenital dislocation of the radial head |
| 2 | Hypoplastic or absent | Absence, hypoplasia, or coalition | Hypoplasia | Hypoplasia |
| 3 | Hypoplastic or absent | Absence, hypoplasia, or coalition | Physis absent | Variable hypoplasia |
| 4 | Hypoplastic or absent | Absence, hypoplasia, or coalition | Absent | Absent |

## Surgical Radial Club Hand

Various surgeries have been used in the treatment of rotating club hands for more than 100 years but the results were relatively poor until centralization was adopted (Bora et al [16]; Lamb [17]; Riordan [18]; Watson et al [19] ]... Buck-Gramcko [20] expressed dissatisfaction with the results of centralization and the introduction of radicalization. There were 14 patients with RCH, 9 patients with bilateral RCH: 15 (83.3%) in V1, and 3 (16.7%) in V2.

The procedure has shown good results, but longer-term consideration is needed before knowing if the deformity may recur as the child grows older. Buck-Gramcko has also stated that this method is not suitable for people with severe or long-standing deformities (personal communication). Many of the cases considered in this article fall into this category, often exhibiting a fixed strain of 90° and this should be kept in mind when reviewing the results.

It is hoped that more children born with this severe deformity will be referred to surgical treatment as soon as correction is easier or to centers where the hand can be adjusted with preoperative traction ( Nanchahal and Tonkin, 1996 [21]. In fact, too many children around the world are still referred to surgeons with permanent, fixed and severe deformities. This study demonstrates the long-term functional and aesthetic outcomes that can be expected from carefully performed centralization in conjunction with ulnar osteotomy and tendon transfer. It is likely that even better results can be achieved in these cases if preoperative traction with an external fixator is available.

We found that long-term maintenance of the correction is often due to spontaneous fusion of the carpal bones. This has the theoretical disadvantage of a loss of wrist motion but is compensated to some extent by stability that improves hand function.

None of the cases in our series had any postoperative ulnar growth inhibition. In a bilateral aplasia case in which correction and fixation of the K-string was performed on only one side, the K-string was preserved during 13 years of development. The ulnae are of equal length.

However, early postoperative K cord rupture is associated with recurrence of the angle of the hand above the forearm. This happened in four cases and had to be replaced in two cases.

Although we believe that overall hand function will be better after pollination, hand strength has not improved. However, pollinating the index finger significantly improves the appearance of the hand (Figure 6).

**Approach for Operative Radial Club Hand**

"The radial club hand is an extremely unusual hand. The rotating club hand is an extremely unusual hand, which is joined to a poor limb due to a damaged wrist" [22] (Flatt, 1994). ). The clinical picture of radial dysplasia usually includes a short forearm that is radially deviated. The distal protrusion with excess skin marks the end of the ulna. The hand is placed on the radial side of the ulna and is in the flexed, pronation, and rotational position.

This deformation is usually bilateral and asymmetrical. Sayre [23](1894) is credited with being the first to centralize the radial club hand. His incision has not been recorded. He removed the lunate and head and fixed the distal ulna in the newly formed groove. The principle of this adjustment by sacrificing the carpal bone, stiffening the wrist, and shortening the forearm has remained unchanged for most of the century. Lamb [17] (1972) further developed this technique. Although he is noted primarily for a large S-shaped incision extending posteriorly from the base of the index finger through the ulnar side of the wrist and across the flexion of the forearm to its radial contour, Lamb was using two different incisions depending on the degree of deformation [2] (Lamb, 1977). With soft tissue contracture, he used two separate incisions, one on the radial side to release contracture and the other on the ulnar side to release the lower end of the ulna and facilitate wrist placement. to its head. Blauth [24] (1969) used a longitudinal incision and resection of two Burow triangles. During the 1970s and 1980s, Flatt [22](1994), Watson et al. [25] (1984), Buck-Gramcko [20](1985), and Bayne and Klug [6](1987) described the hand radial cane correction does not require amputation of the wrist and thus preserves wrist function. Muscle and tendon transfers are also used. Bayne and Klug [6] (1987) made two skin incisions. A transverse incision is made at the end of the ulna to remove excess skin and fibrous fatty tissue. A Z-plasty incision is required on the radial surfaces of the forearm and wrist to add length to the stretch skin on the radial side. Flatt [22] (1994) used an S-shaped incision combined with excision of the excess skin of the convex mass on the ulnar side of the wrist in an elliptical fashion. Manske et al. [5] (1981) described a transverse axial approach, which, in their view, allowed better repositioning of the excess skin on the ulnar side of the wrist. Watson et al. [16](1984) reported on their experience using two Z-plasty incisions. On the rotation side, a standard 60° Z plastic plate with a longitudinal central limb is used to extend along the longitudinal axis of the forearm. The cylindrical incision is a similar Z-plasty incision but with a transverse limb to remove excess skin in this area, transferring excess tissue to the missing rotator cuff area. Buck Gramcko [20](1985) used a large S-shaped incision down to the proximal third of the forearm for his radial technique. Evans et al. [26](1995) introduced the "bilobular flap" to focus on radial dysplasia.

## Conclusion

Concentration and ulnar resection techniques for surgical treatment of the rotator cuff hand are presented. It has been successfully used in 32 hands (23 patients) since 2000. It is named "radial" because after all the fibrous tissue is removed, the radial carpal bone is placed. on the distal end of the ulna; The arm is fixed with a Kirschner rope in a position with moderate cylindrical deflection. Usually, there is no need to remove the wrist bones. Improved mechanical forces are further stabilized by displacement of the radial wrist flexors and extensors; This helps the muscles to be more balanced. The optimal age for surgery is between 24 and 36 months.

## Limitations

Limitations of this study include its retrospective design, small sample size, and lack of comparative osteotomy groups. The lack of preoperative functional assessment is another limitation of this study. However, the surgical management of Ulnar osteotomy has improved. In future studies, it is necessary to evaluate more cases and improve objectivity by tracking changes in functional outcome over time rather than performing a one-time assessment.

## Conflict of Interest

The authors have no conflicts of interest to declare.

## References


1. Bayne LG. Radial club hand. In: Green D. P. (Ed) Operative Hand Surgery. New York, Churchill Livingstone, 1982: Vol 1: 219-232
2. Lamb DW. Radial club hand. Journal of Bone and Joint Surgery 1977; 59A: 1 13.
3. Moberg E (1965). Objective methods of determining the fnnctional value of sensitivity in the hand. Journal of Bone and Joint Surgery 1965; 40B: 4 5 - 47.
4. Jebsen RH, Tayalor N, Trieschmann RB, Trotter MJ, Howard LA. Objective and standardized test of hand function. Archives of Physical Medicine and Rehabilitation 1969; 50:311-319
5. Manske PR, McCarroll HR Jr, James M. Type III-A hypoplastic thumb. J Hand Surg 1995;20A:246–253.
6. Bayne LG, Klug MS. Long-term review of the surgical treatment of radial deficiencies. J Hand Surg 1987;12A: 169–179.
7. Blauth W, Schneider-Sickert F. Numerical variations. In: Blauth W, Schneider-Sickert F, eds. Congenital deformities of the hand: an atlas of their surgical treatment. Berlin: Springer-Verlag, 1981:120–121.
8. Hensinger RN. Hand. In: Hensinger RN, ed. Standards in pediatric orthopedics: tables, charts, and graphs illustrating growth. New York: Raven Press, 1986:136–149.
9. Kelikian H. Radioulnar synostosis. In: Kelikian H, ed. Congenital deformities of the hand and forearm. Philadelphia: WB Saunders, 1974:939–976.
10. Vilkki SK. Distraction and microvascular epiphysis transfer for radial club hand, J. Hand Surg. (Edinburgh, Scotland) 1998; 23 (4): 445–452.
11. Vilkki SK. Vascularized metatarsophalangeal joint transfer for radial hypoplasia, Semin. Plast. Surg. 2008; 22 (3) :195 –212.
12. Shariatzadeh H, Jafari D, Taheri H, Mazhar FN. Recurrence rate after radial club hand surgery in long term follow up, J. Res. Med. Sci. 2009;14 (3) : 79–186
13. Damore E, Kozin SH, Thoder JJ, Porter S. The recurrence of deformity after surgical centralization for radial clubhand, J. Hand Surg. 2000; 25 (4): 745–751.
14. Maschke SD, Seitz W, Lawton J. Radial longitudinal deficiency, J. Am. Acad.Orthop 2007; 15 (1): 41–52.
15. de Jong JB, Moran SL, VilkkiSK. Changing paradigms in the treatment of radial club hand: microvascular joint transfer for correction of radial deviation and preservation of long-term growth, Clin. Orthop. Surg. 4 (1) (2012) 36–44.
16. Bora FW, Nicholson JT, Cheema HM (1970). Radial meromelia: The deformity and its treatment. Journal of Bone and Joint Surgery, 52A: 966 979.
17. Lamb DW. The treatment of radial club hand. The Hand, 1972; 4:22 30.
18. Riordan D C (1963). Congenital absence of the radius. Journal of Bone and Joint Surgery, 45A: 1783.
19. Watson HK, Beebe RD, Cruz NI (1984). A centralization procedure for radial clnb hand. Journal of Hand Surgery, 9A: 541-547
20. BuckC Gramcko D (1985). Radialization as a new treatment lbr radial club hand. Journal of Hand Surgery, 10A: 964 968.
21. Nanchahal J, Tonkin MA (1996). Pre-operative distraction lengthening for radial longitudinal deficiency. Journal of Hand Surgery, 21B: 103 107.
22. Flatt AE. Radial club hand. In: 2nd edn.St Louis, Quality Medical Publishing, 1994:366-411.
23. Sayre RH (1894). A contribution to the study of club-hand. Transactions of the American Orthopaedic Association, 6: 208216.
24. Blauth W (1969). Zur Morphologie und Therapie der radialen Klumphand. Archiv der Orthopedic und Unfal1-Chirurgie, 65:97 123.

25. Watson HK, Beebe RD, Cruz NI (1984). A centralization procedure for radial club hand. Journal of Hand Surgery, 9A: 541-547.

26. Evans DM, Gateley DR, Lewis J S (1995). The use of a bilobed flap in the correction of radial club hand. Journal of Hand Surgery, 20B: 333 337.

**Citation:** Hung NN, Duc HH, Anh LT, Sang PC. Evaluating Outcome of Surgical Centralization for Radial Club Hand in Children. *SVOA Orthopaedics 2023,* 3:5, 111-126.