

Treatment of Radial Club Hand

—with External Fixator cum Distractor and a Bilobed Flap

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Abstract Purpose : Addresses issues inadequately dealt with by conventional centralisation for radial dysgenesis viz. :

1. Acute translocation of the carpus over the ulna, often difficult.
2. Resecting part of the ulna epiphyseal cartilage and the proximal carpal row to create a notch for stabilising the wrist leads to lost mobility and reduced growth potential.
3. Net skin deficit exists on the Radial side, wound problems are known with conventional incisions and there is unnecessary excision of ulnar side redundant skin.

Methods : We have combined the use of an ulnar bilobed flap for exposure with external fixator cum distractor to solve the above issues. The radial tissue defect and redundant skin on the Ulnar side are effectively rebalanced by the Bilobed flap and affords excellent 360 degrees exposure. The external fixator device distracts pre op, holds the reduction peri operatively and post operatively to achieve correction and long term stability without internal fixation or carpal resection. The soft tissue correction and tendon rebalancing are carried out as advocated by Buck-Grancko. Ulnar osteotomy is avoided at the same sitting.

Results : In this preliminary series 13 cases and 19 hands have been treated. Average follow up is 4 years. Good results have been obtained and all carpal bones have been retained. The ulnar head hypertrophy has been recorded and compared to radial breadth in age matched controls and found to be equivalent. The ulna length was found to be 72% when compared to normal controls.

Conclusions : Hypertrophy of ulnar head simulates the radius and affords good stability to wrist while preserving range of motion. Preservation of all carpal bones and ulnar epiphyses is important for growth in a hypoplastic limb. The bilobed flap uses the Ulnar side excess to cover the Radial side shortage.

Introduction

Treatment of Radial dysplasia has been a subject of continuous debate and interest amongst reconstructive hand surgeons. Surgi-

cal options have evolved over several decades and continue to do so. There is however broad consensus on the final goal, which is to obtain an aesthetically acceptable and functional limb with maximum possible growth potential. Tra-

Key words : Radial club hand, Fixator, Bilobed flap

a|b

**Fig. 1.**Corrected
Deformitya : dorsal view
b : volar viewa|b
|c**Fig. 2.** Bilobed Flap Design and Closure

a : Flap utilizing Excess ulnar skin.

b : Flap on Dorsum of hand where Flap B will transpose.

c : Closure of both flaps primarily.

ditionally centralisation is followed as the universally accepted method for corrective surgery. Issues with respect to ideal surgical approach and skin closure however have remained without consensus. Achieving and maintaining reduction of carpus over the wrist entails difficulty : particularly more so in very severe or late cases. Recent follow-up studies have clearly shown that the excision of carpal bones and growing ulnar epiphyses for notch plasty to stabilise the wrist is unable to prevent a recurrence in the long term¹⁾⁻³⁾.

We present a simple and effective combination of using the bilobed flap developed by Evans⁴⁾ to cover the Radial skin defect as well as for exposure of the Ulna and the Carpus. This is coupled with the UMEX^E distractor for translocating the carpus by soft tissue distrac-

tion, to overcome the above difficulties (Fig. 1). Either primarily or secondarily we also do the standard tendon transfer for correction of deviating forces as advocated by Buck Gramcko⁵⁾⁶⁾. This method is suitable both for early and late presentations.

Materials and Methods

In a prospective study 13 cases and 19 hands have been treated by the fixator, flap and tendon transfer method, since the past 5 years. In the first age group of 6 pts (7 hands) who had been seen by us from birth-pre-operative stret-



Fig. 3. Comparative X ray Pictures demonstrating Equal Ulnar (affected Hand) and contra lateral normal Radial diameters at 4 yr follow up

Table 1. Cases in this series

Patients	13
Hands	19
Bilateral	5
Unilateral	9
male	10
Female	9
Avg. Follow up :	4 yrs

Table 2. Radiographic measurement

Ulna Length		Ulna v/sRadius Breadth		
Avg. values in cms				
	Pre op	At 5 yrs FU	Pre-op	At 5 yrs FU
Normal	6.12	11.22	0.53	0.97
Affected	4.95	8.12	0.48	1.05

Table 3. Complications

Infection	1
Recurrence	Nil
Loosening	1
Superficial skin necrosis	2

ching and serial casting was done up to the age of 6 months [1 bilateral and 5 unilateral.]

The second age group comprised of 7 cases (12 hands) where first presentation varied from 8 months to 1 or more years of age oldest being 3 years, four (4) of which were bilateral and three (3) unilateral. One patient with unilateral deformity presented very late at the age of 8 years with a recurred deformity.

Patients who had not presented before the age of 6 months, were given soft-tissue taxis by the fixator devise at the rate of 1/2 mm per day for 6-8 weeks and a holding period of equal duration unless pin loosening occurred

Radiographic parameters documented pre-operatively included measurement of :

- 1) Radial deviation.
- 2) Ulna length of normal and affected side measured from tip of olecranon to ulnar styloid, both clinical and radiological.
- 3) Transverse diameter of head of the ulna- both normal and affected side.
- 4) Normal Length and breadth of the lower end of Contra lateral Radius (in unilateral cases).

The bilobed flap is fashioned as follows-The design of the incision starts at the point of maximum tension when an ulnar force is applied on the radial side of the wrist. The length of the incision is such that the defect, which it opens, gives the length of the flap "A" that is then marked on the dorsum of the wrist, based proximally. Another corresponding flap "B" is fashioned at 90 degrees to Flap A which lies on the area of greatest redundancy on the ulnar side as advocated by Evans⁴⁾ as shown in (Fig. 2). After the radial incision is deepened the median nerve is identified and flexor and extensor carpii radialis tendons are isolated. The cartilaginous anlage of the radius is dissected and excised. Any fascial band or soft tissue, which forms a deforming force, is cut. The entire wrist joint and carpus is exposed after raising the flaps. Ulnar head is released from the wrist and radialisation/centralisation is carried out which includes the appropriate tendon transfers if the tendons are present as per the Buck-Gramko technique⁵⁾⁶⁾. Radiographic parameters adopted post-operatively included measurement of :

1) Ulna length measured from tip of olecranon to ulnar styloid of the normal and affected side, both clinical and radiological.

2) Transverse diameter of the head of ulna both normal and affected side (Fig. 3).

3) Normal Length and breadth of the lower end of Contra lateral Radius (in unilateral cases).

4) Angle of deviation after correction
These measurements were performed at first presentation, immediate pre-op, immediate post-op, 3 mths post-op, 6 months, 1 yr, 18 mths and 2 yrs post op and then yearly up to 5 yrs.

In the primary cases treated by this new method, the UMEX fixator was used on table for acute distraction to achieve reduction, and then maintained for 6-8 weeks. The distraction period was 4-6 weeks at an average rhythm of half a turn i. e. 1/2 mm per day to achieve over correction. This was followed by a holding period of equal duration to maintain the wrist in overcorrection, i.e. ulnar deviation. Plaster casts applied on fixator removal were serially changed at intervals of 1-mth up to 3 months post-op. This was then followed by the application of a thermoplastic splint. The splint is regularly changed as the child grows and recommended up to skeletal maturity. The measurement results were tabulated and are presented in Table 1, 2 and 3.

Discussion

The deformity in radial club hand is multi-dimensional with radial angulation, radial displacement, palmar displacement and angulation of the carpus relative to the ulna. Function is inhibited by instability of the wrist, poor excursion of the extrinsic finger flexor and extensor tendons, diminished elbow flexion, poor mobil-

ity of the digits, particularly those on the radial side, as well as thumb dysfunction.

The past 100 years have witnessed multiple techniques of soft-tissue and bony correction. Quite as much variety exists for the treatment of radial club hand as does for the treatment of clubfoot. Hoffa proposed ulnar osteotomy with or without tenotomies; Romano performed a cuneiform osteotomy, with resection of a segment of the distal ulna, coupled with soft tissue release⁷⁾ and Bardenheuer advocated an interposition of the carpus into the split distal ulna by a Y shaped configuration. Albee⁸⁾ used a tibial graft and Starr⁹⁾ and Riordan¹⁰⁾ transferred the proximal fibula with intact epiphyses. However long term studies with convincing reports of equivalent radio-ulnar growth are still wanting. Prof. Simon Vilki^{11),12)} from Finland has showed good early and now long-term results with the use of a micro-vascular transfer of the metatarso-phalangeal joint in which he has demonstrated an equivalent growth of the hypoplastic ulna as compared to a normal ulna. The procedures are multi-staged. There is the issue of compliance at a tender age and the final procedure is accompanied by all the associated morbidity and possible complications of a major micro-vascular procedure including loss of the free tissue transfer, as well as the additional disfigurement of the foot. He begins the surgical procedures on them at the age of 2 yrs which means that pollicisation would be delayed, again a debatable issue.

Scott Kozin and associates¹⁾, Manske^{2),3)} and others have clearly shown that recurrence has occurred despite ulno-carpal fusion in a review of Hiekel's¹³⁾ work. Manske^{2),3)} and Lamb¹⁴⁾ have reported the longest follow-up of 21 yrs. with late presentations, where they conclusively

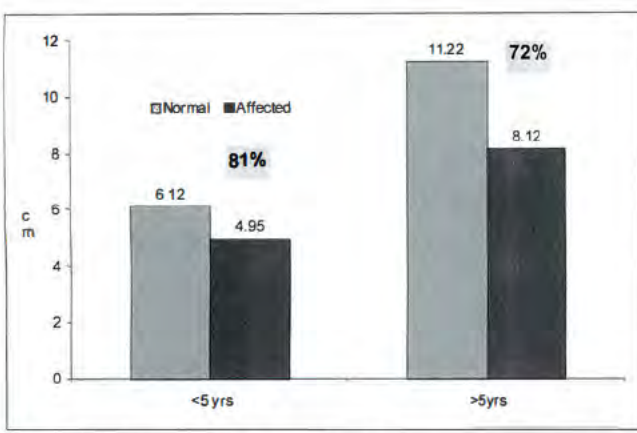


Fig. 4. Average Ulna length of 13 cases [Bar Chart 1]

prove that the forearm always remains short. Cases where ulno-carpal fusion was performed achieved stability at the cost of mobility and growth. Buck-Gramko^{5,6)} in his classical technique of Radialisation improved the ulnar lever arm by transferring the radial flexor and extensor to the ulnar aspect reversing the imbalance of the tight and strong radial musculo-tendinous units ; which gained wide acceptance. In an ideal world all radial club hands thus treated would not recur-but very often one encounters missing or short tendons not adequate for a perfect tendon transfer to rebalance the deforming forces. He also showed that excision of carpal bones and ulnar epiphyseal cartilage is not only unnecessary, but its preservation leads to better range of wrist motion post-op.

With the advent of soft tissue distraction techniques^{15,16)}, various fixator-distractor assemblies have been used with great enthusiasm both for late and severe deformities as staged procedures and also for primary distraction and external fixation followed by corrective open surgery. However most of these devices are cumbersome and cannot be used before 2-3 years of age.

The skin incision and approach for open surgery has again been a topic of many a discussion.¹⁷⁾ Buck-Gramko^{5,6)} and Lamb¹⁴⁾

favoured the dorsal lazy S shaped approach. The disadvantages being a lack of radial skin in late and severe deformities and redundancy of the ulnar skin after correction, which needed excision. Others have recommended a Z plasty along the concave radial border, and adding a longitudinal incision along the ulnar border overlying the ulno-carpal joint ; the skin bridge between the two incisions however impedes access. Manske^{2,3)} used a single ulnar transverse ellipse incision and so did Flatt¹⁸⁾ but invariably both methods have been unable to solve the problem of unnecessary excision of ulnar skin.

The problem of skin cover persisted till Evans⁴⁾ in 1995 published his bilobed flap. Evans et al have described a bilobed incision in which skin from the dorsum of the hand is transposed to the radial side to cater to the shortage, and the redundant excess is utilised to cover the defect now created on the dorsum.

At our institute we have been recording all congenital anomalies in the WADIA HOSPITAL HAND REGISTRY since the past 5 years. Totally recorded cases are 308 and 44 of which are Radial hemimelias. The present series shows the medium term results in 13 patients (19 hands)treated by a combination of bilobed flap and external fixation cum distraction (Table 1, 3). Our method combines the advantage of obtaining reduction without resection of any part of carpus or ulnar cartilage thus retaining all possible growth centres in a compromised limb where late appearance of epiphyses is a well documented phenomenon and also maintains mobility by preserving the joint. It also solves the problem of skin shortage on the radial side by redistribution of good quality skin, which is in accordance with the basic



Fig. 5. Radiograph of Transverse Hypertrophy of ulna at 5 yrs follow up showing stable and mobile wrist.

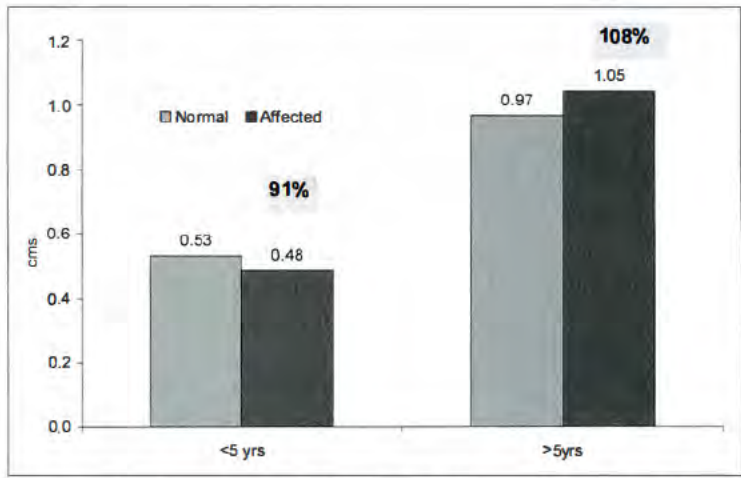


Fig. 6. Average radius breadth of 13 cases [Bar Chart 2]

principles of reconstructive surgery. The prime offenders responsible for recurrence viz. skin closure under tension, elastic recoil of tight musculo-tendinous units subluxation of carpus are negated to a large extent. The longitudinal growth of Ulna is at least as good as that reported in other series (Fig. 4 [Bar Chart 1]) and further long-term follow up is awaited. The transverse hypertrophy of the lower end of the Ulna is excellent mimicking the lower end of Radius on the normal side. In fact it appears to marginally exceed the width of the opposite normal Radius as shown in (Fig. 5, 6 [Bar Chart 2]), which is hard to explain. We prefer not to draw conclusions as the sample size is small and longer follow up is required. It however definitely allows for the formation of a stable and mobile wrist joint which is not always feasible with other methods where you get either one or the other. Also since distraction and formal surgery are used in conjunction in early cases it minimises repeated surgical procedures, reducing the mental duress on the parents and patient. The device used being light is well tolerated as compared to earlier linear assemblies as well as ring fixators and also

allows for inspection of the wound. When used as a secondary treatment for late or recurred cases an ulnar osteotomy can be combined along with it at the same sitting without internal fixation.

Conclusions

We offer a method of correction of Radial Club Hand, which combines two useful concepts. Our method obviates the disadvantages of traditional surgery and has shown good early and medium term results. It is adaptable to both early and late cases thus offering versatility and is technically relatively simple. Long term results and analysis are awaited.

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DISCLAIMER : UMEX is the proprietary name of the Universal Mini External Fixator manufactured and marketed by Sushrut Surgical Co. Mumbai India. The authors have no financial interest in the company nor have we received any aid from them for this project.