

Reconstruction of Wassel Type VI Radial Polydactyly with Triphalangeal Thumb Using an On-top Osteotomy

Kaiying Shen, MD
Zhigang Wang, MD
Yunlan Xu, MD

Background: The purpose of this study was to present a novel surgical technique using an on-top osteotomy and to assess the clinical and radiographic outcomes for the triphalangeal Wassel type VI thumb duplication patients.

Methods: The surgical technique involves ablation of the radial thumb at distal one-third of the metacarpal, corresponding metacarpal osteotomy of the ulnar thumb, with amalgamation of 2 metacarpals and reconstruction of the ulnar thumb by a series of soft tissue procedures. Clinical and radiologic outcomes were evaluated by using the Japanese Society for Surgery of the Hand evaluation form at a minimum of 30 months. The size of the metacarpal was measured and compared to the opposite one to assess the growth of the thumb.

Results: Five patients, including 4 males and 1 female, were observed for an average of 37 months. All amalgamated metacarpal showed bone union in 6 weeks after surgery and revealed growth with the age. The average length of the metacarpal was 86% of the opposite one at the final follow-up. Motion at the metacarpophalangeal and interphalangeal joints showed no restriction after surgery, and they reached excellent function for gripping and pinching. According to the JHHS scoring system, the results were excellent in 3 cases, good in 2.

Conclusions: This novel surgical technique for the reconstruction of Wassel type VI radial polydactyly with triphalangeal shows encouraging results in both clinical and radiologic evaluations; meanwhile long-term results are under evaluation. (*Plast Reconstr Surg Glob Open* 2017;5:e1216; doi: 10.1097/GOX.0000000000001216; Published online 1 February 2017.)

The aim of the management for radial polydactyly is to reconstruct a functional and esthetically pleasing thumb.¹ Wassel classification system is widely used for preoperative planning because of its good practicability.² However, Wassel type VI radial polydactyly with triphalangeal thumb is such a complicated deformity that it is difficult to be categorized according to the Wassel classification.³ The surgical treatment for this special kind of

deformity is very challenging. To our knowledge, it was barely discussed in previous literature.⁴

We have applied an on-top osteotomy technique without flexor pollicis longus (FPL), extensor pollicis longus (EPL) tendon transferring, or flap plasty to correct Wassel type VI radial polydactyly with triphalangeal thumb deformity. We described our technique and reported the preliminary results.

MATERIALS AND METHODS

From 2008 to 2014, 1,658 children with thumb polydactyly were treated by one of the authors in our center. Retrospective analysis of the operation records revealed that Wassel type VI radial polydactyly with triphalangeal thumb was documented in 11 cases (0.7%). Before operation, we followed and observed these patients in clinic until the age of at least 30 months to evaluate the function of radial and ulnar thumbs. We found that the cosmetic ulnar thumb had no active flexion, extension, or pinching function in 6 patients, who were treated with ablation of the ulnar thumb's bony elements and

From the Department of Pediatric Orthopedics, Shanghai Children's Medical Center, Affiliated to Shanghai Jiaotong University School of Medicine, Shanghai, People's Republic of China.

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The first 2 authors contributed equally to this work and should be considered co-first authors.

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Fig. 1. Preoperative evaluation showed that both ulnar and radial thumbs were functional.

preservation of the radial functional thumb despite its narrow flexed posture. Five patients were observed with both functional radial and ulnar thumbs (Fig. 1), who were treated with an on-top osteotomy (Fig. 2) and a series of soft tissue procedures to reconstruct a cosmetic and functional thumb. They have regained stable and functional metacarpophalangeal (MCP) and carpometacarpal (CMC) joints and were allowed for ongoing longitudinal growth. Informed consent was obtained, and institutional review board approval was acquired.

Surgical Technique

Under tourniquet control, a racquet incision was made around the base of the radial duplicated thumb. A periosteal

flap was detached from the base of the proximal phalanx of the radial component and retained along with the abductor pollicis brevis (APB) and flexor pollicis brevis (FPB). FPL and EPL tendons were detached and ablated at the interphalangeal (IP) joint level for the exposure of ulnar and radial metacarpals (Fig. 3A), and ablation of the radial thumb was made with a “V shape” osteotomy at distal one-third of the metacarpal (Fig. 3B). The adductor pollicis muscle and FPL and EPL of the ulnar thumb were preserved, and the corresponding “V shape” metacarpal osteotomy of the ulnar thumb was made to fit into the radial thumb’s remaining proximal metacarpal (Fig. 3B). All the soft tissue between 2 metacarpals was released for the amalgamation of 2 metacarpals (the ulnar thumb’s metacarpal was placed onto the radial thumb’s metacarpal), and the on-top osteotomy was fixed with a longitudinal K-wire to recess 1 metacarpal (Fig. 3C).

The reconstruction of the ulnar thumb was completed by a series of soft tissue procedures, including periosteal suture of metacarpals carefully and transferring of the APB and FPB to the ulnar thumb (Fig. 3D), the suture of preserved EPL of the radial thumb to the radial base side of the ulnar thumb’s proximal digit to enhance the abduction movement, and the ablation of preserved FPL. Finally, the incision was closed with absorbable suture (Fig. 3E, F), and a long-arm thumb spica cast was applied.

Postoperative care includes cast removal in 6 weeks with x-ray evaluation. If adequate healing at the osteotomy site was observed, the K-wires were removed, and the patient was fitted for an orthoplast thumb splint. The splint was worn full time for 4 weeks except during physical therapy and gentle activities that were done 3 times a day. Night-

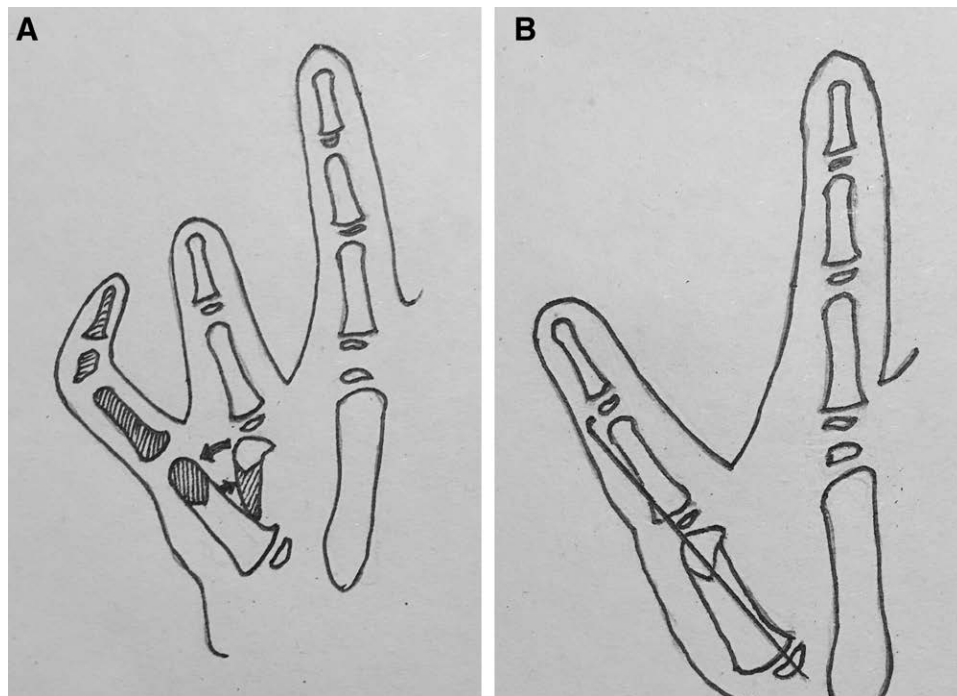


Fig. 2. Surgical techniques. A, Transposition of the ulnar digit to the radial ray. “V shape” osteotomy of the radial and ulnar metacarpals was performed (black area was resected). B, The ulnar digit was transported to the top of the radial metacarpal bone and fixed with a K-wire.

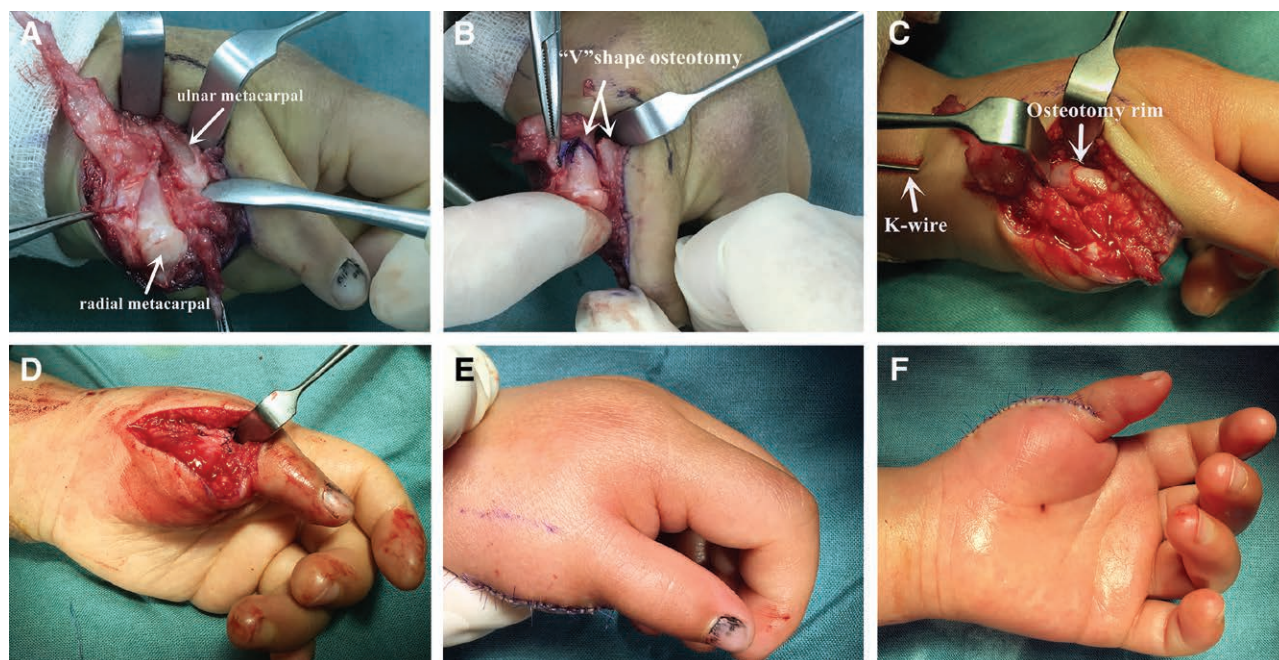


Fig. 3. Intraoperative photographs (case 5). A, Exposure of radial and ulnar metacarpals. B, “V shape” metacarpal osteotomy. C, Amalgamated metacarpals were fixed with a longitudinal k-wire. D, Reconstruction of the APB and FPB. E and F, The appearance after surgery.

time splint use was recommended for 4 more weeks, with resistive exercises for at least 3 months after surgery.

Patient Study

Five patients of Wassel type VI radial polydactyly with triphalangeal thumb (Fig. 4A) treated with an on-top osteotomy were reviewed (Table 1). There were 4 males and 1 female, with an average age of 31 months (range, 30–33 months) during surgical procedure. Preoperative x-ray demonstrated a Wassel type VI radial polydactyly, with triphalangeal thumb of the radial digit in a narrow flexed posture and remarkably hypoplastic metacarpal of ulnar digit (Fig. 5A). Before operation, they had been followed up in clinic for 1 to 2 years for to confirm that they have both functional radial and ulnar thumbs. We focused on the ulnar thumb that had satisfied flexion, extension, and pinching movement (Fig. 1). Patients with almost normal functional ulnar digits were candidates for the on-top osteotomy procedure.

Objective evaluation was based on the assessment of range of motion, joint stability, alignment of the thumb, and growth of the digit. We examined the stability of the MCP and IP joints by manual stress compared with the other side. Range of motion was measured actively with a goniometer actively. The metacarpals' union, the proximal epiphysis and the length of the metacarpal, alignment at the MCP, and IP joints were observed on the x-ray films and compared with the other side. Patients and/or their parents were asked to give their subjective feelings on both the functional and the cosmetic results. The Japanese Society for Surgery of the Hand (JSSH)⁵ evaluation form was adopted to assess functional and cosmetic outcomes of the reconstructed thumbs.

RESULTS

The mean duration of follow-up evaluation was 37 months (range, 30–45 months), and surgical outcomes for 5 patients are listed in Table 2.

The cosmetic point score averaged 4.0 points, although the reconstructed thumb revealed a little hypotrophy compared with the opposite one. The satisfactory appearance and surgical scar were acceptable to the families (Fig. 4B). All amalgamated metacarpals showed bone union in 6 weeks after surgery (Fig. 5B), and it revealed normal growth with the age followed the normal growing proximal metacarpal epiphysis (Fig. 5C); at the final follow-up, the length of the metacarpal was average 86% compared to the opposite one (Fig. 5D).

The functional point score averaged 13.6 points. Stability of the CMC, MCP, and IP joints was good overall, and average active palmar abduction was 74 degrees. Active motion at the MCP and IP joints showed no significant restriction after surgery except 1 patient (case 1) who had 10-degree active extension deficit at the IP joints (Fig. 4C). So in “Extension lag” item of Japanese Society for Surgery of the Hand evaluation, this patient got 1 point (total 2 points), and total functional point score was 14 points. All patients reached excellent function for gripping and pinching (Fig. 4D, E). Malalignment was observed in 1 patient (case 4), who had malalignment at the MCP joint, and there was a radial deviation of 17 degrees. So this patient got 1 point (total 2 points) for “Abnormal alignment/MCP joint” item, and his final functional point score was 14 points.

No patients reported pain or difficulties in their daily activities. Patients and/or their parents were satisfied with the appearance and function of the reconstructed thumb.

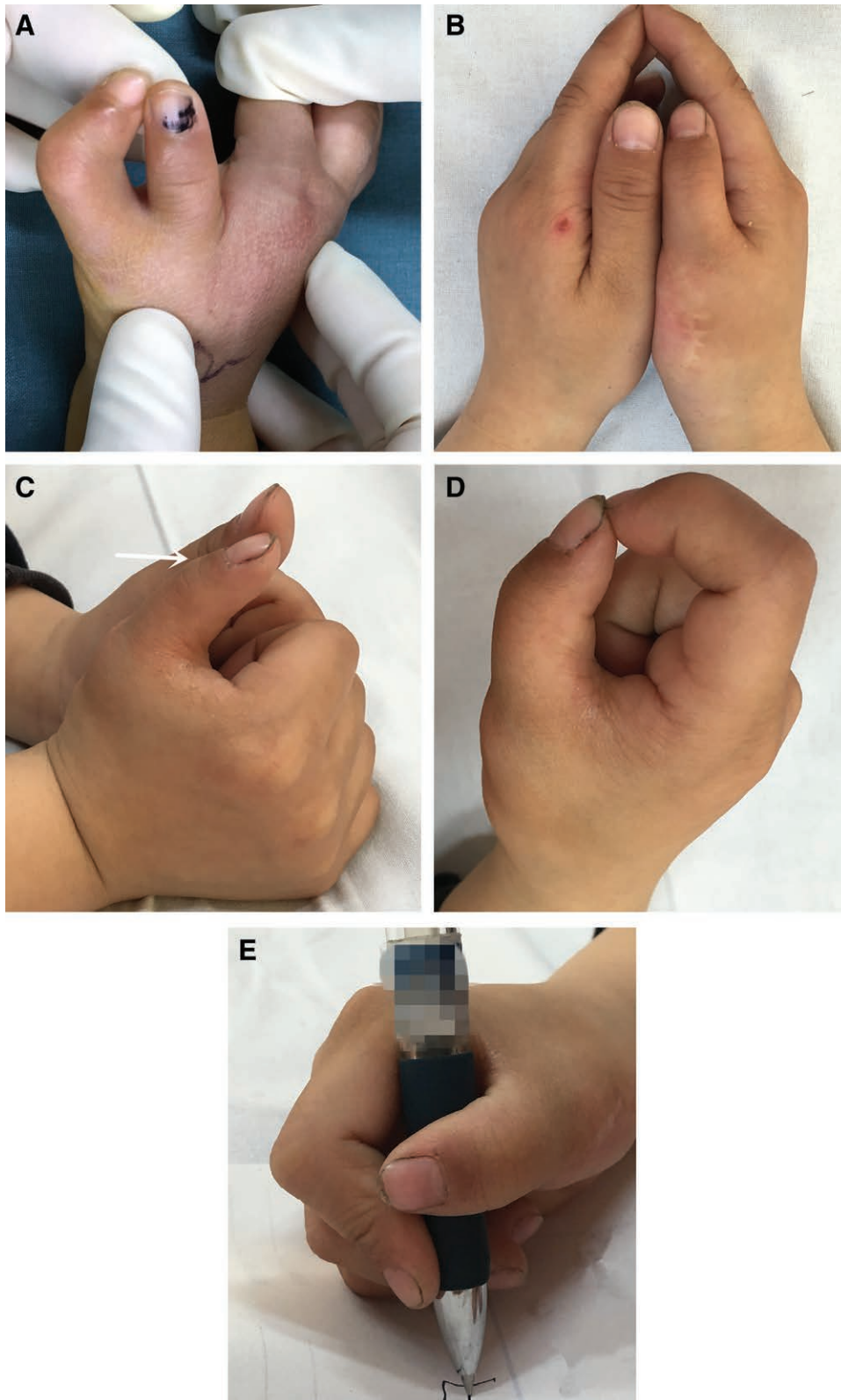


Fig. 4. A 33-month-old boy (case 1) with right Wassel type VI radial polydactyly with triphalangeal thumb. A, Preoperative appearance photograph. B, The satisfactory appearance of thumbs with almost the same sizes between the operative and the opposite side after surgery. C–E, The patient had 10-degree active extension deficit at the IP joints (white arrow) but reached excellent gripping and pinching function.

Table 1. Patient Data

	Gender	Age at Operation (mo)	Laterality
Case 1	M	33	R
Case 2	F	30	R
Case 3	M	32	R
Case 4	M	30	R
Case 5	M	31	L

F, female; M, male.

Total scores according to the JSSH scoring system averaged 19.6 points, and the results were excellent in 3 cases and good in 2.

DISCUSSION

The treatment strategy about which digit would be preserved is the key point to a successful surgery of Wassel type VI radial polydactyly with triphalangeal thumb deformity. We once considered that ulnar digit is not functional and its metacarpal is remarkably hypoplastic, so we were used to removing the ulnar digit and preserving the radial one because of its better function for gripping and pinching. However, several further osteotomy procedures for radial digit should be implemented to achieve acceptable cosmetic results because of the narrow hypoplastic appearance and flexed posture of radial digit. Therefore, in the past few years, we designed a new surgical technique using an on-top osteotomy for those patients who were observed with both functional radial and ulnar thumbs.

In Wassel type VI radial polydactyly with triphalangeal thumb patients, the radial digits always have hypoplastic triphalanges but with almost normal metacarpals. Conversely, ulnar digits have nearly normal phalanges, MCP joints, and distal part of metacarpals. However, the proximal metacarpals are hypoplastic and show deficiency of the epiphyses. The deformity of ulnar digits, especially the remarkably hypoplastic metacarpal, will seriously affect the stabilization of CMC joints and the growth of the digit. Hence, we designed the on-top technique to combine the well-developed phalanges, MCP and distal 1/3 metacarpal of ulnar digit with the 2/3 proximal metacarpal, and the stable CMC of radial digit, which make the reconstructive thumb achieve the almost normal skeletal structure. In the follow-up evaluations, the union metacarpals were amalgamated, the MCP and CMC were stable, the appearance of the thumb was satisfactory, and the JSSH cosmetic point score averaged 4.0 points.

Transposition of the relatively well-aligned ulnar digit to the radial ray was required in on-top technique. Iba et al⁴ preserved the FPL and EPL tendons and APB of radial digit to transfer to the ulnar digit for thumb function, and according to their report, the mean age at surgery was 15 months. In our opinion, it is always difficult to confirm that the ulnar digit has functional FPL, EPL tendon and tendon insertion which can be strengthened by transferred radial digit's ones at such young age. To take the postoperative functional aspect into account, we delayed the surgery un-

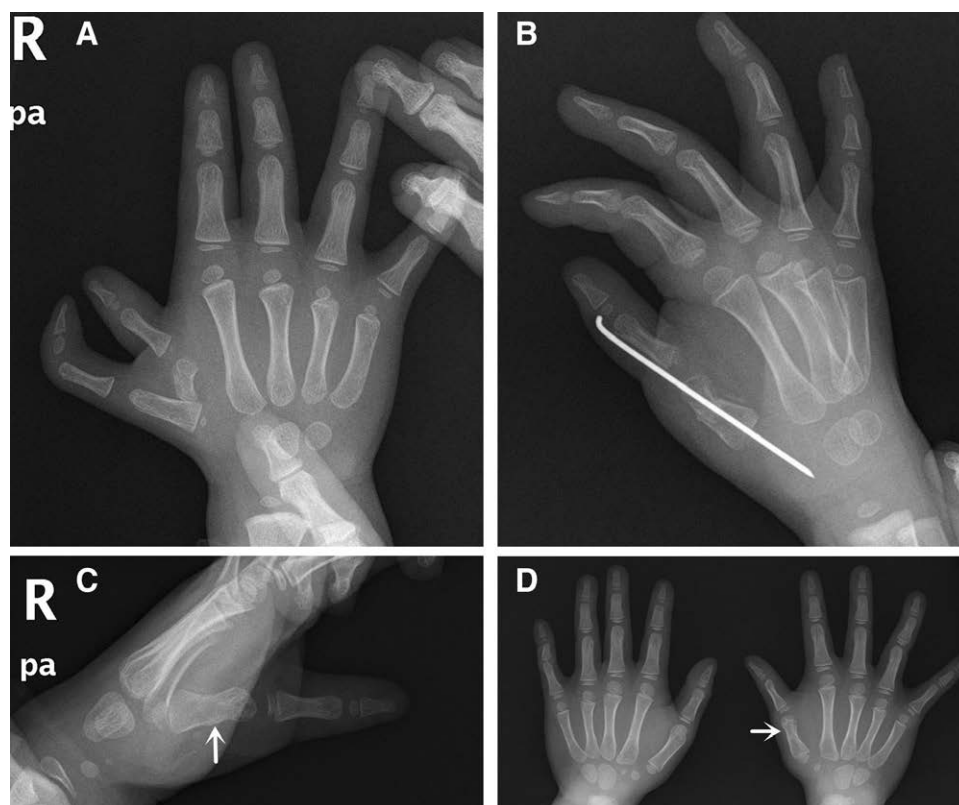


Fig. 5. A, Preoperative x-ray. B, Six-week postoperative x-ray showed amalgamated metacarpals and good bone union. C and D, During the 45-month follow-up, it showed the proximal metacarpal epiphysis had normal growth with the age (white arrow; case 1).

Table 2. All Patients’ Follow-up and Outcome Evaluation

	Follow-up Evaluation (mo)	Cosmetic Points (4 Points)	Functional Points (14 Points)	Pain and Satisfaction (2 Points)	Total (20 Points)	Assessment	Metacarpal Length (%)	Problems
Case 1	45	4	13	2	19	Good	85	IPJ extension deficits (-1)
Case 2	42	4	14	2	20	Excellent	87	—
Case 3	30	4	14	2	20	Excellent	91	—
Case 4	36	4	13	2	19	Good	82	MPJ radial deviation (-1)
Case 5	33	4	14	2	20	Excellent	84	—

IPJ, interphalangeal joint; MPJ, metacarpophalangeal joint.

til the active motion of the patient’s ulnar thumb could be observed at average of 31 months in our study, and the flexor and extensor transfers were not considered in such situation, whereas a periosteal flap retained along with the APB and FPB was detached from the base of the proximal phalanx of the radial component and sutured to the radial side of the reconstructed thumb’s proximal phalanx, which could restore abduction and flexion. It must be emphasized again that the functional transferred ulnar digit is the key to surgical success. The contraindication is the nonfunctional ulnar thumb, as with 6 of 11 patients whose ulnar digit had no active movement, and they underwent the radial thumb preserving procedure and experienced a malalignment and hypoplastic thumb. In this study, 5 of 11 patients who underwent on-top technique scored average 13.6 points in JSSH functional evaluation, postoperative motion at the MCP and IP joints had no significant restriction, and average active palmar abduction on the CMC and MCP joints was 74 degrees.

Our “V shape” osteotomy technique is to preserve the bigger proximal two-thirds of the metacarpal of radial thumb, and then the corresponding “V shape” metacarpal osteotomy of the ulnar thumb was made and fit it into the preserved proximal part of radial thumb’s metacarpal. For this manipulation, the contact area of osteotomy is broader and more stable so that it is conducive to bone healing. Different to Iba et al’s report, in which 1 of 2 cases had bone delayed union,⁴ all the 5 patients in this series had bone healing within about 6 weeks after surgery. In this way, careful periosteal suture of metacarpals is an important procedure for bone union. In addition, all the patients did not receive radial rotational flap plasty, and their postoperative abduction angles of CMC and MCP showed no significant restriction after surgery. In our

opinion, the radial rotational flap plasty is not necessary for Wassel type VI radial polydactyly with triphalangeal thumb patients.

The limitations of this retrospective case series study included a small number of cases, a relatively short post-operative follow-up time, and no patients as a control to prove the isolated effect from our surgical method.

In conclusion, our on-top reconstructive procedure can provide good cosmetic and functional results for Wassel type VI radial polydactyly with triphalangeal thumb deformity. The surgical technique is simplified without tendon or flap transfer. But first, it is important to confirm the ulnar thumb has active function before surgery.

Yunlan Xu, MD

Department of Pediatric Orthopedics
 Shanghai Children’s Medical Center
 Affiliated to Shanghai Jiaotong University School of Medicine
 1678 Dongfang Road
 Pudong New Area
 Shanghai 200127, People’s Republic of China
 E-mail: xylproscmc@163.com

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