Journal of Plastic, Reconstructive & Aesthetic Surgery (2019) 72, 636–641

JPRAS
An International Journal of Surgical Reconstruction
www.JPRASurg.com

Nail size and appearance following nail fusion plasty of thumb duplication☆

Anyuan Wang[1], Hongqiang Wu[1], Long Wang, Zongwei Zhou, Jian Ding*, Weiyang Gao*

Department of Hand and Plastic Surgery, The Second Affiliated Hospital and Yuying Children's Hospital of Wenzhou Medical University, Wenzhou, China

Received 11 October 2018; accepted 21 December 2018

KEYWORDS
Nail reconstruction;
Cosmetic evaluation;
Thumb duplication;
Nail fusion plasty

Abstract *Purpose:* To evaluate nail appearance after nail fusion plasty to treat thumb duplication.
Methods: A modified form of nail fusion plasty was performed on 17 reconstructed thumbs of 16 children with thumb duplications, commencing in January 2010. We assessed nail width and nail, lunular, and nail fold deformities using the Wang-Gao scoring system. All 17 thumbs were evaluated over an average of 32 months (range, 12–48 months) of follow-up.
Results: One patient with bilateral thumb deformities was excluded. The width ratios of 15 reconstructed nails (compared with those of the contralateral thumbs) were 82–118% (average, 97%). Nine thumbs exhibited nail ridges or gaps; the average ridge/gap score was 1.23 (maximum, 2). Six thumbs exhibited lunular deformities; the average score was 1.58 (maximum, 2). Another six thumbs evidenced nail fold deformities; the average score was 1.64 (maximum, 2). Only one thumb exhibited nail dehiscence. Two thumbs had no nail deformity. The final assessments were excellent in 14 cases, good in 2 cases, and fair in 1 case.
Conclusions: We could not significantly reduce the deformity rate of the nail plate, nail fold, or lunula using our new technique, but the deformities were much less marked than previously.

☆The work is attributed to the Department of Hand and Plastic Surgery, The Second Affiliated Hospital and Yuying Children's Hospital of Wenzhou Medical University, Wenzhou, Zhejiang Province. China;

[1]These authors contributed equally to this work and should be considered co-first authors

* Corresponding authors.
E-mail addresses: dingdingdang9770@163.com (J. Ding), weiyanggaoi@126.com (W. Gao).

https://doi.org/10.1016/j.bjps.2018.12.048

Nail fusion plasty usefully enlarges the nail and pulp in patients with hypoplastically duplicated thumbs.

Introduction

Nail fusion plasty is used to treat patients with hypoplastically duplicated thumbs. Bilhaut[1] was the first to combine the two distal phalangeal bones by resecting the central parts of the duplicated thumbs; the new thumb was similar to the contralateral thumb. The appearance of the fused nail is important when evaluating procedural outcomes; detailed data on the frequency of nail deformities after nail fusion plasty are lacking. Dobyns[2] considered that the reconstructed nail should be >80% the size of a normal nail. The ability to reconstruct a normal or near-normal nail affects decision making by surgeons and patients.[3-6] Several authors[7-11] have sought to improve nail reconstruction. In 2009, Gao[12] explored factors causing nail deformities and found that nail reconstruction required improvement. Our surgical technique[12,13] reduces or eliminates deformities. Therefore, since February 2010, we have focused our attention on nail appearance. Here, we describe our procedure and evaluation of nail appearance after fusion.

Materials and methods

The study was approved by our institutional review board and the independent ethics committee of our hospital. The parents of all patients gave written informed consent prior to surgery. The consent forms allow us to store patient information and use it in research.

Patients

Seventeen thumbs of 16 patients treated between February 2010 and December 2015 were included: five thumbs were of Wassel type 2, three were of Wassel type 3, seven were of Wassel type 4, and two were of Wassel type 7. We treated 10 boys and 6 girls with an average age of 19 months (range, 10–36 months) at the time of initial surgery. All thumbs were hypoplastic with nail widths <80% those of the nails of the unaffected sides, or less than the width of the index-finger nail in patients with bilateral thumb conditions.

Surgical procedure

The thumb with the wider nail and pulp, greater range of motion of the interphalangeal (IP) joint, and better alignment of the IP and metaphalangeal (MP) joints (usually the ulnar thumb) was chosen to become the main articulating digit, which featured the articular surface, the physis, and a major portion of the distal phalangeal bone with its overlying nail bed. In patients with unilateral thumb duplications, we used Vernier calipers to measure the nail width on the contralateral thumb (the reconstruction reference). In patients with bilateral thumb duplications, we reconstructed the thumb nail to 135–140% of the width of the index-finger nail.

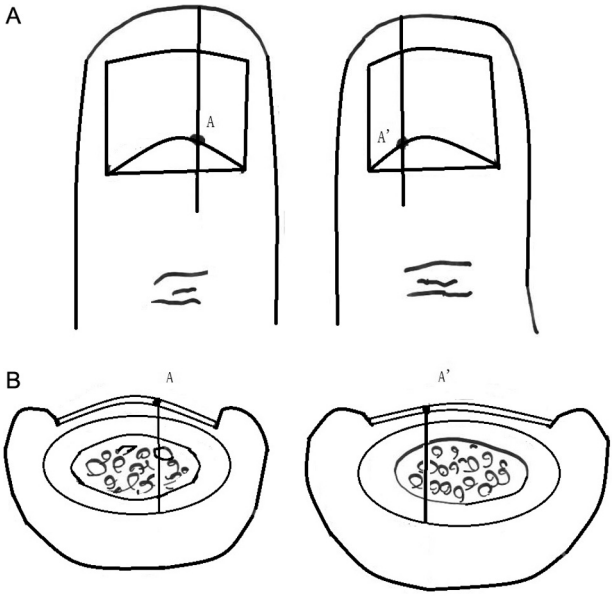

Figure 1 A. The incision at the dorsal part of the nail. B. The incision at the nail cross-section.

1. The incision was designed to ensure that the width of the reconstructed nail was close to that of the nail on the normal side. After choosing the nail width, we identified the point at which the longitudinal lunular lengths were equal in both segments of the duplicated thumb (Figure 1A), and the point at which both segments of the duplicated thumb would be of normal cross-sectional shape (curved) after reconstruction (Figure 1B). When one of these two points could not be defined, we rendered the lunular lengths equal.
2. In Wassel type 2 thumbs, the distal phalanx of the non-dominant thumb was converted to a flap containing the part of the distal phalangeal bone that supported the incised nail bed, and the collateral ligament was attached to the proximal phalanx (Figure 2A and B). In Wassel types 3 and 4 thumbs, we conserved a portion of the distal cortical bone without the collateral ligament of the non-dominant thumb, and used it to reconstruct the fused thumb. The fused bone was fixed via inverted suturing using 5-0 Vicryl (Ethicon, Inc.) (Figure 3). We performed corrective osteotomy of the proximal phalanx or metacarpal when the longitudinal axis of the IP or MP joint deviated from normal. The extrinsic extensors and the FPL were re-inserted without creation of an

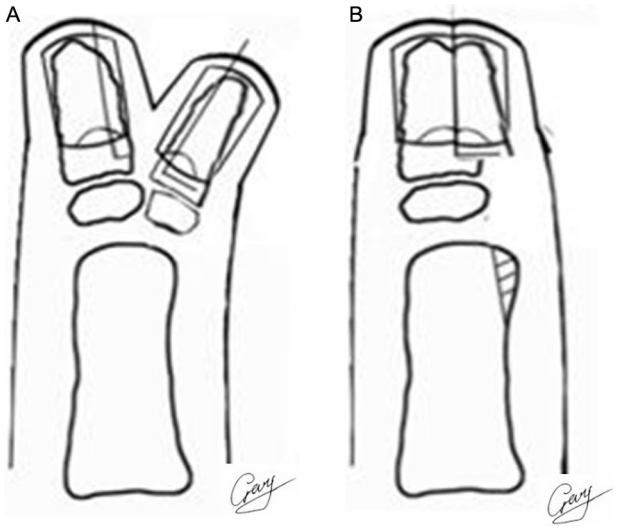

Figure 2 Management of the distal phalanx. A. Osteotomy is performed distal to the epiphyseal line. B. Matching of the distal phalanx.

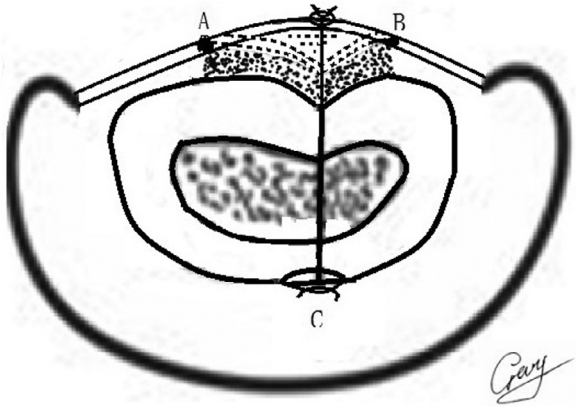

Figure 3 The nail bed is lifted from the periosteum. The fused bones are fixed with sutures. After surgery, the haematoma under the nail bed serves as a pad to prop the nail bed up.

abnormality. We then resected the non-dominant thumb, reconstructed the radial collateral ligament of the MP joint, and re-attached the thenar musculature.

3. The nail bed was lifted from the periosteum, triggering a haematoma under the nail bed after suturing (Figure 3). The first stitch was placed at the nail root, the second was placed at the distal edge of the lunula, and the third was placed at the free edge of the nail bed, which was then sutured using 6-0 Vicryl Rapide (Ethicon, Inc.) (Figure 4). After the nail bed was repaired, the nail plate was replaced and stabilised using the suture that we developed (Figure 5).
4. Nail fold plasty was performed when the proximal nail folds could not be smoothly sutured (Figure 6A), when the two proximal nail folds were of unequal height (Figure 6B), and/or when the extent of the lunula covered by the proximal nail fold rendered the nail apparently shorter than the contralateral nail (Figure 6C).

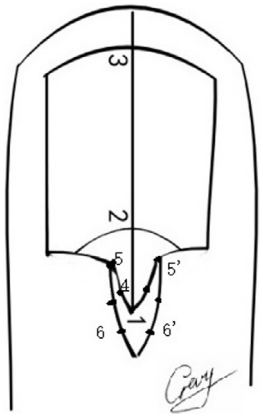

Figure 4 The sequence of nail bed and proximal nail fold repair.

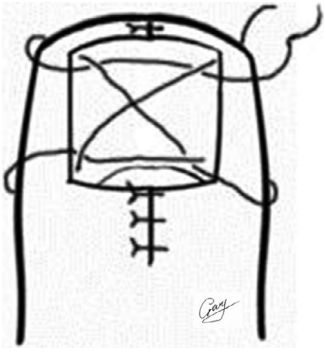

Figure 5 The nail plate fixation pattern.

We scored the results of reconstruction and evaluated deformities using the Wang-Gao method[11] (Table 1). We calculated average scores and deformity rates.

Results

We included 17 cases followed for an average of 32 months (range, 12–48 months). The cosmetic outcomes in the 16 patients are listed in Table 2. We did not include one case of bilateral thumb deformity (compared with the index fingers). The width ratios of 15 reconstructed nails (compared with those of the nails on the contralateral thumbs) were 82–118% (average, 97%). The width ratio of one reconstructed nail was below our acceptable standard of 85% (at 82%). Nine thumbs had nail ridges or gaps; these were the most common deformities after nail fusion plasty (Figure 7). The average ridge/gap score was 1.23 (maximum, 2), the lowest of the three principal deformity scores. Six thumbs had lunular deformities (average score, 1.58; maximum, 2; Figure 8); another six thumbs had nail fold deformities (average score, 1.64; maximum, 2; Figure 9, Table 3). Only 1 of 17 thumbs exhibited nail dehiscence (Figure 9). Two thumbs had no nail deformity (score, 12; Figure 10). The final assessments were excellent in 14 cases, good in 2 cases, and fair in 1 case.

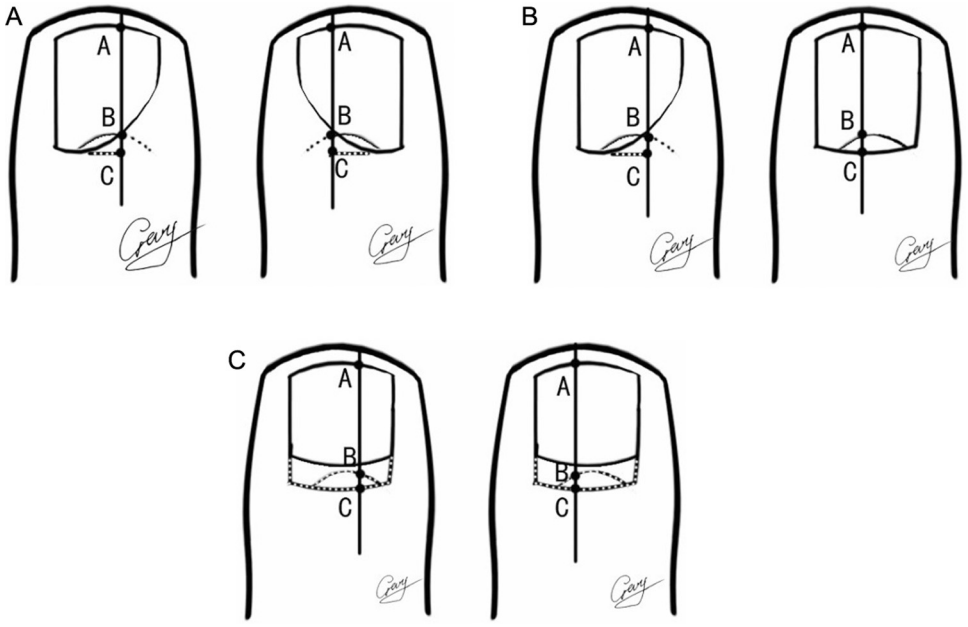

Figure 6 Incision of the lunula and nail fold: A–C. Three types of nail fold in a duplicated thumb. Creation of equal-height incisions is essential to avoid or mitigate malpositioning of the lunula and nail fold; AC and BC must be equal.

Table 1 Scoring system for postoperative nail evaluation.

Criterion	Score		
	2	1	0
The ratio (x) of the width of the operative side to the normal side	$x \geq 85\%$	$70\% < x < 85\%$	$x \leq 70\%$
The surface roughness of the nail: ridge or gap	None	Slight	Obvious
Malposition of the lunula	Smooth	Slight malposition	Obvious malposition
Malposition of the nail fold	Normal	Slight malposition	Obvious malposition
Appearance of the nail: dehiscence of nail or growth failure	None	Either	Both
Satisfaction of Patients' Parents	Satisfactory	Adequate	Unsatisfactory

Total Assessments: Excellent, score of 10–12; Good, score of 7–9; Fair, score of 4–6; Poor, score of 0–3.

Table 2 Patients' date.

Case	Gender	Affected Site	Wassel Type	Age At Surgery (mo)	Follow-Up Period (mo)	Width Ratio (2 points)	Ridge Or Gap (2 points)	Malposition Of The Lunula (2 points)	Malposition Of The Nail Fold (2 points)	Appearance Of Nail (2 points)	Patients' Satisfaction (2 points)	Total (12 points)
1	M	L	4	34	36	2	2	2	2	2	2	12
2	F	R	4	16	24	2	2	1	2	2	2	11
3	M	R	2	15	24	1	2	1	2	2	2	10
4	M	L	4	36	36	2	2	1	2	2	2	11
5	F	R	2	14	12	2	0	2	2	2	2	10
6	F	R	2	17	24	2	2	2	1	1	2	10
7	M	L	3	24	34	2	1	1	2	2	2	10
8	M	L	7	10	35	2	0	0	2	2	1	7
9	M	L	2	14	33	2	2	2	1	2	2	11
10	F	R	7	13	31	2	1	2	2	2	2	11
11	M	L	3	30	31	2	0	2	2	2	2	10
12	F	R	4	11	30	2	1	2	1	2	2	10
13	M	R	3	23	24	2	2	2	2	2	2	12
14	F	L	4	12	48	1	2	2	1	2	2	10
15	M	R	4	25	36	2	1	2	2	2	2	11
16	M	L	2	16	43	2	0	2	1	2	2	9
16	M	R	4	16	43	2	1	1	1	2	2	9

Table 3 Score of the three main deformities.

Total Thumbs	Total score Average score (max 12)	Ridge or gap Average score (max 2)	Malposition of the lunula Average score (max 2)	Malposition of the nail fold Average score (max 2)
17	10.23	1.23	1.58	1.64

Figure 7 Case 8; an obvious nail ridge. Nail score, 7.

Figure 8 Case 3; slight deformity of the lunula and proximal nail fold. Nail score, 10.

Figure 9 Case 6; asymmetry of the lateral nail fold and nail growth failure. Nail score, 10.

Figure 10 Case 13; a natural-looking nail. Nail score, 12.

Discussion

Nail width is the easiest parameter to use when planning accurate excision/operation. Although some authors consider that adequate pulp ensures normal nail development,[14] or that a small reconstructed finger will become of normal size via 'catch-up' growth,[9,15] we found that the reconstructed: normal nail width ratio did not change postoperatively. Like skin scars, nail ridges can be cosmetically improved via delicate operations. Many surgeons eschew the use of tension sutures to avoid ridging, but the details of their approaches differ. Samson[8] suggested that the nail plate (not the nail bed) should be sutured. Iwasawa[16] suggested simultaneous nail plate/bed suturing; others have advocated precise nail bed suturing after nail plate removal.[7,9,11] In our opinion, the nail plate must be removed, and not only the nail bed, but also the nail matrix, must be sutured. The 'seagull' and 'razorback' deformities may develop when nails of different curvatures are linked. Nail fusion without bone fusion,[17] or 'floating' of even a small piece of cortical bone,[16] will also trigger the razorback deformity because of a lack of support under the nail bed. Thus, we prefer the modified Bilhaut-Cloquet technique of Baek[9]. However, our procedure features two key differences. First, we fix the bone by inverted suturing of the bottom of the periosteum, which encourages the top of the distal phalangeal bone to curve in a semi-circular manner. Second, we strip the nail bed at the level of the periosteum, allowing tension-free suturing of the nail matrix and nail bed. After surgery, the haematoncus under the nail bed serves as a pad that props the nail

bed up, avoiding development of the seagull and razorback deformities (Figure 3).

A nail of normal width cannot be created by fusing the nails of two hypoplastic thumbs at the peaks of their lunular arcs. In most cases, development of the 'double hump' and seagull deformities is inevitable, and these deformities will be obvious when the lunular curvature is large. Any height discrepancy at the surgical junctions of the lunulae causes the lunular seagull and 'ladder' deformities.[16] Baek[9] considered the latter deformity, but did not propose a preventative measure. We found that lunular deformities could not be eliminated completely; the original nail lunulae cannot be shaped to become of identical height at the surgical junction. However, technological improvements enable the creation of a smooth and continuous lunular junction, significantly improving the cosmetic appearance.

Unlike the lunula, nail fold deformities are affected principally by the operative design. Nail fold plasty is recommended when the nail folds of the two fused thumbs differ in shape or when the nail lengths vary. Any overheight of the proximal nail fold renders the nail length inadequate; resection of the excrescent, proximal nail fold lengthens the nail (Figure 6C). Nail fold plasty clearly reduces the incidence of deformities and improves cosmetic scores. We believe that any nail fold 'incision' deformity caused by scar contraction can be reduced by careful repair under a magnifier, but cannot be eliminated completely.

Conclusion

Several methods can be used to reconstruct near-normal nails. To prevent development of the seagull and razorback deformities, we strip the nail bed, remodel the distal phalanx longitudinally, and fix the distal phalanx to change the curve of the nail. Nail fold plasty ensures that the two fused thumbs match. Even when the lunulae are of equal length, the seagull deformity may occasionally develop, but deformities attributable to malpositioning do not. Nail plate removal simplifies lunular and nail fold plasty. Precision is essential to avoid nail dehiscence and malpositioning.

Nail fusion plasty has advantages and disadvantages. As the technique has improved over time, nail deformities have decreased in number and become much less obvious than previously. We suggest that our technique can be used to enlarge the nail and pulp when treating hypoplastically duplicated thumbs.

Conflict of interest

No author has any financial interest in any product, device, procedure, or any other aspect of this article.

Funding

None.

Supplementary material

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.bjps.2018.12.048.

References

1. Guerison MB. d'un pouce bifide par un nouveau procede operatioire. *Congres Francais de Chirurgie* 1889:576–80.
2. Dobyns JH, Lipscomb PR, Cooney WP. Management of thumb duplication. *Clin Orthop Relat Res* 1985:26–44.
3. Evans D. Polydactyly of the thumb. *J Hand Surg Br* 1993;**18**:3–4.
4. Abid A, Accadbled F, Knorr G, et al. Type IV-D thumb duplication: A new reconstruction method. *Orthop Traumatol Surg Res* 2010;**96**:521–4.
5. Miura T. Duplicated thumb. *Plast Reconstr Surg* 1982;**69**:470–481.
6. Simmons BP. Polydactyly. *Hand Clin* 1985;**1**:545–65.
7. Tonkin. The Bilhaut-Cloquet Procedure Revisited. *Hand Surgery* 1997;**2**:67–74.
8. Samson P, Salazard B, Magalon G. The "Bilhaut-Cloquet" technique for treatment of thumb duplication. *Handchir Mikrochir Plast Chir* 2004;**36**:141–5.
9. Baek GH, Gong HS, Chung MS, et al. Modified Bilhaut-Cloquet procedure for Wassel type-II and III polydactyly of the thumb. *J Bone Joint Surg Am* 2007;**89**:534–41.
10. Iwasawa M, Hirose T. Nail plasty in the treatment of duplicated thumb. *Ann Plast Surg* 1993;**31**:528–31.
11. Wang AY, Gao WY, Wu LM, et al. Nail Fusion Plasty: Nail Cosmetic Results and Assessment Criteria of Nail Reconstruction. *Ann Plast Surg* 2015;**75**:290–4.
12. Xueguan X, weiyang G, Xinglong C, Zhijie L, Zhi L. Analysis of the treatment outcomes and common complications of Bilhaut-Cloquet surgical procedure for thumb duplication. *Chin J Hand Surg* 2011;**27**:3.
13. Weiyang G, Zhijie L, Xinglong C, Xiaoyang L. Anatomic changes and treatment strategy of crab claw like polydactyly of the thumb. *Chin J Hand Surg* 2013;**29**:5.
14. Masuda T, Sekiguchi J, Komuro Y, Nomura S, Ohmori K. "Face to face": a new method for the treatment of polydactyly of the thumb that maximises the use of available soft tissue. *Scand J Plast Reconstr Surg Hand Surg* 2000;**34**:79–85.
15. Horii E, Hattori T, Koh S, Majima M. Reconstruction for Wassel type III radial polydactyly with two digits equal in size. *J Hand Surg Am* 2009;**34**:1802–7.
16. Iwasawa M, Noguchi M, Mishima Y, Fujita K. Long-term results of nail fusion plasty of the duplicated thumb. *J Plast Reconstr Aesthet Surg* 2008;**61**:1085–9.
17. Cheng JC, Chan KM, Ma GF, Leung PC. Polydactyly of the thumb: a surgical plan based on ninety-five cases. *J Hand Surg Am* 1984;**9**:155–64.