

METACARPAL LENGTHENING BY DISTRACTION OSTEOGENESIS IN CHILDHOOD BRACHYDACTYLY

H. ARSLAN

Metacarpal lengthening was performed by callus distraction in six children with brachydactyly. Four of the patients were girls and two were boys, with ages ranging from 10 to 14 years (mean age : 12 years). Four of the patients had brachydactyly resulting from injury to the hand and damage to the epiphysis related to infection, while the other two had congenital brachymetacarpia. Two patients had short thumbs, two had short index fingers, and the remaining two had short ring fingers. General anesthesia with a pneumatic tourniquet was used during surgery for all patients. Distraction was initiated on the sixth day following osteotomy, and distractions of 0.25 mm were carried out at 12-hour intervals. Adequate length was achieved in an average of 37 days (32-44), and adequate union of the bone in an average of 12.2 (11.5-15) weeks. No bone grafting was done.

In one patient with congenital brachymetacarpia, it was not possible to achieve the desired length because of bending in the Kirshner wires, but union of the bone occurred without difficulty, and the outcome was satisfactory.

Although single-stage metacarpal lengthening by callus distraction is time-consuming, it is a simple procedure without complications, which can be used in children with brachydactyly.

Keywords : metacarpal ; lengthening ; distraction osteogenesis ; child.

Mots-clés : métacarpien ; allongement ; ostéogénèse en distraction ; enfant.

Brachydactyly may lead to functional and cosmetic complaints. Hand function is particularly compromised in cases of short thumb and index finger.

Various types of osteotomy and intercalary bone graft have been used in the treatment of brachymetacarpia. As these procedures require release of soft tissue, they are complicated technically, and it is difficult to achieve the desired degree of lengthening.

An alternative treatment for short metacarpals or phalanges is distraction osteogenesis. This method was first described by Anderson in 1930 and was further developed by Ilizarov, who used a circular external fixator. This method, which was mostly used in tubular bone lengthening, has not been widely applied in the treatment of short metacarpals and phalanges. It was first used by Matev in thumb reconstruction after amputation at the metacarpophalangeal joint (4) . Approximately 10 years later, Kessler *et al.* used Matev's method for functional correction in aplasia (3). It is reported to have been used especially in thumb reconstruction after amputation, the treatment of phalangeal and metacarpal fractures with a bone defect, distal phalanx loss and congenital hand deformities. However, in most of these cases, a two-stage process

INTRODUCTION

Short metacarpals and phalanges may be congenital or may occur as a result of trauma or infec-

Department of Orthopedic and Trauma Surgery, University of Dicle, School of Medicine, Diyarbakır, Turkey

Correspondence and reprints : H. Arslan, Dicle Üniversitesi. Tıp Fakültesi, Ortopedi ve Travmatoloji Kliniği, Diyarbakır, Turkey. E-mail : diclehuseyin@hotmail.com.

was necessary, with lengthening by distraction followed by bone grafting (1, 2, 6).

In the present study, the results of treatment by distraction osteogenesis without grafting in six children with congenital or infection-related brachydactyly are evaluated.

MATERIALS AND METHODS

Metacarpal lengthening by distraction osteogenesis was performed in 6 children with brachydactyly at our clinic between 1997 and 2000. Four of the patients were girls and two were boys, with ages ranging from 10 to 14 years (mean age : 12 years). The cause of brachydactyly was hand injury with early closure of the epiphysis related to infection in four patients, and congenital brachymetacarpia in two other patients. The two patients with congenital brachymetacarpia had short ring fingers ; of the four patients with infection-related shortness, two had short thumbs and the remaining two had short index fingers. In addition to cosmetic considerations, the principal complaint of the patients with short thumbs and index fingers was related to the pinch function. The principal complaint of the two children with congenital brachymetacarpia was cosmetic ; their hand function was found to be normal.

The degree of shortness in the digits was found to be 16-22 mm, calculated according to the length of the corresponding digit of the contralateral hand and the neighboring fingers (table I).

Before surgery, the children and their parents were given detailed information about the procedure. During surgery, general anesthesia with a pneumatic tourniquet was used. A skin incision was made on the dorsal aspect of the metacarpal to be lengthened, and soft tissues were dissected to access the metacarpal. The periosteum was opened longitudinally, and retractors were put in place. Care was taken not to injure the periosteum. Because of

the difficulty of corticotomy, osteotomy was performed after drilling with a 1.9-mm drill. The site of osteotomy was the proximal metaphysis in all but one patient, in whom osteotomy was performed near the diaphysis because of technical difficulties with the device used. After application of the external fixator, the periosteum and skin were closed. In one patient with a short thumb, there was a contracture at the first web, so in the same session a simple Z-plasty was carried out and the web was deepened. Lengthening was initiated on day 6, with a distraction rate of 0.25 mm every 12 hours. Active finger movements began during the early postoperative period. After the distraction procedure was taught to the patient and parents, patients were discharged with weekly follow-ups, during which the stability of the device and the efficacy of the distraction were evaluated. After the planned lengthening was achieved, distraction was discontinued and the bone was allowed to heal. The external fixator was removed after sufficient consolidation had been achieved (after 11.5 to 15 weeks).

RESULTS

The patients were followed up for 12 to 28 months (mean : 19 months). Lengthening equal to the degree of shortness determined was achieved in 32 to 44 days (mean : 37 days), and sufficient healing occurred without further surgery in 11.5 to 15 weeks (mean : 12.25 weeks). Bending of the pins after 18 mm lengthening occurred in the patient with 22 mm shortness, and the distraction was discontinued in order to prevent fixation failure. Union occurred in this patient without complications.

Pinch function improved in the four patients with short thumbs or index fingers, with satisfactory outcome. The cosmetic complaints of the two patients with congenital brachymetacarpia,

Table I. — Patients with short brachydactyly undergoing digital lengthening

	Age	Sex	Cause of shortness	Short digit	Degree of shortness	Patient's complaint
1	14	F	Congenital short metacarpal	4 th metacarpal	16 mm	Cosmetic anomaly
2	11	F	Animal bite and infection	Thumb	20 mm	Impaired pinch function, cosmetic anomaly
3	10	M	Hand injury and infection	Index finger	18 mm	Impaired pinch function, cosmetic anomaly
4	13	F	Congenital short metacarpal	4 th metacarpal	18 mm	Cosmetic anomaly
5	11	M	Hand infection	Thumb	17 mm	Impaired pinch function, cosmetic anomaly
6	13	F	Hand injury and infection	Index finger	22 mm	Functional impairment and cosmetic anomaly



Fig. 1. — Metacarpal lengthening of the thumb in an 11-year-old girl.

A. Postoperative appearance on day one after surgery.

B. Fourteen months after osteotomy, radiography showing good bone healing.

especially regarding the appearance during metacarpophalangeal joint flexion, disappeared. In one of these patients, however, a new cosmetic complaint developed due to the scar tissue forming at the pin site.

No delayed union, nonunion or infection occurred in any of the patients. No distraction-related sensory defects or joint contractures were noted. No fixator problems occurred, other than the bending of the Kirshner wires in one patient, and there were no instances of failure.

DISCUSSION

Various techniques involving osteotomy and intercalary bone grafting have been used in the treatment of short metacarpals and phalanges. It is

difficult to achieve sufficient lengthening with these techniques, and acute lengthenings carry a risk of neurovascular complications. Distraction osteogenesis is an alternative method by which greater lengthening can be achieved with fewer complications. Matev reported the first case of metacarpal lengthening by distraction osteogenesis in 1970, and reported his experience with the first metacarpal lengthenings in 1989 (4, 5). He recommended grafting particularly in patients over 20 years of age in order to achieve satisfactory consolidation. Many authors have followed up on this recommendation, performing two-stage surgery (1, 2, 3, 6). Because osteogenesis in children is excellent, single-stage surgery involving progressive distraction without grafting yields successful results.



Fig. 2. — Metacarpal lengthening of the fourth metacarpal in a 14-year-old girl with congenital short metacarpal.
 A. Postoperative appearance on day one after surgery.
 B. Appearance 9 weeks later, following 5 weeks distraction, followed by another 4 weeks in external fixator.
 C. Twenty-four months later, radiography showing lengthening and consolidation.

Although this technique is simple, certain points must be given careful attention in order to ensure success in metacarpal lengthening in children. The first is that the external fixator and distraction system must be sufficiently stable, lightweight and suitable for the volume of a child's hand. The operation should be performed as quickly and atraumatically as possible. After surgery, active finger movements should be encouraged. Furthermore, in order to avoid angulation and secondary loss of length, the device should not be removed before sufficient consolidation has been achieved.

The most significant disadvantage of this technique in children is that the device remains in place for a long time and therefore requires very good patient compliance. Although it was explained to

the patients and their families that the treatment would take a long time, the most common complaints of both the patients and their parents were that the treatment lasted so long and that the follow-ups were so frequent.

There is general agreement on the time to initiate distraction after osteotomy, the daily pace and the degree in the lengthening of long tubular bones. However, there is no such consensus on these points regarding metacarpal and phalangeal lengthening. Different authors have variously started distraction on days 1-15 with rates of 0.3-1.5 mm/day (1, 2, 3, 5, 6, 7). Based on our experience with distraction osteogenesis in children's long bones, we initiated distraction on day 6 with a rate of 0.5 mm every 12 hours. We investigated the efficacy of the lengthening and the quality of the consolidation radiologically. Sufficient union was achieved within a suitable time period in all patients without fixation failure.

If the length discrepancy between the metacarpals does not cause any cosmetic complaint, there is no need for treatment in patients with congenital brachymetarpia. A popular technique used in the treatment of this deformity is osteotomy and bone graft. Brachymetarpia can more easily be corrected by callus distraction. However, since the only benefit of this treatment is a cosmetic improvement, cosmetic anomalies that may occur as a result of surgery should be taken into consideration, and the patient should not have unrealistic expectations.

CONCLUSION

New bone formation in children is excellent, and therefore single-stage metacarpal lengthening by distraction osteogenesis is a good alternative to complex procedures in childhood brachydactyly. However, it requires very good patient education and compliance, and attention must be paid to technical details of the procedure.

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SAMENVATTING

H. ARSLAN. Brachydactylie bij het kind : metacarpaalverlenging door middel van distractie-osteogenese.

Genoemde techniek werd toegepast bij 6 kinderen met brachydactylie. Het ging om 4 meisjes en 2 jongens, 10 à 14 jaar oud. Bij 4 onder hen was trauma van de groeischijf met secundaire infectie de oorzaak ; bij 2 was de aandoening congenitaal. Twee maal betrof het de duim, tweemaal de wijsvinger, en twee maal de ringvinger. De ingrepen gebeurden onder bloedleegte en onder algemene anesthesie. Zes dagen na de ingreep werd aangevangen met de distractie, a rato van 0,25 mm om de 12 uren. De gewenste verlenging werd gemiddeld na 37 dagen bereikt (uiterste waarden : 32 en 44 dagen). Botheling gemiddeld na 12,2 weken (uiterste waarden 11,5 en 15 weken). Botgreffen waren niet nodig.

Bij één enkel kind met congenitale brachydactylie ploidien de Kirschnerpinnen, zodat de gewenste verlenging niet werd bereikt, maar toch botheling en uiteindelijk een aanvaardbaar resultaat. De beschreven techniek is eenvoudig, vereist slechts één ingreep, brengt weinig verwikkelingen mee en heeft als enig nadeel haar langdurigheid.

RÉSUMÉ

H. ARSLAN. Allongement métacarpien par ostéogénèse en distraction dans la brachydactylie de l'enfant.

Les auteurs ont réalisé un allongement métacarpien chez 6 enfants qui présentaient une brachydactylie, en utilisant une méthode d'ostéogénèse en distraction. Ces enfants, 4 filles et 2 garçons, étaient âgés de 10 à 14 ans. Quatre d'entre eux présentaient une brachydactylie d'origine traumatique, secondaire à une lésion de l'épiphyse d'origine infectieuse, tandis que les deux autres présentaient une brachymétacarpie congénitale. L'anomalie portait sur le pouce dans deux cas, l'index dans deux autres et l'annulaire dans les deux derniers. Les opérations ont été réalisées sous anesthésie générale avec utilisation d'un garrot pneumatique. La distraction a commencé six jours après l'ostéotomie, et a été conduite à un rythme de 0,25 mm toutes les 12 heures.

L'allongement recherché a été obtenu en moyenne après 37 jours (32-44) et la consolidation osseuse après 12,2 semaines en moyenne (11, 5-15). Aucune greffe osseuse n'a été réalisée.

Chez un enfant qui présentait une brachymétacarpie congénitale, l'inflexion des broches de Kirschner n'a pas permis d'obtenir l'allongement désiré, mais la consolidation osseuse a été obtenue sans difficulté, et le résultat a été satisfaisant. Chez des enfants qui présentent une brachydactylie, l'allongement métacarpien par ostéogénèse en distraction apparaît comme une technique simple, qui ne nécessite qu'un temps opératoire, qui donne peu de complications et dont le seul inconvénient est sa durée.