

# Treatment of Complications after Distraction Osteogenesis for Brachymetatarsia of the Fourth Metatarsal

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**Summary:** Congenital brachymetatarsia most commonly involves the fourth ray and may be combined with metacarpal shortening. Numerous reports have demonstrated the usefulness of gradual lengthening of the metatarsals. However, very few studies have investigated methods of recovering the lost regenerative bone. The patient was a 16-year-old girl with bilateral brachymetatarsia of the fourth metatarsal. After a long consolidation period after gradual lengthening of the fourth metatarsal by 20 mm, the patient had an hourglass-shaped regenerated bone. Therefore, we grafted a bioabsorbable hydroxyapatite and collagen composite. Six months after the surgery, well-regenerated bone could be recognized on radiographic evaluation and was resistant to refracture. Callus distraction is a method that aims to avoid donor site morbidity. The strength of artificial bone is often a problem. Bioabsorbable hydroxyapatite and collagen composite compensates for the lack of regenerated bone and distraction gap and prevents refracture, thus preventing complications after metatarsal distraction. (*Plast Reconstr Surg Glob Open* 2016;4:e817; doi: 10.1097/GOX.0000000000000836; Published online 21 July 2016.)

**B**rachymetatarsia is a congenital or acquired condition that most frequently involves the fourth metatarsal.<sup>1</sup> Several surgical options are available for treating brachymetatarsia. Gradual lengthening of the metatarsals is a technique that is becoming increasingly popular, especially when more than 10 mm of metatarsal lengthening is needed.<sup>2-4</sup>

Skirving and Newman<sup>5</sup> first reported on the use of gradual metatarsal lengthening. However, several reports have described the complications of distraction osteogenesis, including digital contracture, pin site infection, scars, and loss of length of the regenerated bone.<sup>3,4</sup> Among these, refracture is a major complication after removal of the distractor. Most often, loss of the regenerated bone causes the refracture.<sup>4</sup> Several methods have been described to prevent the loss of the regenerated bone, such as increas-

ing the rate of lengthening, increasing the consolidation period, and using a reverse distraction technique.<sup>4</sup> However, very few studies have investigated methods of recovering the lost regenerated bone.

In the case reported here, the patient showed an hourglass-shaped regenerated bone after gradual fourth metatarsal lengthening. To prevent a refracture, we grafted a bioabsorbable hydroxyapatite and collagen complex, which ensured regeneration and prevented a refracture.

## MATERIALS

The bioabsorbable artificial bone used in this study was a hydroxyapatite and collagen composite (HA/Col; RIFIT, HOYA Co Ltd, Tokyo, Japan) with a bone-like nanostructure, 35% porosity, and a 100- to 500- $\mu$ m pore diameter. The artificial bone was flexible, with elasticity similar to that of a water-bearing sponge (Fig. 1).

## CASE REPORT

The patient was a 16-year-old girl with bilateral brachymetatarsia of the fourth metatarsal. Although there were no functional abnormalities, she desired an improvement in cosmetic appearance. We performed metatarsal distraction from the left side. After a 1-week latency period, distraction was started at a rate of 0.5 mm twice a

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Received for publication April 24, 2016; accepted June 1, 2016.

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DOI: 10.1097/GOX.0000000000000836

**Disclosure:** The authors have no financial interest to declare in relation to the content of this article. The Article Processing Charge was paid for by the authors.



**Fig. 1.** Bioabsorbable artificial bone. This is an HA/Col composite (RIFIT, HOYA Co Ltd, Tokyo, Japan) with a bone-like nanostructure, 35% porosity, and a 100- to 500- $\mu$ m pore diameter.

day and was continued until the distraction was 20mm. Radiographs obtained 3 months after surgery revealed an hourglass-like-shaped metatarsus (Fig. 2). Although the consolidation period was continued until the seventh month after surgery, the shape of the regenerated metatarsus did not change. The regenerated bone did not have sufficient thickness, and the risk of refracture was present.

Based on this observation, we concluded that the regeneration would not improve, even with further consolidation. Therefore, we planned to graft HA/Col composite and simultaneously remove the external distractor.

A medial longitudinal incision of 3.0cm was made at the metatarsal shaft, and the periosteum was longitudinally incised and carefully elevated. The regenerated bone was thin, similar to what radiographic evaluation had shown. Between the periosteum and thin regenerated bone, the HA/Col composite was grafted and the periosteum was closed with resorbable sutures, after which the skin was also closed accordingly (Fig. 3).

From the fourth day after surgery, we allowed the patient to walk bearing full weight. We permitted sports activities 3 months after surgery. At 6 months after the surgery, well-regenerated bone could be recognized on radiographic evaluation (Fig. 2). During the follow-up period, there were no fractures or relapse.

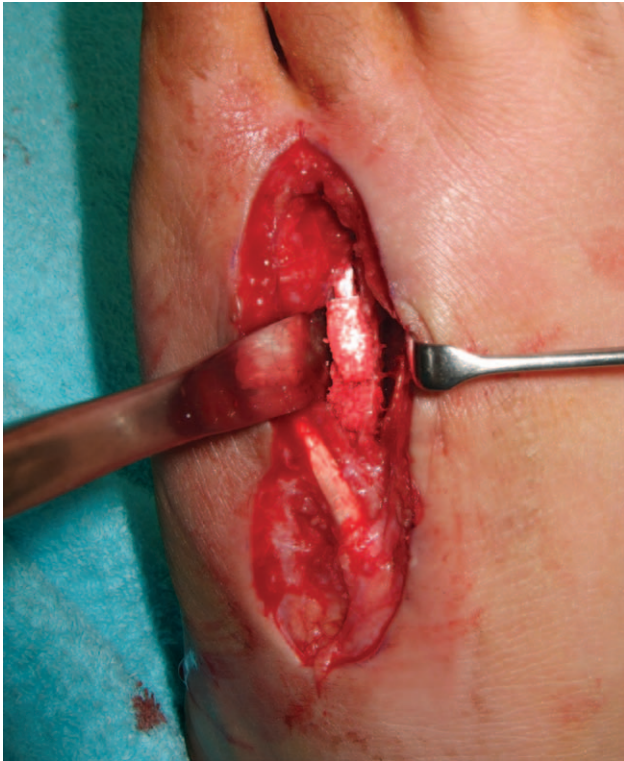
### DISCUSSION

Among the various treatments for brachymetatarsia, metatarsal distraction is less invasive, as no bone graft is required. However, soft tissues such as tendons, vessels, nerves, muscles, and periosteum are resistant to elongation of the metatarsal bone. The periosteum is thought to be important for the guidance of bone regeneration.<sup>6</sup> The hourglass-like shape of the regenerated bone seen in our patient was likely due to lack of extension of the periosteum. Metatarsal hypoplasia usually occurs when conventional procedures are used for autologous bone graft.<sup>4</sup> However, callus distraction is a method that aims to avoid damage to other sites due to bone grafting; thus, performing autologous bone graft for a complication caused by callus distraction is often not appropriate. On the other hand, the strength of artificial bone is often a problem, especially in load-bearing sites.

The benefits of using HA/Col in place of autogenous bone have already been reported.<sup>7,8</sup> We believe that the autologous bone-substitute-absorbing artificial bone used in this case is one method for solving these problems



**Fig. 2.** Anteroposterior view, radiograph. A, After a 7-mo consolidation period. Note that the regenerative bone does not have sufficient thickness and resembles an hourglass. B, Intraoperative view immediately after removing the distractor and grafting of HA/Col. C, 6 months after the second surgery. Note the sufficient thickness of the metatarsal.



**Fig. 3.** Intraoperative view. The HA/Col is grafted beside the narrowed regenerative bone.

because the artificial bone will finally be replaced with autologous bone without sacrifice of the donor site.

For one-stage metatarsal lengthening, usually allograft, autograft, or synthetic implants are preferred for metatarsals that only need to be lengthened up to 10mm.<sup>9,10</sup>

We do not yet have the experience, but we believe that HA/Col can be used for one-stage metatarsal lengthening.

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