Reconstruction of Temporomandibular Joint With a Fibula Free Flap: A Case Report With a Histological Study

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Reconstruction of the temporomandibular joint (TMJ) for congenital or acquired deformities is a major challenge for maxillofacial surgeons. The alternatives for reconstructing the TMJ include free grafts (costochondral, iliac crest, clavicle, or metatarsus), free flaps (fibula), osteogenic distraction, and alloplastic grafts. The lack of biological knowledge of cartilaginous grafts and their reaction to the environment of the TMJ is largely responsible for the inability to predict growth. This report describes the use of a free flap for TMJ reconstruction.

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Reconstruction of the temporomandibular joint (TMJ) for congenital or acquired deformities is a major challenge for maxillofacial surgeons.[1-3] Active proliferation of cartilage and endochondral ossification of the condylar skeletal unit (CSU) is necessary for the normal growth and development of the lower third of the face in the vertical, transverse, and horizontal directions.[4] The absence of normal condylar growth has the consequence of progressive and severe facial disharmonies. Successful reconstruction of the TMJ must reproduce the structures that are involved to restore their form and function and allow normal mandibular growth.[1]

Alternatives for reconstructing the TMJ include free grafts (costochondral, iliac crest, clavicle, or metatarsus), free flaps (fibula) when the defect is major, osteogenic distraction, and alloplastic grafts.[5]

The CSU can be reconstructed at a young age or once skeletal maturity has been achieved.[6]

The lack of biological knowledge of cartilaginous grafts and their reaction to the environment of the TMJ is responsible for the inability to predict growth. It is not known whether the area of the TMJ provides an appropriate environment for the continuous growth of cartilaginous grafts or whether different types of cartilaginous grafts respond differently to the environment of the TMJ.[6]

Report of Case

A 17-year-old male patient presented with a high-flow arteriovenous malformation that compromised the chin area and his entire left hemimandible.

He received 7 coil onyx embolizations without a satisfactory response. He was admitted to the emergency service with profuse hemorrhage, hypovolemic shock, and a hematocrit level of 17%. A hemimandibulectomy was performed by disarticulating the TMJ (from the mandibular right permanent lateral incisor to the highest area of the left mandibular condyle) followed by immediate reconstruction using a fibular free flap. The articular disc was preserved. The graft was obtained according to the procedure described by Fernandes[7] and Riaz and Warraich.[8] At the first control, mandibular asymmetry with deviation of the chin

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toward the healthy side was observed owing to the free flap's excess length. A year after free flap reconstruction, the mandibular deviation remained exactly as it was initially. The authors decided to remove the excess at the most proximal segment of the graft (part of the condylar reconstruction; Figs 1, 2).

The clinical discovery was medullary canal obliteration. A biopsy examination was carried out. The histologic characteristics using hematoxylin and eosin stain and ×4 magnification confirmed the presence of bone marrow, trabecular lamellar bone, and cartilage (Fig 3). Magnification at ×10 showed lamellar bone tissue with osteocytes and hypertrophic hyaline cartilage with fibrocartilage (Fig 4). Magnification at ×20 showed hypertrophic cartilage and fibrocartilage, numerous normal chondrocytes, lamellar bone with osteocytes, inactive osteoclasts, and bone marrow (Figs 5, 6).

This study was approved by ethical board of the Hospital del Salvador (Santiago, Chile).

Discussion

The costochondral graft is the most widely used autogenic technique for reconstructing the condyle. The advantages of this graft are its biological compatibility, malleability, functional adaptability, and low levels of morbidity in the donor region. The growth potential of costochondral grafts makes them an ideal option for children.[3] However, excessive mandibular growth and cartilage fractures have been identified as potential complications of this graft.[9]

After costochondral grafts were installed in Marmoset monkeys (*Callithrix jacchus*; whose TMJ is very similar to the human one), clinical and radiographic evaluation showed a deviation of 0.5 to 2 mm from the lower midline toward the unoperated side in growing monkeys where grafts with long cartilage were used. This deviation became clear 3 to 4 months after surgery. The deviation gradually increased until 13 to 15 months of age. Adult and growing monkeys that received shorter cartilages showed no deviation from the lower midline.[10]

In growing monkeys with long cartilage reconstruction, measurements of the glenoid cavities showed that the cavity was located in a slightly more posterior and medial position on the operated side compared with the unoperated side. In addition, there was virtually no difference between the sagittal or transverse position of the glenoid cavity on the operated side and the unoperated side in growing monkeys reconstructed with grafts using shorter cartilages and in all adult monkeys.[10] This is evidence of the cartilage's growth potential in separating tissues, causing midline dental deviation, and causing the glenoid cavity to be relocated farther back on the grafted side. With a larger amount of cartilage and therefore more germinative cells, the growth potential of the graft increases.[11,12] This increased growth has an effect on the articular surface of the costochondral graft because in all monkeys the articular head was larger on the grafted side, which agrees with the study by Perrott et al.[13]

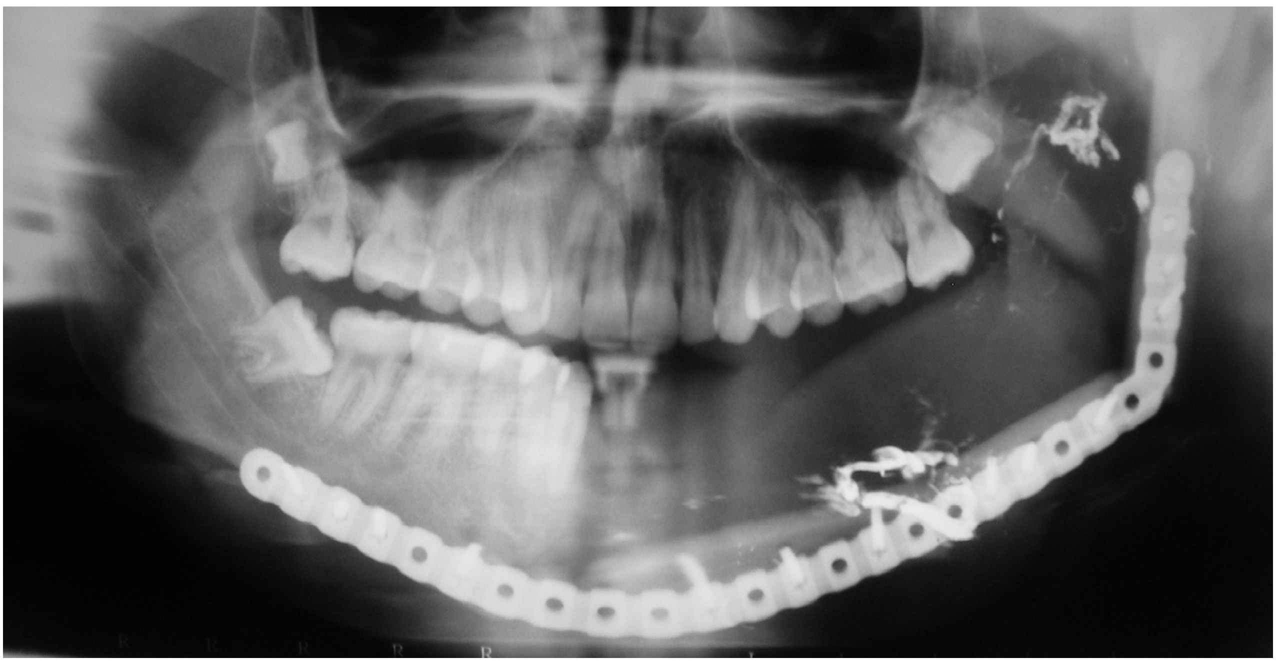

FIGURE 1. Panoramic radiograph 1 month after mandibular reconstruction.

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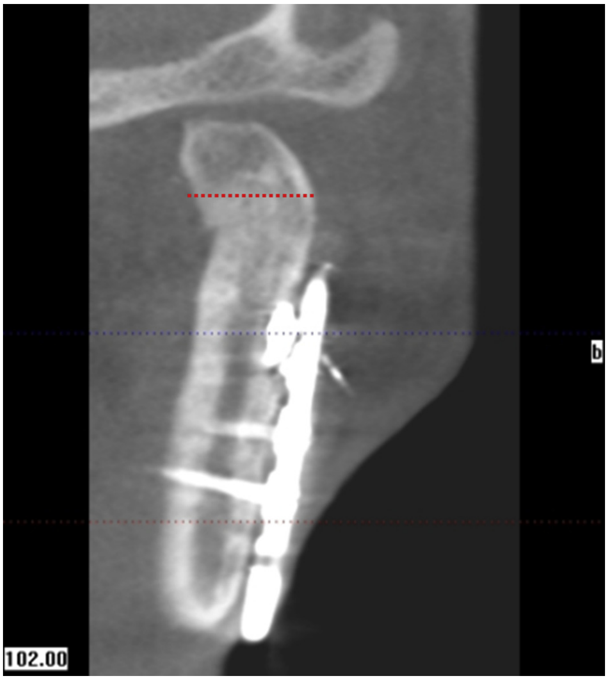

FIGURE 2. Cone-beam image of the condylar area of the fibular free flap at 1-year follow-up. The *red line* represents the area of the fibula that was resected.

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The present patient who underwent reconstruction with a free flap presented an initial lateral deviation caused by a graft that was longer than the resected mandible. This deviation did not increase over time. That is, there was no growth 1 year after grafting.

The appearance of the new condyle found in the graft is a comparable example of condylar regeneration, as has been reported in previous studies on monkeys,[6] which would explain the appearance of cartilaginous tissue on the fibula (which was transplanted without cartilage).

Growth hormone is the most important of the growth-promoting hormones and growth factors. According to the dual-effect theory,[14] germinative cells are target cells for the direct effect of the growth hormone, causing their differentiation and proliferation. The indirect effect causes an augmented response to insulin-like growth factor-I (IGF-I), which together with the local production of IGF-I, stimulates growth of the rib.[15] Although the costal cartilage synthesizes IGF-I throughout the entire length of the germinative zone, in the condylar cartilage only the thin layer of undifferentiated cells seems to produce IGF-I.[16] This difference suggests a difference in the hormonal control of the mandible's condylar cartilage and the costal

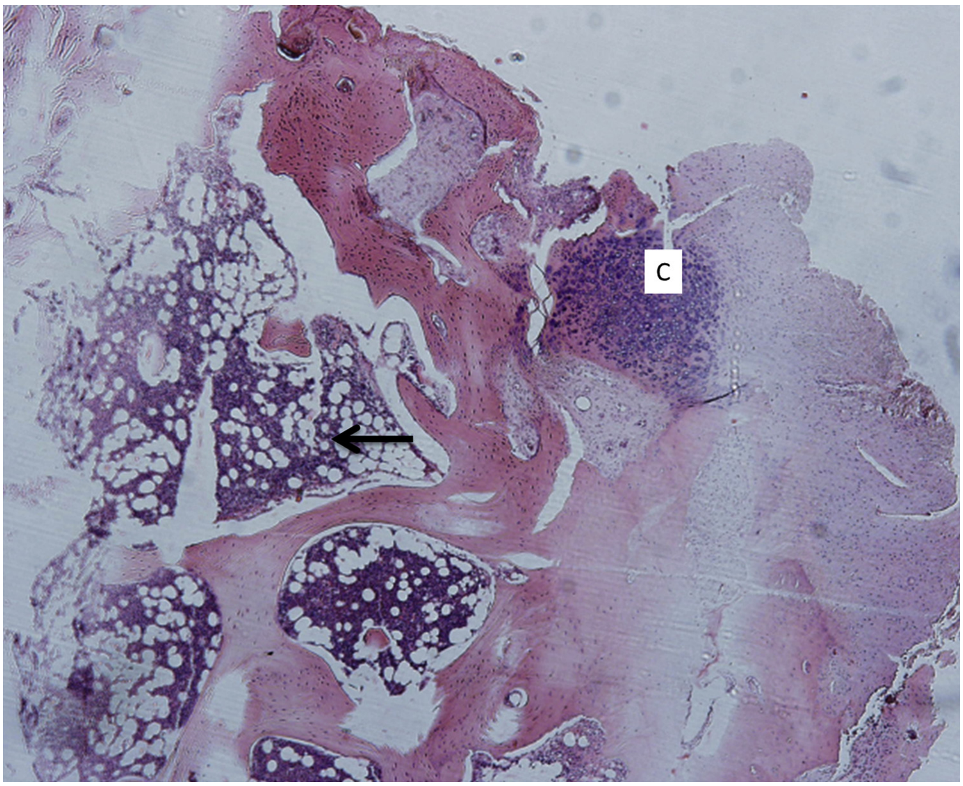

FIGURE 3. Low-power view of the fibula free flap, with bone marrow (*arrow*), trabecular lamellar bone, and cartilage (*c*) (hematoxylin and eosin stain; original magnification, ×4).

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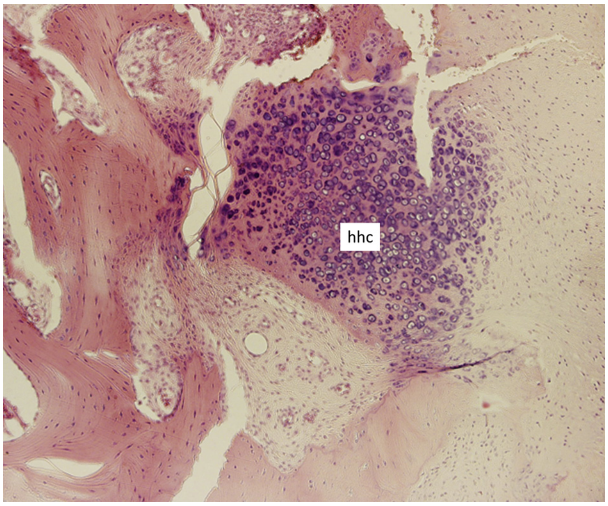

FIGURE 4. Lamellar cancellous bone tissue with normal aspect, osteocytes, and hyaline hypertrophic cartilage (*hhc*) covered with fibrocartilage (hematoxylin and eosin stain; original magnification, ×10).

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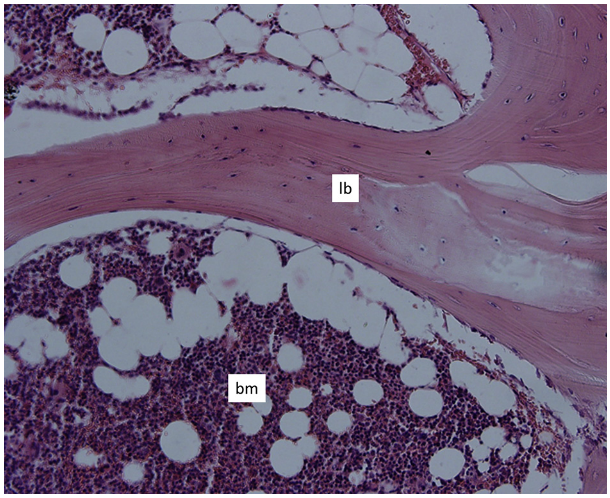

FIGURE 6. Lamellar bone (*lb*), with normal osteocytes and inactive flattened osteoblasts, and bone marrow (*bm*) (hematoxylin and eosin stain; original magnification, ×20).

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cartilage, thus making the problem of excess graft growth in children more comprehensible. The function and compression of the fibular graft, together with the IGF-I, could explain the production of fibrocartilage on the fibula after reconstructive surgery.

Obwegeser[17] treated patients with ankylosis of the TMJ using interpositional arthroplasty with lyophilized cartilage, which contains unviable cells. At follow-up, these patients showed normal growth patterns.[17]

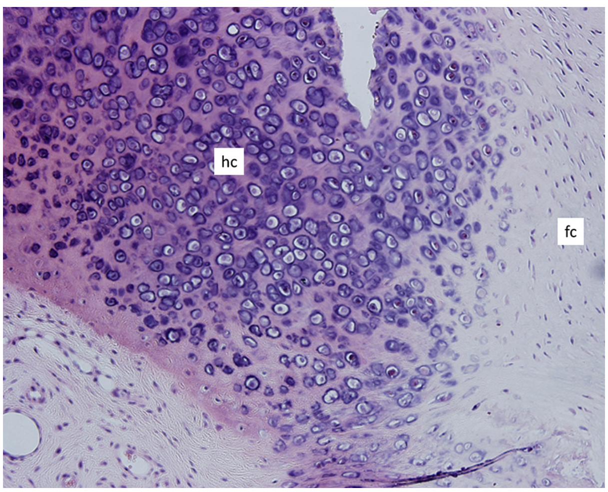

FIGURE 5. Hypertrophic cartilage (*hc*) and fibrocartilage (*fc*), with numerous normal chondrocytes (hematoxylin and eosin stain; original magnification, ×20).

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Based on the histologic discoveries of the present case, the synovial membrane probably closed the medullary canal, with bone apposition and synthesis of fibrocartilage on the surface bone of the articular area.

These discoveries raise doubts regarding the validity of using cartilaginous grafts to restore mandibular growth. Current evidence suggests that the condylar cartilage is a secondary cartilage, different from other growth cartilages in the skeleton, in structure and function. Phylogenic, morphologic, developmental, biochemical, histochemical, and biomechanical studies have shown that the growing mandibular condyle is highly adaptable and that it quickly responds to subtle changes in its biophysical environment.[17]

The authors propose the theory that many autologous bone grafts, including those without cartilage, could be adequate for replacing the mandibular condyle. Maintaining biomechanical architecture and function are apparently more important than the nature of the graft used, although more studies should be performed to support this theory.

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