

Spontaneous Bone Regeneration after Mandible Resection in a Case of Ameloblastoma – A Case Report

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Abstract

Introduction: A case of spontaneous bone regeneration after mandible resection is reported. **Case Report:** A 6-year-old boy suffered from ameloblastoma in his right mandible. Six months after haemimandibulectomy, a bone regeneration forming a new form of mandible is seen. **Histopathology:** Lamellar mature bone was observed. Resection of the large portion of the mandible as the choice of treatment as the tumor was grown extensively. Spontaneous bone regeneration after a mandible resection. **Conclusion:** Unexpected spontaneous bone regeneration may be explained by the fact that periosteum, as the source of osteogenic cells, might be responsible for this process.

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Key words: Jaw reconstruction, Lamellar bone, Periosteum, Spontaneous bone regeneration

Introduction

Ameloblastoma is a true neoplasm of enamel organ type tissue which does not undergo differentiation to the point of enamel organ.¹ This type of tumour occurs mostly in the mandible and grows slowly with variable clinical and histological characteristics, but it is histologically benign. Resection of the mandible is the choice of treatment due to the very high chance of recurrence if it is not treated adequately.^{1,2}

Resection of the mandible involving the condyle and anterior region in young patients will cause deformity and dysfunction. Immediate reconstruction of the resected mandible with a reconstruction plate and screws to rectify an aesthetic problem can be used as a temporary alternative treatment.

The healing event in post-mandible resection with spontaneous bone regeneration is an unexpected phenomenon that may take place in large mandibular defects secondary to tumour resection. A review of literature presents several factors that may influence this process. These include the development of new bone from periosteum³⁻⁶ which serve the direct source of osteogenic cells,⁷ from scattered devitalised bony particles which serve as osteoinductors for mesenchymal cells in surrounding soft tissue, from mandibular stumps which

also serve the direct source of osteogenic cells.⁸ It has been suggested that functional or mechanical stress on the stabilised stumps,⁹ immobilisation,⁶ and a young age may have an influence in this bony regeneration process.

Boyne,⁴ in a series of 6 cases of mandibular resection, noted consistent radiographic and clinical evidence of new bone formation within the empty titanium mesh tray that served as temporary reconstruction material. This new bone increased in height and thickness until approximately 9 months, at which time the regenerative growth of bone appeared to stabilise.

Spontaneous bone regeneration in a 6-year-old boy is reported herein and some explanations might support this phenomenon. The explanation of unusual healing events may be derived from the mechanism of fracture healing as described by McKibbin,¹⁰ in which the presence of periosteum is believed to be the primary source of osteogenic tissue, and a rapid widespread cellular activity that involves the surrounding soft tissues takes place in order to form a bridging external callus whose primary purpose is to maintain the stability of fragments in this bone regeneration process.

Recently, new antibodies which can identify cells undergoing osteogenic differentiation have become available.¹¹

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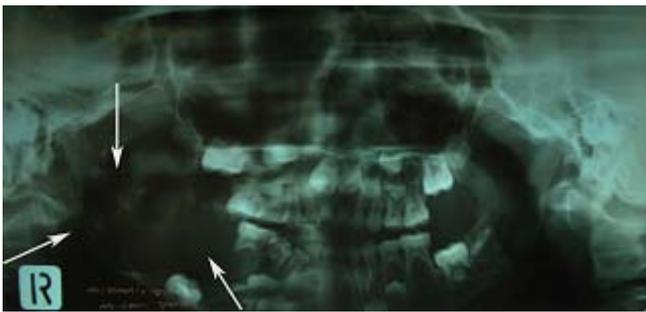


Fig. 1a. Radiograph of ameloblastoma in the right jaw of a 6-year-old patient showed the lesion extending from the canine area to the upper ramus.



Fig. 1b. Radiograph showed the radiopaque appearance about the reconstruction plate 6 months after surgery.

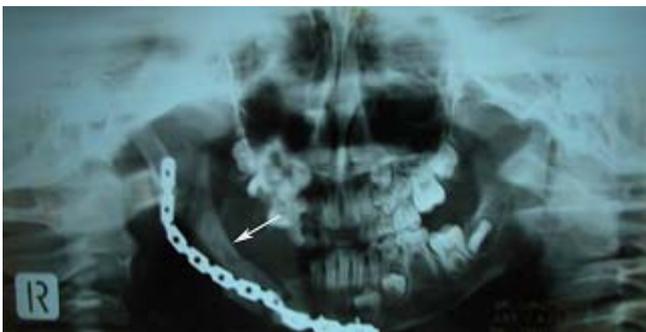


Fig. 2a. Radiograph of broken reconstruction plate in the resection site (arrow) showed radiopaque appearance.



Fig. 2b. Radiograph showed the presence of 3 holes, covered by bone, after surgery to remove the plate.

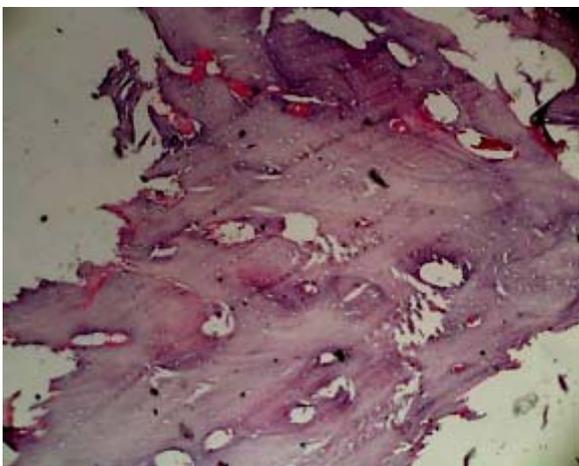


Fig. 3a. Biopsy of the ascending ramus of "new" mandibular bone showed haemorrhage in the Haversian canals (Haematoxylin-eosin stain, magnification x100).

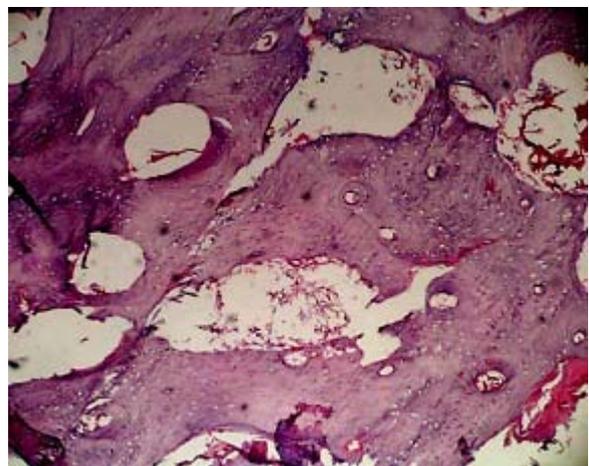


Fig. 3b. Biopsy of the body region of the "new" mandibular bone showed spongiosus marrow that is not clearly visible, due to processing artefact (Haematoxylin-eosin stain, magnification x100).

Case Report

A 6-year-old boy visited the Department of Oral and Maxillofacial Surgery, Dental Faculty of the Airlangga University in September 2001 because of swelling in his right mandible. Clinical examination revealed a painless firm swelling in the right canine extended to the area of the right ascending ramus involving the condyle and coronoid

process (Fig. 1a).

With a clinical diagnosis of ameloblastoma, a biopsy was performed and the result was established as ameloblastoma, i.e. plexyform type. Surgery was planned with two options of treatment as follows: a dredging method¹² or a mandible resection, dependent on the tumour extension, involving the mandible seen intraoperatively.

During the surgery, the tumour was inspected carefully and it had grown extensively. The cortical bones of the condyle and coronoid process were discoloured and appeared dark grey. A sub-periosteal mandible resection from the region of the right canine, including the right condyle and coronoid process, was done. A stainless steel plate with 3 titanium screws, immediately inserted to give a mandibular form, solved the aesthetic problem. The soft tissue was then placed back into position layer by layer and the periosteum sutured, forming an envelope following the form of the reconstruction plate.

Postoperatively, a routine clinical evaluation was done and a radiograph was taken 14 postoperative days and 6 months after surgery. The radiopaque appearance seen at 6 months after surgery showed bone regeneration forming a new mandible (Fig. 1b).

One year after surgery, further clinical evaluation continued and deformation of the face was seen. Another X-ray radiograph was taken and the newly formed mandible and condyle were clearly seen (Fig. 2a).

Surgery was done to remove the plate to facilitate the growth process of the right mandible. The reconstruction plate had been broken along the resection line and the 3-hole plate seen in the radiograph was totally covered by mature bone (Fig. 2b). To prevent the mandible from fracturing, the plate was temporarily held in place. Bone specimens were taken from 2 regions – the ascending ramus and the body of mandible – and histological examination revealed matured lamellar bone (Figs. 3a & 3b).

Discussion

Various surgical methods, both conservative and radical, could be used to manage ameloblastoma.^{1,2} Considering the success of the dredging method as published by Kawamura,¹² our surgery was planned with this method. Intraoperatively, we took into consideration the tumour's characteristics and its extension in the whole part of the right mandible and, in order to avoid the risk that the tumour might grow to involve the upper jaw, resection of the mandible was performed. Further treatment included planning for the resected mandible to be replaced with a homogenous bone mesh graft.

Observation during the 6 months after surgery was pleasantly surprising. New bone formation was seen resulting in a new form of right mandible. A possible explanation would be that the periosteum of the resected mandible, which was left intact and sutured in position, was responsible for this bone regeneration process.

Spontaneous bone regeneration, and several explanations after resection in a large portion of the mandible, have been proposed by some authors. These include the development

of new bone from intact periosteum.

Chalmer et al¹³ suggested that 3 conditions must be present for bone induction to occur: 1) an inducing agent; 2) an osteogenic precursor cell; and 3) an environment which is permissive to osteogenesis. De Villa et al¹⁴ proposed the necessity of immobilisation in aiding the regeneration process.

There are 3 cell types usually discussed in conjunction with osseous histology: osteoblasts, osteocytes and osteoclasts. Some uncertainty exists concerning the origin and developmental relationship of these cells. Classically, they are considered to undergo differentiation from a common pool of stem or osteoprogenitor cells located perivascularly in periosteum or endosteum. This model entails the division of a stem cell to yield 2 progenies, one of which remains as a pluripotent osteoprogenitor cell, while the other becomes an osteoblast or osteoclast.¹⁵

According to Roth and Calmes,¹⁵ the periosteum is composed of a dense sheath of fibrous connective tissue that invests bone with its outer aspect, with the exception of the articular surface. It consists of two layers, the outermost of which is composed of dense, fibrous connective tissue containing a variable number of blood vessels. The inner osteogenic layers are of somewhat looser consistency and collagen fibres that enter the osseous tissue as Sharpey's fibres and serve as an anchorage from the periosteum to the bone. The cell of the inner layer can play an important role in remodelling and resorption, and periosteum together with endosteum function as limiting membranes of bone, controlling the ingress and egress of ions.

The endosteum is a layer in the reticular connective tissue that lines the medullary cavity. Its pluripotent cells subserve both haematopoiesis and osteogenesis.¹⁵

Osteoblasts become differentiated from embryonic fibroblasts in the inner layer of the periosteum and bone is formed by the intramembranous method. Formation of new periosteal bone keeps pace with formation of new endochondral bone. The bony cortex increases in thickness and compactness as development of the bone proceeds.¹⁶ Van Rensburg¹⁷ found that the inner cellular layer of periosteum was, contained as a loose network of elastic fibres and osteogenic by means of osteoblasts, especially during the period of appositional growth.

Delvin and Sloan¹⁸ proposed that monoclonal antibodies [Runt-Related Transcription Factor 2 (Runx2), SB-10 and SB-20] which can identify cells undergoing osteogenic differentiation have become available. Immature osteocytes, which are proportional to endosteal osteoblasts, pre-osteoblasts present in the layer adjacent to the bone surface, and spindle-shaped osteoprogenitor cells can be expressed strongly by nuclear Runx2 staining. The osteoprogenitor,

pre-osteoblasts and osteoblast cells which are responsible for bone regeneration expressed on their surface antigens, reacted with SB10 and SB20 antibodies.

New antibodies, against Runx2 and activated leukocyte-cell adhesion molecule (ALCAM), that specifically identify mesenchymal stem cells undergoing osteogenic differentiation have become available. Runx2 regulates osteoblast function and differentiation, because it induces in non-osteoblastic cells the expression of osteoblastic-specific genes.¹⁹ Disruption of Runx2 activity in embryonic mice causes a complex lack of bone formation in the skull and mandible.²⁰ Runx2, a strong marker in osteogenic differentiation, is strongly expressed by osteoblasts. The presence of osteoprogenitor, pre-osteoblast and osteoblast cells which surround the trabeculae, was evident on the cell surface, as the antigen reacted with the SB10 and SB20 antibodies.

Osteogenic tissue may originate from the periosteum and bone marrow¹¹ or blood vessel-associated pericyte.^{21,22} Reynders et al²³ proposed in their experimental study that the periosteum was likely to be the source of osteoblasts in the process of bone defects. Einhorn²⁴ mentioned that the presence of committed and uncommitted mesenchymal cells in the periosteum contributes to the process of fracture healing by recapitulation of embryonic intramembranous and endochondral bone formation.

In this case of bone regeneration process after a mandible resection, the growth of new bone could be attributed to the periosteum.

Conclusion

Unexpected spontaneous bone regeneration may be explained by the mechanism of fracture healing or bone healing in an extraction socket. Although spontaneous bone regeneration is an unexpected phenomenon, with consideration to the presence of the intact periosteum as the source of osteogenic tissue, mandibular stabilisation, and the young age of our patient, spontaneous bone regeneration after mandible resection could be expected.

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