Physiological healing patterns: What clinicians need to know about tooth extractions

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After a tooth has been extracted, a series of processes are set in motion that ultimately results in the healing of the alveolus. As demonstrated in animal and human studies, intra-alveolar healing usually starts with the formation of a coagulum in the alveolus immediately after the tooth has been extracted. This clot is then progressively replaced by a provisional matrix, which functions as a scaffold for the woven bone that will form from the lateral walls and the bottom of the alveolus to fill the extraction socket eventually. Subsequent ly, the immature bone becomes mature alveolar bone.

In this time, intra-alveolar processes continue. Extra-alveolar healing occurs concomitantly and will result in vertical and horizontal resorption of the walls of the extraction sockets, a process that is more pronounced at the buccal than at the lingual aspects.5, 6

A recent systematic review on post-extraction alveolar dimensional changes in hard and soft tissue in humans7 reported a horizontal dimensional loss of 29 to 65 percent and a vertical dimensional loss of 11 to 22 percent six months after tooth extraction. Moreover, it reported that the reduction of alveolar crest dimensions was faster during the first six months of healing and continued after that. In a clinical study, the width of the alveolar crest at the buccal and lingual aspects was measured in edentulous sites and compared with the dentate contralateral sites in 49 cast models.8 A reduction of the alveolar crest of about 5.5 to 5.6 mm at the buccal aspect and 1.7 to 2.0 mm at the lingual aspect was observed. Another study found a total reduction of the width of the alveolar crest of about 50 percent after 5 months and of 50 percent after 12 months.9

When an implant is placed immediately into an extraction socket, the physiological healing patterns of the alveolus are different from those described above. In order to better understand these processes, it is important to mention two processes that have been proposed as explanations for osseointegration, namely distance and contact osteogenesis.10 While new bone is formed on the surfaces of the native bone in distance osteogenesis and the bone will come into contact with the implant surface as a result, new bone forms first on the implant surface in contact osteogenesis. An experiment was conducted on animals to test these processes11 by preparing cylindrical defects in the alveolar bone and implants (smaller in dimension than that of the alveolus and with a moderately rough surface) placed and stabilised by devices to guarantee their stability despite the absence of primary contacts with the native bone. After implant placement, gaps of 0.2 to 0.7 mm were obtained between the implant surface and the bony walls. After three months of healing, very little osteointegration was observed at the defect sites (0.5 to 3.5 per cent) compared with the control sites (46.1 per cent), in which implants were placed in full contact with the native bone (Fig. 1). Moreover, the defects were found to be filled with newly formed bone, which, however, did not reach the implant surface along its entire length. A space of 0.4 to 0.5 mm in width between the front of the new bone and the implant surface was observed, occupied by connective tissue that surrounded almost the entire body of the implant. Proper osseointegration may be difficult to achieve when there is no primary contact with the native bone.

In order to study this supposition, a series of experiments on animals were conducted.12, 13 Recipient implant sites of 10 mm in depth were prepared in the alveolar crest according to the usual protocol. The marginal 5 mm of the sites was subsequently widened with a drill so that a marginal gap of 5 mm in depth and 1.25 mm in width was obtained between the rough surface implant and the bony walls after implant placement. All of the experimental sites were covered with collagen membranes.

The fully submerged and histological outcomes were evaluated after one, two and four months. It was observed that the defects had filled with newly formed bone after one month (Fig. 2). However, the bone was separated from the implant surface by a 0.4 mm-wide layer of connective tissue, similar to that described in the previously mentioned study.13 Only in the apical 1.8 mm of the defects was new bone integrated on to the implant surface, leaving the coronal 3.2 mm occupied by connective tissue attached to the implant surface.

After two months, 1 mm more was gained coronally, leaving a remaining defect of 1.9 mm. After four months, bone healing was finally complete (Fig. 2). Similar patterns of healing have been described for implants placed immediately into extraction sockets,14, 15 demonstrating again that bone formation originated from the lateral bony walls, rapidly filling the defect. Osseointegration on the surface, however, started apically within the defect from the site of contact between the implant and the native bone, and took a longer time to complete (three to four months) compared with the physiological healing of an extraction socket (one month).

Another important factor to be considered is osteoconduction,16 which can be defined as the process during which bone grows on to a surface.16 It is a well established that moderately rough surfaces provide higher osteoconductivity and induce a higher degree of osseointegration compared with smooth surfaces.17 While this difference in osteoconductivity may have limited clinical significance, further attention should be paid to marginal gaps present at implant placement. In fact, clinical and experimental studies have demonstrated incomplete healing of marginal defects with implants with turned surfaces.18-20 This may be related to the lower osteoconductive potential and capacity of turned surfaces to maintain this property over time compared with rough surfaces. This may be relevant when implants with a turned surface are placed into extraction sockets or placed at the same surgical stage of sinus floor elevation, for example.