Pulpal and apical changes secondary to segmental osteotomy in the mandible – an experimental study

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SUMMARY. Posterior segmental osteotomies were performed on 7 dogs to investigate postoperative changes in the pulpal and periodontal tissue. Osteotomy cuts were made at various distances from the apices of roots. After 3 to 6 months, results were evaluated clinically, radiographically and histopathologically. Clinical and radiographic healing of the osteotomy sites was uneventful. Histological evaluation revealed that when the osteotomy cuts were made at a safe distance (3–5 mm) from the apices of roots, neither important pulpal degeneration nor loss of teeth occurred. Even two of the teeth whose apices were cut off had completely healthy pulpal and periapical tissues. The periodontium in almost all of the cases was also found to be healthy.

INTRODUCTION

In the treatment of dentofacial abnormalities, surgical intervention is being used to correct malrelations of teeth and bone and also to maintain good aesthetics. There are various modifications of these osteotomies, and mandibular segmental osteotomy is commonly used. Some complications such as ischaemia, non-union, infection and necrosis of the segment and teeth, sensory loss and necrosis of pulps may be expected as a result of these operations. Pulpal and apical changes in teeth which are close to the osteotomy line or damaged by the osteotomy cut, and their future viability, are still under discussion.

Pulpal response to various stimuli following segmental osteotomy had been reported first by Kole (1959) and Mohanac (1966) followed by Johnson and Hinds (1969), Leibold et al. (1971), Ware and Ashamalla (1971), Poswillo (1972), and Bell et al. (1975). Varying degrees of pulpal degeneration are reported following transient interruption of blood supply to the pulps and surrounding tissues during segmental osteotomy and the initial healing period (Poswillo, 1972; Banks, 1977; Sugg et al., 1981; Nanda et al., 1982).

There are some factors influencing the viability of teeth in the osteotomised segments. Conflicting results have been reported about the effect of the degree of segment mobilisation. Today, the safe distance of the osteotomy line from the apices of teeth is accepted to be 3 to 5 mm, but various complications may still occur and teeth may receive some damage (Peipersack, 1973; Bell et al., 1973; Kohn et al., 1974; Sugg et al., 1981; Vedelofte and Nattesstad, 1989). The status of the teeth cannot be accurately evaluated by clinical measurements. It is almost impossible to make a histological investigation on human teeth with routine methods. Therefore this subject should be further studied using animals.

In this study we aimed to make a histological evaluation of the pulpal status of teeth following mandibular segmental osteotomies in dogs.

MATERIALS AND METHODS

This study was performed using 7 healthy beagle dogs with a permanent dentition. The animals were anaesthetized with 50 mg/kg sodium pentothal. On each side of the mandibular premolar region, a few millimetres below the mucogingival junction, horizontal incisions were made. Mucoperiosteal flaps were elevated. In each exposed area, two vertical bone cuts in the interdental spaces of the target teeth were made using burs. Then horizontal cuts of the apices of roots (Fig. 1) were made at three different levels. In the first group, horizontal cuts were far from the apices (3–5 mm) of the roots. In the second group, the cuts just cut off the apices, and in the third they transected

Fig. 1 – Segmental osteotomy line in the posterior mandible during operation.
the lower thirds or halves of the roots. The bone segments were not mobilised and a few millimetres of bone were left at the top of the alveolar segments. The flaps were sutured with 3(0) atraumatic silk. Following the operation, all animals were given a 5-day course of antibiotic (Amoxicillin 1000 mg 2 × 1) and fed a soft diet. The animals were killed with pentothal overdose at the end of the third month after operation. Osteotomised bone segments were resected and fixed in 10% buffered formalin solution. They were demineralized in 10% formic acid solution. A total of 26 teeth were examined. Most of these teeth belonged to the second group. The specimens were embedded in paraffin, sectioned at 5 micron intervals in the vertical plane and stained with haematoxylin and eosin.

RESULTS

No infection or delayed wound healing occurred in the animals. The target teeth showed no colour change or mobility. Radiographic examination revealed complete bony union in all cases. Histological evaluation criteria included the pulpal changes, wound healing and the presence of inflammatory infiltrates. Histological results were evaluated in three groups:

1. Osteotomy line 3 to 5 mm remote from the apices (Fig. 2A).
2. Osteotomy line at the apices (Fig. 2B).
3. Osteotomy line at the lower third or half of the roots (Fig. 2C).

Six teeth were examined in the first group. Histologically, pulpal tissues were within normal limits except slight congestion and minimal homogenisation of pulpal connective tissue in one tooth (Fig. 3). In two, there were inflammatory cells at the osteotomy site but no detectable changes in the dental tissues. Periodontal tissues and the adjacent tissues were normal.

Seventeen teeth were examined in the second group where the osteotomy lines were at the apices of the roots. Seven of the teeth showed PMN leukocytic infiltration in the pulpal tissues. The odontoblast layer was totally lost (Fig. 4). In the periapical tissues,
granulation tissue formation and resorptive activity were observed. Two teeth showed coagulation necrosis in the pulp and total loss of the odontoblast layer (Fig. 5). In 5 teeth whose apices were partially or totally cut-off, the roots were closed with osteocement (Fig. 6). There was homogenisation and fibrosis in the pulps and minimal loss of the odontoblast layer (Fig. 7). Periodontal tissues and alveolar bone were normal in all cases.

Three teeth were examined in the third group, where the osteotomy lines passed through the lower thirds or halves of the roots. Epithelial proliferation and granulation tissue were seen in and around the osteotomy line in all the teeth (Fig. 8). Pulpal tissues were heavily infiltrated by purulent exudate. There were marked resorptive changes in dentine, cement and alveolar bone.

**DISCUSSION**

Many clinical and experimental studies have been carried out to study the effects of various osteotomy techniques on dental tissues and their postoperative complications. Since there is a scarcity of histological information obtained from patients, it should be demonstrated by experimental studies and throw light on the similar problems in humans.

In this study we have seen different outcomes depending on the level of the osteotomy cuts. In the first group, where osteotomy lines were 3 to 5 mm from the apices of the roots, the pulp, periapical and periodontal tissues of all teeth were almost normal, as might be expected. In the second group half of the teeth that were cut-off apically showed varying degrees of pulpal and periapical inflammation, resorptive changes, pulp fibrosis and coagulation or liquefaction necrosis. The interesting findings in this group were the 5 teeth with healthy pulpal tissues whose apices were closed with osteodentine. All 3 teeth belonging to the third group showed pulpal tissues heavily infiltrated by purulent exudate. There are some conflicting results concerning the effects of segment mobilisation on the viability of teeth. It has been suggested that the degree of pulpal degeneration differs according to the degree of mobilisation of the segment (Poswilho, 1972). On the other hand, many investigators have reported that regardless of the segment mobilisation, the teeth remained unaffected by the osteotomy as long as the roots were not damaged by the surgical cut (Bell, 1969; Ware and Ashamala, 1971; Bell and Darn, 1973; Banks, 1977; Holland and Robinson, 1986; Di, 1988). Clinical evaluation of the pulpal status of teeth in the osteotomised segment may give unreliable results (Bell, 1969; Johnson and Hinds, 1969; Tajima, 1975; Banks, 1977). There are conflicting reports of clinical and histological studies. Although it is possible to obtain more accurate findings by histological evaluation, performing such an investigation on humans is not possible. The dogs used in experimental studies may have more efficient bone healing than that in the human, but they are good models for this type of study due to the relative ease and reproducibility of surgical manipulation. Therefore, this property should be taken into account when the histological findings obtained from dogs are being compared with human results.

Various experimental and clinical studies with segmental osteotomies have shown that pulpal cir-
culation can be preserved when the osteotomy cuts were at a safe distance (3 to 5 mm) from the apices of the roots (Pepersack, 1973; Bell et al., 1975; Burk et al., 1977; Sugg et al., 1981; Vedtofte and Nattestad, 1989). There were no degenerative changes in vital pulps except for a temporary disappearance of sensory nerves. Teeth which were devitalised were usually the ones that were transected apically or that were very close to the surgical cut (Pepersack, 1973; Bell et al., 1975; Burk et al., 1977; Sugg et al., 1981; Vedtofte and Nattestad, 1989). Some apically transected teeth have also been reported to have completely healthy periapical tissues and maintain their vitality (Kent and Hinds, 1971; Hutchinson and Macgregor, 1972; Bell and Dann, 1973; Browne et al., 1980). These teeth also showed repair of roots with osteodentine and ankylosis formation just like the ones in our study. Contrary, some investigators have reported that segmental osteotomies were highly dangerous for pulp vitality (Poswill, 1972; Banks, 1977). After mobilising the segments experimentally they concluded that even when the roots were not damaged, pulpal damage, progressive pulpal fibrosis and calcification were detected in all the teeth.

Periodontal tissues have been damaged minimally even in cases which showed progressive changes (Kent and Hinds, 1971; Bell and Dann, 1973; Theisen and Guernsey, 1976; Nanda et al., 1982; Kwon et al., 1985; Quejada et al., 1986). This was the same in all our cases except the third group.

It is concluded that with an adequate and meticulous technique, if osteotomy cuts are made at a safe distance (3–5 mm) from the apices of the roots, neither significant pulpal degeneration nor loss of teeth would be anticipated. The results obtained here may also be applied to teeth included in bone fractures and root fractures.

Fig. 8 – (A) Epithelial proliferation and granulation tissue formation around the osteotomy line in the third group (HE, ×25). (B) High power appearance of the inset shows root, dentine and circumscribing squamous epithelium (HE, ×200).

References

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