CORTICOTOMY-FACILITATED ORTHODONTICS

A thesis submitted in partial fulfillment of the requirements for the degree of

Doctor of Clinical Dentistry

by

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3. SIGNED STATEMENT

I certify that this work contains no material which has been accepted for the award of any other degree or diploma in my name, in any university or other tertiary institution and, to the best of my knowledge and belief, contains no material previously published or written by another person, except where due reference has been made in the text. In addition, I certify that no part of this work will, in the future, be used in a submission in my name, for any other degree or diploma in any university or other tertiary institution without the prior approval of the University of Adelaide and where applicable, any partner institution responsible for the joint-award of this degree.

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Berna Kim

4. SUMMARY

The duration of orthodontic treatment is an important determinant of patient satisfaction, and the demand for shorter-duration treatment options appears to be increasing. Prolonged orthodontic treatment can become an obstacle to certain social interactions – especially in adults. From a biological point of view, disadvantages of prolonged treatment time include white spot lesions and root resorption. Therefore there has recently been a renewed interest in investigating options to reduce orthodontic treatment time.

Corticotomy-facilitated orthodontic tooth movement (OTM) has been reported to reduce treatment time by two thirds, and involves surgical intervention to the cortical bone. The insult to the bone induces the regional acceleratory phenomenon whereby OTM is increased via up-regulation of bone remodelling and transient osteopenia. Contrary to popular belief, the method dates back to 1959 and results are well documented with one author in 1991 publishing the outcome of 395 treated cases. Nevertheless, despite its long standing history in the study of orthodontics, the method has still not been widely adopted by orthodontists.

The reasons behind this lack of adoption were examined in the first study "Accelerating orthodontic tooth movement with the aid of periodontal surgery – what the practitioners are thinking". Two separate questionnaires were developed for specialist periodontists and orthodontists. For the periodontists, a survey questionnaire was handed out by the primary investigator at the Australian and New Zealand Academy of Periodontists' 16th scientific conference, which was held in Hobart, Australia, from 6-9th of March 2013. For the orthodontists, a survey questionnaire was handed out by the principal investigator at the Australian Society of Orthodontists' Foundation Meeting which was held in Canberra Australia from 15-17th of March 2013.

The results showed that a majority of orthodontists and periodontists believe more research is required on the topic of corticotomy-facilitated orthodontic tooth movement before they would be willing to recommend it to patients. More than half of the orthodontists would never recommend corticotomy-facilitated orthodontics to their patients, while the minority who would recommend the procedure would limit it to adult patients, ankylosed teeth, impacted canines and patients susceptible to root resorption. Over 90% of periodontists believe that there are side effects associated with the corticotomy procedure. Finally, the proportion of practitioners who have undertaken at least one case per annum was quite low,

with few orthodontists (11.5%) and periodontists (18.2%) reporting experience with the procedure.

Despite the perceived lack of research on the topic by the professional community, numerous studies have already attempted to validate the biological mechanism behind corticotomy-facilitated OTM. For example utilising radiographic, tomographic, molecular biology techniques along with histology, studies have investigated the possible mechanism behind corticotomy-facilitated OTM using the rat. Incapable of demonstrating the dynamic remodelling of the bone in the region pertaining to the corticotomy, the methods described above only quantify the static effects of the corticotomy surgery. Furthermore, these studies use a mesially-directed force to the upper first molar; this may be applicable to the closing of an extraction space, but the direction of this force does not represent the clinical scenario of expansion-based, non-extraction treatment plans.

For these reasons, the second study in this thesis titled "Dynamic response of the alveolar bone to corticotomy-facilitated orthodontic tooth movement" aimed to augment the research evidence on the mechanism by which corticotomy accelerates OTM. Using double fluorescent bone labelling to quantify the mineral apposition rate, the changes that take place in bone over a period of time – rather than at a specific time-point – add another dimension to the understanding of corticotomy-facilitated OTM.

To conduct this analysis, thirty-six male Sprague Dawley rats were obtained from Laboratory Animal Services (University of Adelaide), and for comparison a control group without any intervention was included. A bone label, calcein was administered three days prior to appliance insertion and a second label, alizarin red, was administered five days after appliance placement. The rats were randomly assigned to one of six groups:

Group	Appliance	Surgery
1	No	No
2	No	Flap
3	No	Corticotomy
4	Yes	No
5	Yes	Flap
6	Yes	Corticotomy

For the groups undergoing orthodontic tooth movement, buccally directed force (100g) was delivered to the maxillary right first molar. The activated appliance remained *in situ* for seven days. The animals were sacrificed at the end of the observation period, and the maxilla was dissected and embedded in polymethylmethacrylate. Coronal sections of 5μm thickness were then chosen to study the effects of corticotomy along the length of the root of the first molar tooth in the buccal aspect. Histomorphometric analysis of the mineral apposition rate (MAR) was performed by selecting five random slides.

There was a statistically significant difference in mean average values between the six groups ($p < 0.0001$). From the six groups tested, the OTM+corticotomy group had the highest MAR. This was followed by OTM only, OTM+flap, corticotomy only, flap only and control. The MAR for the OTM+corticotomy group was approximately 1.19 times higher than for the OTM-only group and 2.37 times higher than the control group. When the groups were compared to each other, there was no significant difference in the MAR of OTM and OTM+flap.

Based on these results it is concluded that when no OTM is involved, there is a trend towards increasing MAR accompanying both the raising of a mucoperiosteal flap and a corticotomy procedure. In contrast when OTM is involved, raising a flap does not significantly increase the MAR beyond the levels of OTM; therefore, it is concluded that injury to the cortical bone is essential to increase MAR, and thus the rate of OTM. OTM itself increases MAR and it is postulated that this is a result of micro-damage to the alveolar bone in the vicinity of the tooth undergoing OTM.