Short Communication

Effect of longstanding jiggling on experimental marginal periodontitis in the beagle dog

INGVAR ERICSSON AND JAN LINDHE

Department of Periodontology, Faculty of Odontology, University of Gothenburg, Gothenburg, Sweden

Abstract. The aim of the present experiment was to study the effect of a prolonged period of jiggling force application on the rate of progression of ligature-induced, plaque-associated marginal periodontitis in the beagle dog.

The experiment was performed on eight dogs fed a diet which permitted dental plaque accumulation. On Day 0 a phase of periodontal tissue breakdown was initiated around the mandibular fourth premolars (4P, P3) by the placing of plaque retention ligatures around the neck of the teeth. The ligatures were exchanged once a month throughout the entire study. On Day 60 trauma from occlusion of the jiggling type was produced in the P3 region and maintained for 300 days. The animals were sacrificed on Day 360. Following sacrifice tissue sections comprising M, 4P, 3P and P3, P4, M1 were produced and subjected to microscopic analysis.

The experiment revealed that in the dog jiggling forces applied to teeth which are also subjected to ligature-induced and plaque-associated marginal periodontitis, may enhance the rate of destruction of the periodontium.

During the last decade a number of animal experiments have been performed in attempts to evaluate the influence of trauma from occlusion on the initiation and progression of plaque-associated periodontal disease (for review see Svanberg 1974, Ericsson 1978). Svanberg & Lindhe (1973) described a model by means of which it was possible to study the influence of jiggling forces on the periodontium around mandibular premolars in the beagle dog. They reported that jiggling trauma was characterized by a series of transient alterations of the periodontium, such as increased vascularity and increased vascular permeability, alveolar bone resorption and a gradual widening of the periodontal ligament. In dogs with normal gingiva or overt gingivitis the jiggling forces did not establish conditions which favoured an apical shift of the dento- gingival epithelium along the root surfaces. When similar jiggling forces were applied to teeth also subjected to experimentally-induced marginal periodontitis (Swenson 1947, Ericsson et al. 1975), however, the resulting tissue alterations seemed to enhance the rate of destruction of the supporting apparatus (Lindhe & Svanberg 1974).

In a series of investigations Polson and coworkers (for review see Polson 1980) used the squirrel monkey as an experimental animal to study the effect of “repetitive mechanical trauma” on the periodontium around maxillary and mandibular second and third bicuspids. In monkeys with overt gingivitis this type of jiggling trauma caused bone resorption and
angular widening of the periodontal ligament but no alteration of the supra-alveolar connective tissue attachment. When “repetitive mechanical trauma” during a 10-week period was combined with experimental marginal periodontitis (Kennedy & Polson 1973) further loss of connective tissue attachment, beyond that caused by the plaque-associated lesion, did not occur (Meitner 1975).

The reason for the difference regarding the effect of jiggling trauma on experimental marginal periodontitis in the studies by Lindhe & Svanberg (1974) and Meitner (1975) can only be speculated upon. However, the authors used different animal models (dogs vs monkeys), different techniques to produce marginal periodontitis and also different methods to induce and maintain jiggling trauma. Thus, in the dog experiments, the traumatic forces were elicited on the experimental teeth each time the animals occluded and disoccluded, while in the monkey study the traumatic forces were installed and reversed only once every second day. It is likely, too, that in the dog studies the forces used were of greater magnitude and had a greater intrusive component than in the monkey experiments. It should also be realized that while the beagle dog experiments were performed during a 6-month period, the study on the squirrel monkey was terminated already after 10 weeks of “repetitive mechanical injury”.

The aim of the present experiment was to study the effect of a prolonged period of jiggling force application on the rate of progression of ligature-induced, plaque-associated marginal periodontitis in the beagle dog.

Material and Methods
Eight inbred beagle dogs were used. At the start of the experiment the animals were 10–12 months old and had been inoculated against distemper, canine hepatitis and Parvo virus enteritis. A clinical examination revealed that the gingiva in the lower premolar region of all dogs was slightly inflamed but also that the supporting apparatus in this part of the dentition had a normal height (Figs. 1A, 2A, 3A).

![Fig. 1. Radiographs of test teeth obtained on Day 0 (A) and on Day 360 (B, C). Note the variation in depth of the angular bony defect on Day 360 in Fig. B (Dog 2) and in Fig. C (Dog 6).](image-url)
Throughout the entire period of observation the animals were fed a diet which allowed gross plaque accumulation (Hamp et al. 1972).

On experimental Day 0 cotton floss ligatures were placed around the neck of the mandibular fourth premolars (4P and P4) in the manner previously described by Ericsson et al. (1975) and Lindhe & Ericsson (1978). Due to a gradual disintegration of the cotton floss material the ligatures were exchanged and replaced on the retracting gingival margin once a month throughout the entire study. On Day 60 a cap splint was cemented to the canine and the premolars in the left (test) side of the maxilla. The cap splint was designed with an oblique plane (Svanberg & Lindhe 1973) which made "primary" contact with the left lower premolar (P4). Following the installation of the cap splint, the incisors did not reach contact in occlusion. This means that when the mandible was moved towards centric occlusion, P4 became subjected to an excessive force and tilted in a mesio-buccal direction. A lingual bar was fitted to the canine and the first molar of the left mandibular jaw. A spring (hard wire: \( \Theta = 0.6 \text{ mm} \), Remanium\textsuperscript{®}, Dentaurum Ltd.) was attached to the lingual bar and introduced through a channel prepared in a buccal-lingual direction – in the crown of P4. Each time the animal disoccluded the spring pulled P4 back to its original position.

The experiment was continued until Day 360 when the animals were sacrificed by an overdose of Pentothal sodium. Specimens containing the distal portion of the third premolar, the fourth premolar and the mesial portion of the first molar (M, 4P, 4P and P3, P4, M1, respectively) were harvested, fixed in formalin, decalcified in formic acid and embedded in paraffin. Mesio-distal sections were cut with the microtome set at 6 \( \mu \text{m} \) and stained in hematoxyline-eosin. From each biopsy five sections, 18 \( \mu \text{m} \) apart, were used for determining the following linear distances on the mesial surface of the mesial root of 4P and P4:

1. Cemento-enamel junction (CEJ) - the most apical cells of the pocket epithelium (JE).
2. CEJ - the apex of the root.

Loss of connective tissue attachment was also expressed as the quotient CEJ-JE/CEJ-apex. In addition, the presence of infrabony pockets was recorded.

Fig. 2. Radiographs of a control tooth (Dog 6) obtained on Day 0 (A) and on Day 360 (B). Note that in the control tooth region there were no signs of angular bony defects on Day 360 (B).

Röntgenaufnahmen eines Kontrollzahnes (Hund 6) vom Tage 0 (A) und vom Tage 360 (B). Beachten Sie, dass am Tage 360 (B) in der Region der Kontrollzähne keine Zeichen angulärer Knochendefekte vorliegen.

Radiographies d’une dent témoin (Chien 6) obtenues au Jour 0 (A) et au Jour 360 (B). Noter que dans la région dentaire contrôle de la dent, il n’y a pas de signe de lésions osseuses angulaires au Jour 360 (B).
Fig. 3. Clinical photographs illustrating the periodontium of the buccal aspect of the lower fourth premolars of Dog 6 on Day 0 (Fig. A-P) and on Day 360 (Fig. B-P, Fig. C-P).


Photographies cliniques montrant en vue vestibulaire le parodonte des quatre prémolaires inférieures du Chien 6 aux Jours 0 (Fig. A-P) et 360 (Fig. B-P, Fig. C-P).

Differences between test and control teeth regarding the histometric parameters were analyzed using Student’s paired t-test.

Results
Following the installation of the cotton floss ligatures large amounts of plaque and calculus started to form on the lower fourth premolars. On Day 60 as well as on Day 360 the gingiva around the test and control teeth was red and bled on gentle probing (Figs. 3B,C). The installation of the cap splint and bar devices on Day 60 within a few weeks resulted in a marked increase of the mobility of the test teeth. Towards the end of the experiment the lower right fourth premolars of all eight dogs were mobile not only in a mesio-distal and bucco-lingual direction but in an apical-coronal direction as well. The control teeth showed no signs of increased mobility.

The roentgenograms obtained on Day 360 revealed the presence of angular bony defects on the mesial aspect of six out of eight test teeth (Fig. 1C) while no such defects were observed in the control teeth regions (Fig. 2B). In two dogs, the destruction of the alveolar bone had reached the level of apex (Fig. 1B) of the mesial root of the test teeth.

The average distance between the cemento-enamel junction and the most apical cells of the pocket epithelium (CEJ-JE) was 6235 μm ± 1065 (s.d.) in the test teeth and 4680 μm ± 125 (s.d.) in the controls. This difference is statistically significant (\( P<0.01 \)). The attachment loss expressed as the quotient:

\[
\frac{\text{CEJ-JE}}{\text{CEJ-Apex}} \times 100 \%
\]

was 62.6% ± 9.4 (s.d.) in the test teeth and 45.1% ± 2.8 (s.d.) in the controls. Also this difference is statistically significant (\( P<0.01 \)).

In six out of eight test teeth examined, the presence of infrabony pockets could be identified both in the radiographs and in the tissue sections (Figs. 1B,1C,4,5). In the remaining two
Fig. 4. A photomicrograph of a lesion of a test tooth (Dog 2) which extends beyond apex. Note the presence of plaque and calculus in the apical portions of the mesial root (X 15).

Mikrofotografie der Läsion eines Testzahnes (Hund 2), die sich über den Apex hinaus erstreckt. Beachten Sie das Vorkommen von Plaque und Zahnstein an den apikalen Abschnitten der mesialen Wurzel (X 15).

Photomicrographie d'une lésion d'une dent d'expérimentation (Chien 2) s'étendant au-delà de l'apex. Noter la présence de plaque et de tartre dans les parties apicales de la racine mérale (X 15).

test teeth and in all control teeth only suprabony pockets could be identified (Figs. 2B,6).

Discussion

The results of the present investigation demonstrated that jiggling forces applied to teeth which are also subjected to ligature-induced and plaque-associated marginal periodontitis may enhance the rate of destruction of the periodontium. Thus, in six of the eight dogs examined the amount of attachment loss observed after 360 days of experiment was more pronounced in the test than in the control teeth regions. In addition, in two of the test teeth the destruction of the attachment apparatus had reached the periapical area and wide marginal-apical pockets had formed (Figs. 1B, 4). The attachment loss observed in the control teeth regions during 360 days of experiment amounted to 45.1% (±2.8) of the length of the premolar roots. This value is comparable to that reported from a similar study (Lindhe & Ericsson 1978) in which ligature placement and plaque accumulation during a 360-day period resulted in an attachment loss of 46.1%. The results of the present study, therefore, seem to confirm and extend observations previously reported by Lindhe & Svanberg (1974) and Nyman et al. (1978), by showing that in certain situations jiggling forces may act as a "co-destructive factor" for marginal periodontitis. In variance with findings reported by Meitner (1975) and Nyman et al. (1978) in the present study the "co-destructive factor" effect was
that the magnitude of the jiggling forces produced by the dogs in this study was much greater than that of forces elicited by trauma from occlusion in humans. Nonetheless, the findings reported here demonstrate that jiggling forces may under certain conditions, act as a "co-destructive factor" and enhance the role of breakdown of a periodontium which is also subjected to plaque-associated periodontal disease.

Fig. 6. A photomicrograph illustrating a suprabony pocket formation in the control tooth region of Dog 3 (×15).

Mikrofotografie, die eine supraossäse Taschenbildung der Kontrollzahnregion des Hundes 3 (×15) zeigt.

Photomicrographie illustrant la formation d'une poche supra-osseuse dans la région dentaire de contrôle du Chien 3 (×15).

always associated with the presence of infrabony pockets and angular bony defects. Thus, in the two dogs of this experiment in which jiggling resulted in suprabony pocket formation only, the attachment loss was almost similar in the test and control teeth regions.

The interpretation of the results from the present experiment in beagle dogs must be made with caution and no immediate conclusions regarding the effect of trauma from occlusion in the human dentition should be allowed. A careful examination of the radiographs obtained from the lower premolars towards the end of the observation period revealed that the test teeth but not the controls had become somewhat intruded into the jaw. This finding together with the observation on the markedly increased mobility of the test teeth may indicate

Zusammenfassung

Der Effekt lang andauernder Auslenkungsbewegungen (jiggling) auf experimentell erzeugte marginale Parodontitis

Mit der vorliegenden experimentellen Untersuchung wurde beabsichtigt, bei Beagelhunden die Folgen längerer Zeit applizierter buko-lingualer Auslenkungsbewegungen (jiggling) auf den Verlauf von, durch Ligaturen erzeugter, plaqueinduzierter marginaler Parodontitis zu studieren.


Das Experiment zeigte, dass beim Hunde parodontal-gewebliche Auflösung beschleunigt werden kann, wenn bei marginaler, durch Ligaturen erzeugter, plaqueinduzierter Parodontitis an Zähnen Kräfte angebracht werden, die Auslenkungen (jiggling) hervorrufen.

Résumé

Effet d'une force de va-et-vient de longue durée sur la parodontite marginale expérimentale chez le chien briquet

Le but de la présente expérimentation était d'étudier l'effet de l'exercice prolongé d'une force de va-et-vient sur la progression d'une parodontite marginale due à la plaque dentaire retenue par des ligatures, chez le chien briquet.
L'expérimentation a été faite chez huit chiens ayant suivi un régime permettant l'accumulation de plaque dentaire. Au Jour 0, une phase de destruction de tissu parodontal a été entreprise autour des quatre pré-molaires mandibulaires (4P; P4) en plaçant des ligatures destinées à retenir la plaque autour du collet des dents. Les ligatures ont été changées chaque mois durant cette étude. Au jour 60, un traumatisme occlusal de type va-et-vient a été provoqué dans la région P4 et maintenu pendant 300 jours. Les animaux ont été sacrifiés au jour 360. Après le sacrifice, des coupes de tissu comprenant M, 4P, 3P et P3, P4, M1, ont été effectuées et analysées au microscope.

L'expérience a révélé que chez le chien, des forces de va-et-vient exercées sur des dents atteintes de parodontite marginale due à la plaque retenue par des ligatures peuvent augmenter le taux de destruction du parodonte.

References


Address:
Ingvar Ericsson
Department of Periodontology
Faculty of Odontology
Box 33070
S-400 33 Gothenburg
Sweden
This document is a scanned copy of a printed document. No warranty is given about the accuracy of the copy. Users should refer to the original published version of the material.