Lack of effect of trauma from occlusion on the recurrence of experimental periodontitis

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Abstract. The experiments were performed in 15 dogs fed a diet which allowed dental plaque accumulation. A phase of experimental periodontal breakdown was initiated on day 0. After 210 days five dogs were sacrificed. In the remaining 10 dogs the periodontal pockets around the fourth lower premolars (P4 and P4) were eliminated. During surgery a notch was prepared in the root at the level of the marginal termination of the alveolar bone in order to facilitate measurements in histological sections. From day 210 to day 450 the teeth of the animals were brushed twice daily. After 60 days of healing, i.e. on day 270, five of the dogs were sacrificed. Trauma from occlusion of the jiggling type was on day 270 produced in the P4 region of the remaining dogs by the installation of a cap splint and a bar device. The final five dogs were sacrificed on day 450. Following sacrifice, tissue sections comprising P3, P4, M and P3, P4, M were produced and subjected to microscopic analysis.

The experiments revealed that, in the dog, forces produced by occlusal trauma are unable to induce a phase of progressive destruction of the periodontal tissues in tooth regions where the supporting tissues are markedly reduced but non-inflammatory.

Experiments in dogs reported by Saxe et al. (1967), Svanberg et al. (1973) and Lindhe et al. (1973, 1975) have demonstrated that, in the presence of dental plaque and calculus, a longstanding gingivitis in most instances develops into a progressive and destructive periodontitis. These observations demonstrate the central role played by the microbial plaque in the etiology of periodontitis and corroborate data from epidemiological studies and assessments made in human autopsy material.

It has been claimed (Glickman 1963, 1967) that trauma from occlusion is an important co-factor in the pathogenesis of marginal periodontitis. According to Glickman, trauma from occlusion alters the pattern and rate of tissue breakdown in plaque-induced periodontal disease. In a review paper from 1967, Glickman concluded “Animal and human studies have led to the concept that trauma from occlusion is an integral part of the disease periodontitis rather than an unrelated disease entity. Such a trauma from occlusion is an etiologic factor in the formation of infrabony pockets and angular or crater-like osseous defects”. This concept, however, has not been unanimously accepted (for review see Svanberg 1974, Meitner 1975a).

Animal studies by Wentz et al. (1958), Glickman & Smulow (1968), Svanberg &
Lindhe (1973, 1974) and Kantor et al. (1976) have revealed that experimentally produced trauma from occlusion (jiggling) may induce (1) increased tooth mobility (2) angular resorption of the marginal alveolar bone and (3) increased width of the periodontal ligament. In animals with normal gingiva or overt gingivitis, jiggling forces neither induce loss of connective tissue attachment nor result in the formation of periodontal pockets. In dogs suffering from a rapidly progressing periodontitis, however, traumatic forces result not only in very pronounced tooth hypermobility but also in the production of angular osseous defects, infrabony pockets and an enhanced rate of periodontal tissue breakdown (Lindhe & Svanberg 1974). This influence of jiggling forces and hypermobile teeth on the progression of periodontitis was recently studied also in squirrel monkeys by Meitner (1975b). He reported that jiggling forces caused an increase in the apical downgrowth of the dentogingival epithelium in only one area out of four studied. Based on this finding he discarded the co-factor theory of Glickman.

Treatment of periodontitis must involve the elimination of plaque and retention factors for plaque, as well as the establishment of an anatomy in the dentogingival region which facilitates proper tooth cleaning (Suomi et al. 1971, Ramfjord et al. 1973, Lindhe & Nyman 1975). Therefore, the essential question remains, what effect trauma from occlusion may have once the plaque-induced lesion has been eliminated. This problem was in part recently studied in dogs by Lindhe & Ericsson (1976). A process of breakdown of the periodontal tissues was first initiated using a method originally described by Swenson (1947). After 180 days of plaque accumulation, a jiggling-type occlusal trauma was also introduced. Periodontitis was treated 100 days later by surgical pocket elimination, scaling and plaque control, but trauma from occlusion was allowed to persist. The analysis of tissue sections obtained 90 days following elimination of periodontal pockets demonstrated that the jiggling forces did not detrimentally affect healing.

The aim of the present experiment was to assess the effect of jiggling produced by occlusal forces on markedly reduced but non-inflammatory periodontal tissues.

Material and Methods

Fifteen beagle dogs were used. During a preparatory period of several weeks the animals were subjected to a careful plaque control program. Hence, once a week their teeth were scaled and twice daily brushed with toothbrush and dentifrice. At the start of the study all dogs had clinically healthy gingiva and normal height of the periodontal tissues.

Experimental Procedure

On day 0 (Fig. 1) a phase of experimental periodontitis was initiated in all dogs. The method originally described by Swenson (1947) and modified by Lindhe & Svanberg (1974) was utilized. In the regions of the fourth lower premolars ($P_4$) mucoperiosteal flaps were raised. About 1 mm of the marginal alveolar bone around these teeth was removed using a bur. To prevent reattachment and to enhance plaque formation, copper bands extending down to the surgically established bone level were punched close to the teeth. The plaque control regimen was terminated and the dogs placed on a diet which allowed the accumulation of plaque. Twenty-one days later the copper bands were removed and substituted by cotton floss ligatures which were placed at the level of the cemento-enamel junction (CEJ). 210 days after the installation of the copper bands (Fig. 1), the animals had accumulated abundant amounts of plaque.
TRAUMATIC OCCLUSION AND RECURRENT PERIODONTITIS

Fig. 1. Outline of the experiment. A phase of periodontal breakdown was induced on day 0, the dogs accumulated plaque between day 0 and day 210 by ligation placements on \( P \) and \( P_4 \). Pathologically deepened pockets were eliminated on day 210 in the \( P \) and \( P_4 \) regions. A jiggling type occlusal trauma was induced on \( P_4 \) (test) on day 270. The experiments were terminated on day 450.

Plan de l'expérience. Une phase de destruction parodontale a été déterminée au jour 0 : après pose de ligatures sur \( P \) et \( P_4 \), la plaque s'est accumulée chez les chiens entre le jour 0 et le jour 210. Les culs-de-sac de profondeur pathologique ont été éliminés au jour 210 dans les régions \( P \) et \( P_4 \). Un traumatisme occlusal de type "va-et-vient" (jiggling) a été introduit au niveau de \( P_4 \) (test) au jour 270. Les expériences se terminaient au jour 450.

and exhibited very pronounced signs of periodontal inflammation and breakdown. Five dogs were sacrificed at this stage.

In the remaining 10 dogs the experimentally induced periodontal inflammation was subjected to treatment. Thus, the periodontal pockets around \( P \) and \( P_4 \) were eliminated by an apically repositioned flap procedure (Friedman 1962). Scaling was performed and a notch prepared in the roots of \( P \) and \( P_4 \) at the level of the marginal termination of the alveolar bone. The dogs were then again placed on a careful plaque control regimen including toothbrushing twice daily. Particular care was taken to clean the bifurcation area of \( P \) and \( P_4 \).

On Day 270 (Fig. 1), i.e. 60 days after the surgical pocket elimination, five dogs were sacrificed. In the remaining five dogs, trauma from occlusion of the jiggling type was introduced on the test side by the installation of a cap splint and a bar device in the manner described by Svanberg & Lindhe (1973). Hence, on the left side of the maxilla each animal was supplied with a cap splint fitted with an oblique plane which made primary contact with the lower left fourth premolar (\( P_4 \)). Following installation of the cap splint the incisors did not reach contact in centric occlusion. On the left side of the mandible the canine and the first molar were fitted with crowns which were connected with a lingual bar. A spring was attached to the bar and was also introduced through a channel in the crown of \( P_4 \). When the animal disclused, the spring pulled \( P_4 \) back to its original position. In order to obtain similar conditions on both sides of the jaws, the right lower jaw (control side) was supplied with a similar bar and spring device. No force, however, was produced by the spring on \( P \). Six months after the installation of the cap splint and bar device, i.e. day 450 (Fig. 1), the remaining five dogs were sacrificed.

Clinical Assessments

On day 0, 210, 270 and 450 (Fig. 1) the dogs were subjected to the following clinical examinations:

Tooth mobility. T500-values for \( P \) and \( P_4 \) were assessed in accordance with the method described by Mühlemann (1954).
Attachment level. On the mesial aspect of $P$ and $P_4$, the distance was measured between an amalgam mark made in the crown of each tooth and the bottom of the mesial periodontal pocket (Lindhe et al. 1973).

Alveolar bone level. Standardized radiographs were obtained of the marginal alveolar bone in the $P$ and $P_4$ regions in accordance with a modification of a method described by Eggen (1969) and Lindhe et al. (1973). The radiographs were developed in a standardized way and placed in a Diavisor® (Esselte, Sweden) which produces a magnified ($\times 10$) image of the radiograph on a glass screen. The outline of the marginal alveolar bone, the contours, as well as particular landmarks on the premolars were reproduced on a transparent paper. Using the tracings representing day 0 as a guide, the radiographs obtained on days 210, 270 and 450 were placed in a Diavisor and the outlines of the "new" marginal alveolar bone levels were traced on the same paper. This method of assessing bone level alterations was recently described in detail by Rosling et al. (1976a).

In the reproductions of the radiographs the following distances were measured:

1. CEJ – the apex of the mesial root
2. CEJ – the coronal level of the marginal alveolar bone.

The measurements were confined to the mesial parts of $P$ and $P_4$; the bone level alterations were expressed as percentage reduction in relation to the length of the mesial root.

Histological Assessments

Following sacrifice, the mandibles were dissected and divided along the midline. Specimens containing the distal portion of the third premolar, the fourth premolar and the mesial portion of the first molar were harvested, fixed in formalin, decalcified in formic acid, dehydrated and embedded in paraffin. Mesio-distal sections were cut with the microtome set at 4 $\mu$m apart. The sections were stained with hematoxylin and eosin. From each biopsy five sections, 20 $\mu$m apart, were selected. They were magnified ($\times 98.4$) in a microscope (Leitz, Orthoplan®) and their images depicted on white paper. The size of the mesial periodontal ligament area (PLA) of $P$ and $P_4$ was determined by the use of a planimeter (9527-12 Ingut polar compensating planimeter, Ingut Ltd, Sweden) in the manner.

![Diagram](image-url)

**Fig. 2.** Schematic drawing illustrating the various linear distances which were measured in the histological sections. CEJ = cemento-enamel junction. JE = most apical cells of the junctional epithelium.

Diese schematisch skizzierte Aufstellung verdeutlicht die varierenden linearen Abstände in den histologisch untersuchten Sektionen. CEJ = Schmelz-Zementgrenze. JE, die am weitesten apikal gelegenen Zellen des Grenzepithels.

Représentation schématique illustrant les différentes distances linéaires qui ont été mesurées sur les coupes histologiques. CEJ = jonction cément-émail. JE = cellules les plus apicales de l'attache ment épithelial.
described by Svanberg & Lindhe (1973). The vascular cross-section area (VCA) within the PLA was also assessed planimetrically.

In the sections the linear distances between (1) CEJ and the most apical cells of JE (2) CEJ and apex of the mesial root, (Fig. 2) were assessed. Loss of connective tissue attachment was expressed as the quotient \( \frac{(1)}{(2)} \times 100 \% \).

**Results**

On day 0 the gingiva of the dogs was either clinically healthy or exhibited minute signs of inflammation. Radiographs revealed that the marginal alveolar bone level was located around 1 mm from the cemento-enamel junction. Fig. 3A presents the clinical appearance of the test and control side of one of the dogs (No. 2) as well as the radiographs (3B) from the same tooth regions on day 0. Following 210 days without active tooth cleaning, the animals had accumulated abundant amounts of plaque and calculus and the periodontal tissues exhibited signs of pronounced periodontal inflammation and breakdown. Fig. 4 illustrates in a clinical (4A) and radiographical (4B) picture the condition of the periodontal tissues of dog No. 2 on day 210. Note that about 40 % of the alveolar bone around \( \text{P}_1 \) and \( \text{P}_4 \) is lost.

On day 270, i.e. 60 days after surgical pocket elimination, debridement and the initiation of a careful plaque control program, the gingivae of the remaining 10 dogs were again non-inflammatory. The gingival margin, however, was located around 4-5 mm apical to the cemento-enamel junction and the fusions were open. Figs. 5A and B demonstrate the conditions around \( \text{P}_4 \) and \( \text{P}_4 \) of dog No. 2 on day 270.

Figs. 6A and B illustrate the clinical and radiographical appearance of the \( \text{P}_4 \) and \( \text{P}_4 \) regions at the end of the experiment, i.e. after 180 days of jiggling. The gingivae of the remaining five dogs were clinically healthy but the gingival margins were located several mm apical to the cemento-gingival junction. All five \( \text{P}_4 \) teeth were extremely mobile, not only in a mesio-distal and buccal-lingual direction but also in a vertical direction.

The marginal termination of the alveolar bone around the non-jiggled control teeth (\( \text{P}_1 \)) was even (Fig. 6A, C) and distinctly outlined. In the test tooth regions (T) angular bony defects were noted in relation to the marginal portion of both the mesial and distal roots. Radiolucencies were also detectable around the apices of the jiggled teeth.

**Tooth Mobility (Fig. 7)**

On day 0 the average T-500 values of the test and control teeth were 7.9 (mm/100) (s. d. 2.4) and 7.2 (s. d. 1.6) respectively. On day 210 the mobility values had increased from 7.9 to 17.4 (test) and from 7.2 to 12.8 (control). After 60 days of healing and careful plaque control, i.e. on day 270, T-500 values of around 10-15 remained. The installation of the cap splints and the bar devices resulted in an extremely increased mobility of the test teeth but not of the control teeth. T-500 values calculated from measurements on day 450 were 65.9 (test) and 11.2 (control).

**Clinical Attachment Level (Fig. 8)**

During the phase of experimental periodontal breakdown, i.e. day 0 to 210, both the test and control teeth suffered a significant loss of clinical attachment. Thus, the average increase of the distance from the amalgam mark to the bottom of the pocket on the mesial aspect of the test and control teeth was 4.5 mm (s. d. 1.4) and 4.8 mm (s. d. 1.2) respectively. The pocket elimination and the institution of the tooth clean-
ing program on day 210 resulted, during the following 60 days, in a slight gain of attachment (around 1 mm) in both the test and control tooth regions. The introduction of jiggling forces on the test teeth on day 270 did not, during the following 180 days, result in a significant alteration of the attachment level.

**Alveolar Bone Level (Fig. 9)**

After 210 days of experimental periodontitis the reduction of the level of the supporting alveolar bone in relation to the root length of \( P_4 \) and \( P_3 \) was around 40–45%. On day 270, i.e., after 60 days of healing, there was in comparison to the day 210-values some bone regained. Thus, the marginal termination of the bone was located at a more coronal level than on day 210. On day 450 bone loss was significantly \((P < 0.01)\) larger in the test than in the control teeth. This was the result of the

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**Fig. 3.** Clinic (A) and radiographic (B) appearance of the test (T) and control (C) tooth regions of dog No. 2 at the start of the experiment (day 0, Fig. 1).

Klinisches (A) und radiographisches (B) Bild der Region der Zähne \( P_4 \) (Testzahn, T) und \( P_4 \) (Kontrollzahn, C) des Hundes Nr. 2 beim Versuchsbeginn (Tag 0, Fig. 1).

Aspect clinique (A) et radiographique (B) des régions dentaires expérimentales (test = T) et des régions témoins (control = C) chez le chien no 2 au début de l'expérience (jour 0; fig. 1).

**Fig. 4.** Clinic (A) and radiographic (B) appearance of the \( P_4 \) (test, T) and \( P_4 \) (control, C) regions after 210 days of experiment. Dog No. 2.

Klinisches (A) und radiographisches (B) Bild der Region der Zähne \( P_4 \) (Testzahn, T) und \( P_4 \) (Kontrollzahn, C) nach 210 Versuchstagen. Hund Nr. 2.

Aspect clinique (A) et radiographique (B) des régions \( P_4 \) (test = T) et \( P_4 \) (control = C) au bout de 210 jours d'expérience. Chien no 2.

**Fig. 5.** 60 days after surgical pocket elimination and meticulous plaque control the gingivae of the test (T) and control (C) regions of dog No. 2 are clinically healthy (A). The alveolar bone level is located 4–5 mm apical of CEJ.

60 Tage nach der chirurgischen Taschenentfernung und peinlich genauer Plaquekontrolle ist die Gingiva sowohl der Versuchs- (T) als auch der Kontrollregion (C) des Hundes Nr. 2 klinisch gesund (A). Das alveolare Knocheniveau befindet sich 4–5 mm apikal vom Messpunkt CEJ.

60 jours après l'élimination chirurgicale des culs-de-sac et grâce au contrôle méunitieux de la plaque, les gencives des régions expérimentales (test = T) et témoins (control = C) du chien no 2 sont saines à l'examen clinique (A). Le niveau de l'os alvéolaire est situé à 4–5 mm de CEJ en direction apicale.

**Fig. 6.** At the termination of the experiment (day 450) the gingivae of the \( P_4 \) (T) and \( P_4 \) (C) regions are still clinically normal (Fig. 6A). In the radiographs (Fig. 6B) it can be seen that the marginal termination of the non-jigged tooth (C) is distinctly outlined. In the \( P_4 \) region (T) angular bony defects (arrow) can be detected in relation to the marginal portion of both the mesial and distal roots.

Beia Versuchsende (Tag 450) ist die Gingiva in den Regionen der Zähne \( P_4 \) (T) und \( P_4 \) (C) immer noch klinisch normal (Fig. 6A). Die Röntgenaufnahmen (Fig. 6B) zeigen, dass die marginalen Grenzen der Zähne ohne okklusale Traumata vom Wackeltyp (C) sich deutlich abzeichnen. In den Regionen des \( P_4 \) (T) werden winkelförmige Knochendefekte (Pfeil) gesehen, deren Lage von den marginalen Abschnitten der mesialen und distalen Wurzeln abhängig ist.

À la fin de l'expérience (jour 450), les gencives des régions de \( P_4 \) (T) et \( P_4 \) (C) sont encore saines à l'examen clinique (fig. 6A). Sur les radiographies (fig. 6B) on peut voir que la limite marginale au niveau de la dent n'ayant pas subi de va-et-vient a un contour net. Dans la région de \( P_4 \) (T), des lésions osseuses angulaires (voir flèche) sont visibles au niveau de la portion marginale des racines mésiale et distale.
production of angular bony defects around the roots of the test teeth.

**Connective Tissue Attachment (Fig. 10)**
After 210 days of experimental periodontitis the loss of connective tissue attachment was 31.9% (s. d. 2.3) in the test tooth and 33.1% (s. d. 3.1) in the control tooth region. This degree of attachment loss persisted throughout the 450 days of observation. In sections obtained from the five dogs, which were used throughout the entire 450-day period, the attachment loss was around 35%. There was no difference in the degree of attachment loss between the test and control teeth on day 450 (test 33.9%, s. d. 3.9; control 39.0%, s. d. 5.8).

**Periodontal Ligament Area (Fig. 11)**
The periodontal ligament area (PLA) and the vascular cross section area (VCA) within PLA were assessed on days 210, 270 and 450. The PLA and VCA values of the test and control teeth increased from around 300 (PLA) and 50 (VCA) on day 210 to around 500 (PLA) and 80 (VCA) on day 270. At the termination of the experiments, i.e. on day 450, the average PLA value of the test teeth (879.5) was more than twice as large as the corresponding value of the control teeth (361.3). The VCA values exhibited almost the same relation between the test and control teeth (111.4 and 51.2).

**Discussion**
The present experiments have demonstrated that in the dog, trauma from jiggling forces are unable to initiate a phase of progressive destruction of the periodontal tissues in tooth regions where the supporting tissues are markedly reduced but not-inflammato-
from the present experiments are compared with the findings by Lindhe & Svanberg (1974), it becomes obvious that the determining factor in the initiation, progression and recurrence of periodontitis is the microbial plaque present in the gingival pockets.

In all the dogs used in this study, a phase of rapid breakdown of the periodontal tissues was induced on day 0 by (1) surgically producing a pocket around the lower fourth premolars (2) preventing reattachment and (3) allowing microorganisms to accumulate in the surgically created pockets. This treatment resulted in the development of an inflammatory reaction in the periodontal tissues of P and P, which not only encom-

![Diagram 9](image-url)

Fig. 9. Diagrammatic presentation of the alterations of the bone level of the test and control teeth. The bone level alterations have been expressed as percentage bone loss in relation to the length of the mesial root (mean ± standard deviation).

![Diagram 10](image-url)

Fig. 10. Diagrammatic presentation of the average loss of connective tissue attachment (% of root length) on the mesial aspect of test and control teeth. The attachment loss was measured in sections sampled on days 210, 270 and 450 (mean ± standard deviation).

tory. This finding corroborates and extends data from animal experiments presented by Wentz et al. (1958), Glickman & Smulow (1968) and Svanberg & Lindhe (1973) by demonstrating that, in the absence of a plaque-induced progressive lesion within the periodontal tissues, trauma from occlusion may induce tooth hypermobility and angular bone resorption but not cause chronic gingivitis, apical shift of the dentogingival epithelium or infrabony pockets. In dogs with an ongoing destructive periodontitis Lindhe & Svanberg (1974) used the same model for the production of jiggling forces as the one utilized in this study. They reported that trauma from occlusion seemed to accelerate the rate of progression of the plaque-induced lesion. If the data
mere ligature placement will not cause breakdown of the supporting tissues in the absence of microorganisms (Rovin et al. 1966), the ligature in this kind of experiment probably operates as a plaque collector and provides in addition to retention perhaps also particular living conditions for plaque-forming bacteria (Schroeder & Lindhe 1975).

Elimination of the periodontal pockets, calculus and plaque and institution of a careful plaque control program from day 210 and onwards resulted in a resolution of the lesion. Thus, on day 270 the gingiva displayed no clinical or histological signs of inflammation. The marginal termination of the alveolar bone was smooth and distinct and no signs of an ongoing bone resorption could be detected in the histological sections. The fact that elimination of plaque and calculus and establishment of a proper plaque control program resulted in periodontal health has earlier been described by Lindhe et al. (1973) in dogs and by Suomi et al. (1971), Ramfjord et al. (1973, 1975) and Lindhe & Nyman (1975) in humans.

During surgery on day 210 a notch was prepared at the level of the marginal border of the alveolar bone. In all sections from the five dogs sacrificed on day 270 the apical cells of the junctional epithelium were found to be located within the notch. Furthermore, the marginal border of the alveolar bone was also located at the notch level. This means that the surgical treatment neither resulted in further resorption of the alveolar bone nor in loss of connective tissue attachment. This is at variance with data presented by Donnenfeldt & Glickman (1964), Pfeifer (1965) and Donnenfeldt et al. (1970). Rosling et al. (1976b) presented data from a clinical study which indicated that the surgical treatment of the periodontal tissues inevitably caused some resorption of alveolar bone. The reason
why in the present study loss of periodontal tissue support did not occur following surgery is unknown, but may probably be attributed to the very careful plaque control program which was initiated immediately following surgery.

When on day 270 the cap splint and bar device were installed, the periodontal tissues around the fourth lower premolars in all five remaining dogs were non-inflammatory but markedly reduced in height. The jiggling forces rapidly produced a pronounced increase of the mobility of the test teeth. The mobility of the control teeth remained unchanged. In addition the test teeth were somewhat intruded. After 180 days of jiggling (day 450) the average T-500 value of the test teeth was 65.9. The mobility increase from day 270 to day 450 was 55.0 mm/100. This increase is almost identical to the one reported by Lindhe & Svanberg (1974) from similar experiments in beagle dogs suffering from progressive periodontitis.

Although the marginal periodontal space of the jiggled teeth markedly increased in size (PLA Fig. 11) the traumatic forces failed to establish conditions which promoted connective tissue detachment and apical shift of the dentogingival epithelium.

The jiggling forces not only produced angular defects in the marginal alveolar bone but also obvious radiolucencies around the apices of the test teeth. Such periapical bone resorptions were also observed by Lindhe & Svanberg (1974). They suggested that the periapical alteration should "be regarded as adaption of the tissue to the increased functional requirements".

Zusammenfassung

Der Mangel an Bedeutung des Traumas durch die Okklusion für die experimentelle Parodontitis


Die Versuche zeigten, dass Kräfte die bei Hunden durch okklusales Trauma hervorgerufen werden, nicht instande sind den Ablauf fortschreitender Destruktion parodontaler Gewebe in solchen bezeichneten Abschnitten einzu­leiten, in denen die Stüggewebe weitgehend reduziert, jedoch nicht entzündlich verändert sind.

Résumé

Absence d'action des traumatismes occlusaux sur la récidive des parodontopathies

Cette étude expérimentale a été effectuée sur 15 chiens recevant un régime permettant l'accumulation de la plaque. Une phase de destruction expérimentale du parodonte a été commencée au jour 0. Au bout de 210 jours, cinq chiens ont été sacrifiés. Chez les 10 chiens restants, les culs-de-sac existant autour des quatrièmes prémolaires inférieures (P$_4$ et P$_3$) ont été éliminés par intervention chirurgicale. Pendant l'intervention, une rainure a été préparée dans la racine au niveau de la limite marginale de l'alvéole pour faciliter les mensurations sur les coupes histologiques. Du jour 210 au jour 450, les dents des animaux ont été brossées deux fois par jour. Après 60 jours de guérison, c'est-à-dire au jour 270, cinq des chiens ont été sacrifiés. Un traumatisme occlusal de type "va-et-vient" (jiggling) a été produit au jour 270 au niveau de la région P$_2$ des chiens restants, en plaçant une attelle de recouvrement et un dispositif relié à une
References


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