Histological Observations of the Mandibular Canal Perforated by Self Tapping Implants in Canines

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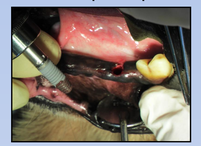
Introduction:

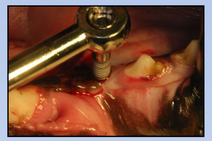
There are many reports of sensory disturbances caused by injury to the mandibular canal during implant placement. This study aims to investigate the histological alterations of the inferior alveolar neurovascular bundle by self-tapping implants in dogs over a 3-month period.

Methods:

Six postmenopausal female beagles were used. Three months before implant placement, four premolars were extracted.

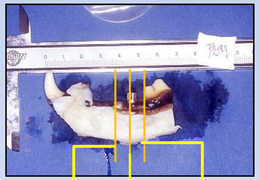


First, the initial implant bed (4mm width, 8mm depth) was prepared using a mechanical hand-piece drill.



Then, a rough surface titanium implant (4.2mm width, 10mm length) was placed by self-propelling motion using a ratchet.

The placement depth was determined by the resistance felt from the implant tip contacting the inferior cortical bone of the mandible.



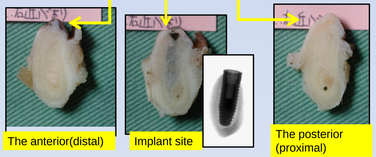
The dogs were euthanized immediately at the initial placement, at 2 weeks and 3 months.

Light microscopic observations were carried out using HE-stained specimens at three sites:

1- the directly perforated area (Implant site),

2- the distal site (in relation to the nerve injury) located anterior to the perforated area,

3- the proximal site (in relation to the nerve) posterior to the implant.

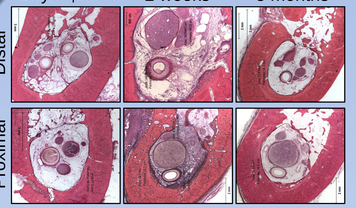


Mandibular Canal: After placement, the implant occupied the majority of the medullar cavity surrounded by the cortex.

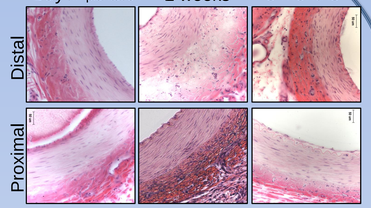
The arteries and nerve bundles were completely compressed by the implants and the cortical bones in all cases.

Results:

Mandibular Canal

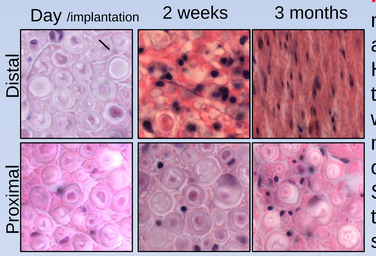


Arteries



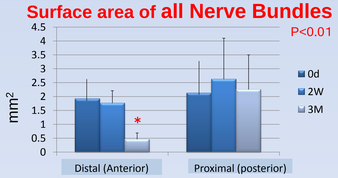
Arteries: Since the day of implantation to 3 months, there was no significant morphological alteration seen in the basic structure of the arteries at both the distal and proximal sites. However, at the day of implant placement, enlargement of vessels and thrombosis were seen in some arteries located at the proximal site.

Nerve Bundle

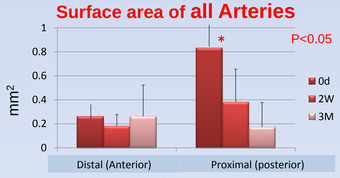


Nerve Bundles: In the nerve bundle no significant alterations were observed at the day of implantation in both sites. However, in the distal site of the nerve, the axon degeneration was slight at 2 weeks and became prominent at 3 months. Furthermore, the degeneration of myelin sheath and the increase of Schwann cells were observed (figure). In the proximal site, the degeneration was similar but not as severe.

Surface area of all Nerve Bundles

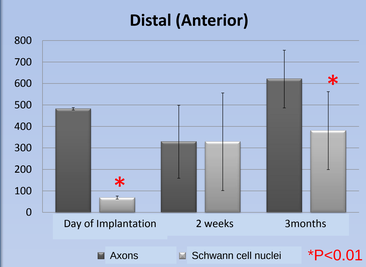


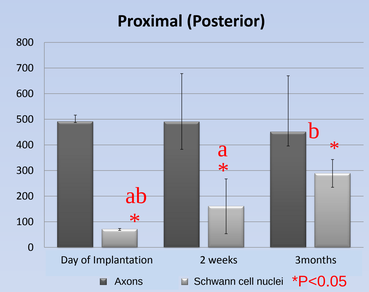
Surface area of all Arteries



Surface area of arteries and nerve bundles: The size of the nerve bundle at the distal site did not change until 2 weeks, and decreased rapidly at 3 months. The size of the nerve bundles at the proximal site did not significantly change at all time points. The size of the arteries at the distal site remained the same at 0day, 2 weeks, and 3 months. The artery size at the proximal site greatly enlarged at the day of implantation.

Number of Axons and Schwann cell nuclei





Number of axons: There were no significant differences between the number of axon fibers when comparing the distal and proximal site, at the day of implantation, 2 weeks, and 3 months after implantation.

Number of Schwann cell nuclei: At 2 weeks the increase of Schwann cells can be observed in the proximal site (*P<0.05). After 3 months this increase was significantly different at both the proximal and distal sites(*P<0.05 and *P<0.01, respectively).

Discussion:

After the implant placement, the arteries and vessels were compressed between the implant and the cortical bone. Anastomosis from branches of the facial and lingual arteries may have supplied the blood flow to the distal site of the injury, preventing degeneration in this area.

The difference of necrotized and alive axons cannot be clearly determined by HE-staining, therefore, both types of axons were counted. Consequently, a difference in the number of axons was not seen at the proximal and distal site and at any time points (graph). On the other hand, Schwann cells has been known to have phagocytotic activity to remove cellular debris. So the increase in Schwann cells can be linked to degeneralized neurons.

At the distal site at 2 weeks, the number of Schwann cells rapidly increased so it can be stated that degeneration of axons increased also. However, at the proximal site, the number of Schwann cells gradually increased, and at 3 months and reached the similar level to that of the distal site.

Conclusion:

1-The self-tapping implant placement did not sever the inferior alveolar neurovascular bundle, it was crushed in the cortical bone in all cases.

2-After implant placement, the arteries were compressed between the implant and the cortical bone, leading to a temporary stop in the blood flow. However, the fundamental morphology of the vascular system was not altered in all cases.

3- Nerve alteration was observed both in the proximal and distal site after 2 weeks. The nerve damage was more prominent and earlier at the distal site when compared with the proximal site.