Surgical Procedure

The animals were pre-anesthetized with acepromazine, 0.2% - 1.5 mg / kg ten minutes before being given butorphanol (0.2 mg / kg) and medetomidine (7µg/kg). The mixture was injected intramuscularly into the quadriceps femoris. The animals were taken to the operating room, an intravenous catheter (22 or 20 G) was inserted into the cephalic vein, and Propofol was injected at the rate of 0.4 mg / kg / min. Local infiltrative anesthesia was applied at the surgical sites. These procedures were supervised by a veterinary doctor.

Mandibular premolars were extracted (p2, p3, and p4) as well as a molar (M1) from both half-arches. The teeth were sectioned at the furcation in the lingual-vestibular direction using a tungsten carbide drill to extract the roots individually using a syndesmotome, elevator and forceps, while attempting to keep the bony walls intact.

After appropriate alveolar debridement, implant sites were prepared in the distal alveoli following the manufacturer's recommended protocol to a depth of 10 mm, to achieve insertion of the implant leveled with the bone crest.

Eight implants were inserted randomly into each dog. Implants were made of Grade 23 titanium (Ti-6Al-4V ELI alloy), and all had a similar surface treatment (sandblasting + acid etching). Group A: 16 LANCE Implants (MIS® Implant Technologies Ltd., Bar Lev Industrial Park, Israel), with external hexagonal connection; group B, 16 SEVEN® Implants (MIS® Implant Technologies Ltd., Bar Lev Industrial Park, Israel), with internal hexagon; group C 16 C1 Implants (MIS® Implants Technologies Ltd., Bar Lev Industrial Park, Israel), with internal conical connection. (Fig.1)

The implants were positioned as centered as possible relative to the vestibular and lingual bone walls. All implants were inserted with a minimum torque of 35 Ncm, fitted with healing abutments torqued to 20 Ncm, and neither regeneration procedure nor bio-material were applied. (Fig.2 and Fig.3)

During the first week following surgery the animals received antibiotics and pain killers: amoxicillin (500 mg, twice a day) and 600 mg ibuprofen (three times a day), via systemic route. The sutures were removed after two weeks and the dogs were fed a soft diet for 14 days. Plaque control was achieved by cleaning the oral cavity with chlorhexidine gluconate.

Histological preparation and histomorphometric analysis

The six dogs were euthanized 12 weeks after implants insertion with an overdose of Sodium Pentothal (Abbot Laboratories), and perfused via the carotid arteries with a fixer containing a mixture of 5% glutaraldehyde and 4% formaldehyde. The jaws were dissected and each implant site extracted using a diamond saw (EXAKT Apparatebau, Norderstedt, Hamburg, Germany).

The biopsies were processed for sectioning following the methods described by Donath and Brenner (1982)31; the biological and histomorphometric analyses were performed in order to evaluate CBL and BIC.

The samples were dehydrated using different ethanol concentrations up to 100%, infiltrated with methacrylate and polymerized. They were then sectioned with a diamond saw in the vestibulo-lingual direction, using an Exakt® saw (Exakt Apparatebau, Norderstedt, Hamburg, Germany). Two sections were obtained, about 100µm thick, and reduced to 40µm final thickness using an Exakt 400s CS device (Exakt Apparatebau).

The samples were stained using toluidine blue and a semi-quantitative evaluation was made of CBL and BIC. The CBL was stated in mm, referring to the upper edge of the implant platform and to the first bone-implant contact (f-BIC), vestibular (V=fBIC) or lingual (L-fBIC) (Fig. 4). The BIC was stated as a percentage, and measured along the whole vestibular and lingual surface of the implant by computing the mineralized bone contacting the implant surface vs. the total length.

The morphometric analysis was performed using calibrated digital images at 10X and 40X magnification, using a Leica® Q500Mc microscope by Leica Microsystems, Wetzlar, Germany.

Statistical analysis

The analysis unit was each dog. The intra-reviewer reliability was determined performing three measurements and then calibration, for a maximum 5% error.

The ANOVA test for independent samples was run, as well as a Bonferroni post-test for multiple comparisons between means.

The data was stated in millimeters for CBL and as percentages for BIC. A descriptive statistic was performed using the mean and standard deviation values. The value of p was set at 0.05.

Results

Three healing abutments were lost, no implants were lost and there were no signs of mobility. All the groups showed a decrease in crestal bone, which was highest for group A.

In group A there was a 2.463±0.231 mm decrease of CBL; in group B there was a decrease of 1.163±0.187 mm, while group C exhibited a decrease of 1.215±0.122 mm. A comparison between all groups showed that the external connection implants in group A exhibited a larger CBL ($p<0.05$) compared to groups B and C, differences between groups B and C were not statistically significant ($p>0.05$).

For group A, BIC was 38.62%±2.3% ; for group B it was 40.10%±5.3% and for group C it was 44.02%±4.2%. A comparison between all groups showed that there was no difference regarding the BIC between groups A and B ($p>0.05$) while BIC was highest for group C ($p>0.05$) compared to groups A and B.

Discussion

Dental extraction followed by immediate implant placement results in notable changes in the dimensions of the vestibular crest (30-43%), horizontal loss (63-80%), as well as vertical (65-69%)[32].

This research showed that there was bone resorption both in the vestibular and lingual crest after implant placement, which corroborates the findings reported in previous studies[22,5,6,17].

The evidence of healing of periimplant tissues around implants inserted immediately after tooth extraction, without regenerative techniques, agrees with findings from other animal studies[5,6,16].

Bone formation begins simultaneously with important bone resorption, and the size of the socket seems to affect the bone healing process[32,33].

In a study aimed to find whether the reduction of the alveolar ridge which takes place with post-extraction implants is affected by the size of the hard tissue walls of the cavity, it was found that the marginal space that existed between the implant and the bone walls disappeared and was filled with bone that at the same time resorbed at the crest. The remodeling of the alveolus in the marginal region happened together with a marked decrease in the dimensions both of the delicate vestibular wall and the lingual wall. On the vestibular side this resulted in a certain marginal loss of osseointegration[6].

In order to reduce bone remodeling the implants should be inserted about 1 mm deeper than the level of the vestibular and lingual alveolar ridge, in a position relative to the center of the socket, in order to reduce or eliminate exposure above the alveolar ridge of the pitted and treated surface of the implant[34].

Even though in clinical practice implants are normally placed at bone crest level, subcrestal placement of the implant may be used in esthetically important areas to minimize the risk of metal showing and allow for enough room along the vertical to develop an adequate emergence profile[24,35,26].

Tomasi et al. (2010)[37], in a clinical test with a multivariate multilevel model used to analyze

Group	Mean CBL ± SD (mm)
Group A, LANCE n(16)	2.463±0.281mm*
Group B, SEVEN® n(16)	1.163±0.187mm
Group C, C1 n(16)	1.215±0.122mm

Table 1. Implant groups and CBL. The * marks the value with highest bone loss. ($p<0.05$)

Group	Mean BIC ± SD (%)
Group A, LANCE n(16)	38.6±22.3%
Group B, SEVEN® n(16)	40.10±5.32%
Group C, C1 n(16)	44.02±4.6% *

Table 2. Implant groups and BIC. The * marks the value with highest bone loss. ($p<0.05$)

the factors that may affect bone alterations during scarring after placement of the immediate implant, noted that the position of the implant relative to the vestibular alveolar ridge and the position in the vestibulo-lingual direction, affected how much resorption there was of the vestibular ridge.

Conclusion

Within the limitations of this study in dogs, we may conclude that:

The neck configuration, specifically the connection type, impact the height of the crestal bone. Implants with an external connection have larger CBL. Implants with an internal connection, hexagonal or conical, have smaller CBL.

The BIC is larger in conical implants of type C1.

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