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Bone-to-implant contact percentage at Trausim implants: an experimental study in dogs

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[Abstract] PURPOSE: The aim of this study was to evaluate the Trausim implants hone remodeling at early stage of implantation, to provide necessary experimental parameters for improving the characteristics of the surface treatment technique. **METHODS:** 14 Labrador dogs were prepared for teeth extraction of the mandible first premolar to first molar under general anesthesia. After bone healing for 3 months, each dog was implanted with 3 Trausim implant and 3 Straumann implant. 2, 4, 8 and 12 weeks later, the animals were sacrificed and bone-to-implant contact (BIC%) was assessed using histological and (histomorphometrical methods. All statistical analysis was performed using SPSS 19.0 software package. **RESULTS:** All 84 implants achieved clinical stability at the time of insertion, the healing was uneventful. Bone-to-implant percentage was highest at 8-week for Trausim implant (71.64%±6.66%) and Straumann implant (72.98%±8.97%). At 12-week it was lower than at 8-week, but stability was as usual. Moreover, at different healing periods, no significant difference for BIC% between Trausim and Straumann implants was found. **CONCLUSION**: The present study showed that Trausim implants induce good hone-to-implant contact after implantation. The BIC% was similar to Straumann implants. Supported by Research Fund of Science and Technology Commission of Shanghai Municipality (09411955000).

(Key words] Trausim implant; Straumann implant; Bone-to-implant contact
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Implants are developed based on bony union theory [1]. Good bony union is the precondition for the function of implants, and the implant can only be loaded after ensuring a good bone-implant union rate [2]. Biomechanical environment is one of the key factors affecting the

implantation. The stress of implant-bone interface has important effects in the formation and reconstruction of implant-bone interface. Marginal bone loss (MBL) around the implant is one of the most important reasons for affecting long term success of implant. Although the pathophysiological mechanism of such bone absorption is still not clear, it is related to the stress of the implanted denture. Under normal function and load, to ensure the stress transferred from implant to surrounding bone does not exceed the physiological limit of bone tissue, avoid bone absorption caused by bone trauma, certain bone union must be achieved between implant and surrounding bone tissues. This is the mark of successful implantation, and also the material basis for the implant to bear various loads. Currently, most implant systems used in China are imported implant systems, for all of them, bone-implant union rate is calculated and assessed under laboratory and clinical conditions. Trausim implant independently developed by Jiangsu Trausim Medical Instrument Co., Ltd. makes up for the deficiency of dental implant field in China. This study has performed experimental study on early union between bone tissues and implant for Trausim implants, and compared with Straumann implants, assessed bone-implant union rate, provided experimental reference for improvement of surface treatment and clinical application.

1. Materials and methods

1.1 Experimental materials and equipment

Trausim implant (MPS surface treatment technology) (Jiangsu Trausim Medical Instrument Co., Ltd., China), strength: 3.3mmx10mm, 42 pieces; Straumann implant (SLA surface treatment technology) (Institut Straumann AG, Switzerland), strength: 3.3mmx10mm, 42 pieces, planter (HKM, Germany).

1.2 Preparation of experimental animal

Totally 14 healthy adult male Labrador dogs were chosen, 26-30 months old, with a body weight of 25-30kg. Bilateral first, second and third premolars and first molars were extracted in advance for experimental animals, surgical field was cleaned, incision was sutured, antibiotic was administered for 3 days after the operation. The animals were fed with routine semi-fluid food. The animals were fed this way for 3 months for later use. According to the healing time, experimental animals were randomized into 2-week group of 4 animals, 4-week group of 4 animals, 8-week group of 3 animals, and 12-week group of 3 animals.

1.3 Implantation

Animals were intramuscularly injected with 1 mg/kg toluene thiazide and 15 mg/kg ketamine before anesthesia, and intravenously injected with pentobarbital 20mg/kg for general anesthesia. In the whole course of implantation, experimental animals were maintained by dripping normal saline.

Experimental animals had well healed bilateral mandibular alveolar fossae, smooth surgical field, no obvious bony crest. The full layer of mucous membrane was cut along the alveolar bone crest, with flap turned over to expose buccal and lingual bone plates. The surgical field for implantation was arranged and located, dilated to 10mm, one side implanted with 3 Trausim implants, and 3 Straumann implants on the contralateral side. For all experimental animals,

totally 84 implants were implanted. The implantation depth was the interface between smooth and rough surfaces. The implant showed good initial stability, healing cap was screwed in, and the incision was closed by using non-embedded suture.

Antiphlogistic and analgesic drugs were administered after operation. The animals were fed with routine semi-fluid food.

After operation, the animals were examined regularly, incision was cleaned to prevent complication, and healing cap was also cleaned. All experimental animals were executed by over dose anesthesia at 2, 4, 8 and 12-week according to the animal groups.

1.4 Preparation of tissue specimens and histological analysis

Separate bones containing the implants were fixed in 4% methanol solution, dehydrated in gradient ethanol, and embedded in resin. Specimen was divided into hard tissue sections (Leica, SP1600, Nussboch, Germany) with a thickness of 150-200μm, which was grounded manually to 60-80μm, polished with a piece of cloth [3]. Tissue sections were stained with methylene blue-acid fuchsin, and histological analysis was performed with standard optical microscopy. The specimen was placed under the optical microscope to observe the histological shape, and Image-Pre Plus 6.0 software was used to analyze the bone-implant union rate around the implant. The bone-implant union rate was defined as the ratio of direct contact surface between implant and bone in the total surface area of the implant. The full length from the interface between rough and smooth surfaces of implant neck to the implant top was measured as the range of bone-implant union rate.

1.5 Statistical treatment

All measurement data were processed by using SPSS 19.0 software. The *t* test was applied to compare whether the 2 implants had difference in bone-implant union rate in different healing periods. $P<0.05$ was adopted as the statistical significance level for difference.

2. Results

2.1 Gross manifestation

All experimental animals had good incision healing, stable implants. The survival rate was 100% for all implants, and no specimen was impaired in preparation of histological specimens. All specimens could be included in data analysis, and the sample size was n=84.

2.2 Histological assessment

Histological manifestations of 2 implants were observed under the optical microscope (x25), and described respectively according to healing times.

2-Week: 2 implants showed no obvious difference in manifestations under optical microscope for reaction of bone tissues, and a little bone absorption in crest and top region. The implant had less direct contact with bone, region near the implant showed no obvious formation of new bone, osteoblasts were flat, without typical osteoblast population, a few regions had neonatal osteoid and small blood vessels, and mesenchymal cell mitosis. Osteoblast nuclei were deeply stained, synapses connected mutually, with basophilic granules in cytoplasm. Distance

between basophilic reversal lines was relatively short, with osteoclasts in region near the implant (figure 1 and 2).

4-Week: implant basically contacted bone in full length, basically new bone was observed under the microscope, with actively growing new bone, osteoblasts, small blood vessels generated, new bone formed showed osteoid layer below the osteoblast layer, bone mineralization was distinctively intermittently (Figs. 1 and 2).

8-Week: implant screw was fully filled with new bone, with obvious basophilic reversal lines, less osteoblasts which were flat, less new blood vessels, newly formed mineralized bone had formed bone lacunae. Osteoid was practically not observed. Osteoclast was not observed. Bone trabecula was orderly arranged, new and old bones almost connected in one piece (figure 1 and 2).

12-Week: bone trabecula was orderly arranged, basically vertical to the implant surface, mineralized bone showed distinctive phases, osteoblasts were flat, osteoid was not rich, showing no osteoclast (Figs. 1 and 2).

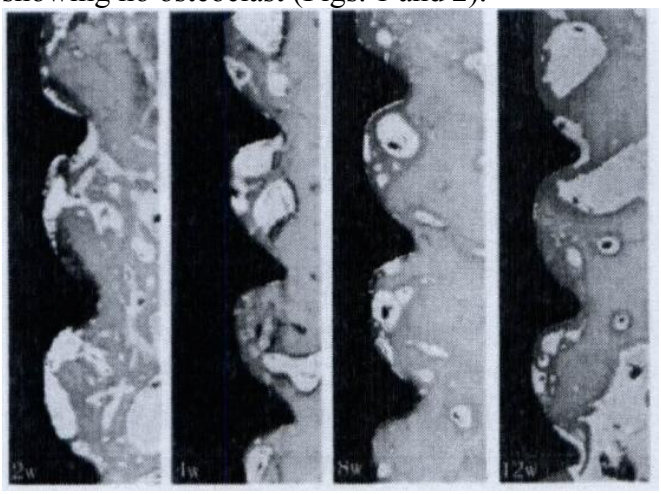

Fig. 1 Microscopic view of Straumann implant at different stage (x25)

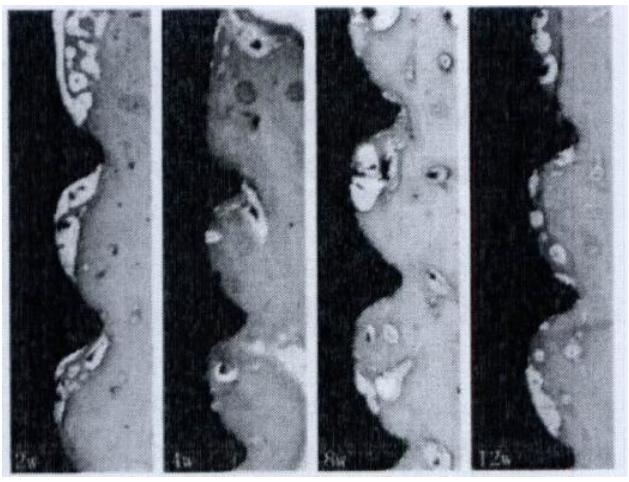

Fig. 2 Microscopic view of Trausim implant at different stage (x25)

After experimental animals were executed, X-ray film showed no radioactive low density shadow around 2 kinds of implants. No implant was loosened. Bone tissues showed good reaction to 2 kinds of implants, reaching good bone union at the time of 12 weeks.

2.2 Results of statistical analysis

See BIC% results of 2 kinds of implants in table 1.

Table 1. Bone-to-implant contact percentages for Trausim and Straumann implants at different stage (BIC%)

	Trausim implant			Straumann implant			P value
	n	$\bar{x}$	s	n	$\bar{x}$	s	
2 weeks	12	44.97%	3.66%	12	44.80%	7.58%	0.94
4 weeks	12	62.74%	4.34%	12	64.24%	6.10%	0.65
8 weeks	9	71.64%	6.66%	9	72.98%	8.97%	0.48
12 weeks	9	60.71%	5.39%	9	60.86%	7.31%	0.97

In early phase of implantation, 2 kinds of implants showed no significant difference in BIC% (P>00.5).

3. Discussion

By comparing early BIC% of Trausim and Straumann implants, this study has assessed the early bone healing after implanting Trausim implant. It is indicated by many literatures that, Straumann implant has obtained good bone-implant union rate due to SLA surface treatment [4-6], so it is used as the reference to compare with Trausim implant.

Analysis of BIC% has showed no significant difference between 2 kinds of implants. In 4-week and 8-week groups after implantation, bone-implant union rates are higher than that in 2-week group, and bone tissues on implant surface are persistently formed and reconstructed. At the time of 12 weeks, bone-implant union rate is slightly reduced. This is because the measurements in 2-week and 4-week specimens may be overestimated compared with that for 12-week specimen. In this experiment, BIC% is measured from the interface between rough and smooth surfaces of implant neck, along the full length of implant surface to the top. In 12-week group, crest top shows bone absorption, the rough surface of implant is slightly exposed [7], but basic value of BIC% measurement is not changed, bone union is reduced on crest top. Although bone-implant union surface persistently increases in the embedded bone tissues of the implant, the measurement data are finally reduced. BIC% measured in this experiment is persistent with the results of other studies [8-9].

In this experiment, the mandibular premolar area of dog is used as the implantation field, 2 kinds of implants are implanted on both sides of lower jaw by using the same implantation method to try to exclude the human factors, then the surface treatment technology of implant becomes the critical factor for bone-implant bone union. Trausim implant has changed surface

structure and element distribution by using the special MPS technology, which is helpful for adhesion, elongation, growth and proliferation of osteoblasts on the implant surface. This technology is similar as the SLA surface treatment technology of Straumann implant [10]. The 2 implants have formed microscopic rough surfaces, and higher chance of bone contact and good union after implantation. The 2 implants have achieved good bone-implant union rates at the time of 12 weeks. However, in this experiment, implants are implanted into the mandibles of experimental dogs. Mandibles have high bone density, and ideal bone conditions for implantation. There is no experimental data for bone union capacity on implant surface under poor conditions. Schwarz et al.[11] have recently assessed the capacity of improved SLA surface treatment technology to support bone formation. They have implanted in the standard bones to observe the effects of SLA surface treatment on bone formation, obtained positive conclusion in accordant with results of a previous study[12]. Further experiment should be performed on support of Trausim implant in bone formation, to investigate the effects of surface treatment technology on bone formation. A recent experimental study on volunteers has confirmed that bone union speed in human alveolar bone is lower than that in experimental dogs [13]. Trausim implant animals have obtained good results, but more research tasks should be performed before clinical application.

Conflict of interest statement: none.

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