

Research

Analysis of Bone Microstructure in Relation to Implant Macro Geometry in Bovine Bone. Histological Study Comparing between Double Spire Implants (Immediate Load) and Other Implant Systems

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Abstract

Reason

The purpose of this study is to compare the bone histology in proximity of the implant between macrostructure double loop (Immediate load) with other implant companies. This work, according to the authors, helps the clinician to determine more precisely which type of implant is less damaging to the surrounding bone and which implant preserves a greater erythrocyte infiltration.

Materials and Methods

In this study, 10 titanium implants of 5 companies, with comparable diameters and heights have been introduced in the medullary and cortical bovine bone. All systems are platform-switching. After surgery, the implants were removed with a trephine drills and the histomorphometric analysis of bone tissue has been studied.

Results

By histological analysis, the presence or absence of vascular infiltration in the vicinity of the implant coils and microscopic bone appearance after preparation and insertion of different implants was noticed.

Discussion and Conclusion

From the observed results, we have highlighted which implant company appears to have greater vasculature bone and lower compression necrosis.

Key Words: Bone Histology Near Fixture; Implant Surface; Implant Shape

Introduction

Histological examination of bone appears to be one of the most effective means to assess the surgical success following the

introduction of the fixture. From the microscopic point of view, in implantology, to the concept of the Bone Implant Contact (BIC) is essential.

The BIC was introduced as a scientific control measure in implant-therapy success evaluation around the 90s. In fact BIC turns out, if the histological sample analysed is properly prepared and there are no artefacts, to be definitely one of the most direct and effective means of assessment. The BIC allows you to observe the contact amount percentage: the contact between the total surface area of the peri-implant bone and the fixture inserted [1,2].

Obviously the greater is the measurable contact, the greater is the BIC. Histological analysis of the BIC of osseointegrated implants in general, successfully show a percentage of mineralized tissue (which is often not bone) to around 50-60% contact. This is due, according to the manufacturers, to the optimum surface characteristics of the implants. For this reason, over time numerous surface treatment techniques have followed, with the hope of arriving at what is

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called in Bone Biology, the Primary Bone Repair (ROP), which coincides with the post-traumatic “restitutio ad integrum”, which equates 100% within 45 days [3,4].

In addition to the BIC, one of the keys to implantology success is the amount of osseointegrated bone in close contact with the implant during the prosthetic loading phase [5]. Although in this study, implants were introduced into heterogenous in vitro bone, the aim was to compare the behaviour between different bone implants with different macrostructure from many different manufacturers. This data, only obtainable with a histological study, appears to be of substantial help to the clinician in the choice of the system to employ.

Intimate adhesion and primary stability are recommended to keep the micro-movements below a critical level to allow osseointegration. [3] Albrektsson and Jacobson have reported that interactions on bone surface in contact with the implant are not determined by factors resulting exclusively from the implant alone. They have established that parameters such as surgical technique and loading conditions are equally important for osseointegration. In our study, to produce even more reliable data, the implants have been introduced by the same operator on the same bone (bovine bone).

Materials and Methods

In accordance with the manufacturer’s protocol, and with the same insertion torque, 10 implants belonged to 5 different manufacturers (Mis; Branemark; Friident; Alphabio; Immediate load) were inserted into bovine bone.

Table 1: macroscopic characteristics of each implant used in this study

Implant Company	Height (mm)	Diameter (mm)
1.Friident	11	3,4
2. Branemark	12	3,75
3.Immediate Load	11,5	5
4.Immediate Load	6	6
5.Immediate Load	11,5	4
6.Mis	13	3,3
7.Mis	13	4
8.Immediate Load	10	4
9.Immediate Load	11,5	4
10.Alphabio	16	3,3

All the systems are made of pure Titanium (cp ti; grade 4-5) with treated surface. Insertion took place in similar sites with no anatomical interference (Figure 1). These positions were previously selected in such a way as to make the results more truthful at the end of the study (Figure 2: Postoperative orthopantomography).

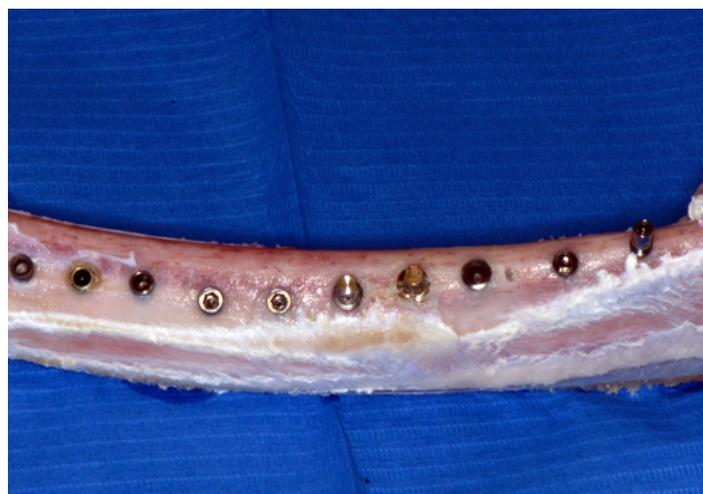


Figure 1

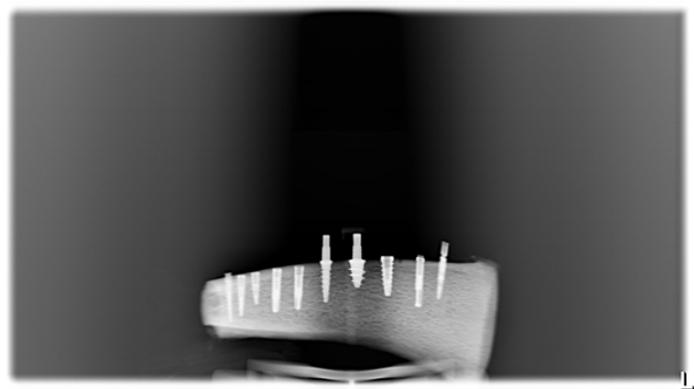


Figure 2

Once the fixtures were introduced, the bovine bones were fixed to formalin buffered at 10%. Subsequently, thanks to circular saw, a thick specimen of 4mm was taken and they were decalcified in Mielodec for at least 15 days by checking daily decalcification. Next, the decalcified samples were processed in the conventional manner and included in paraffin. From Paraffin blocks, histological preparations of 4 microns thick were then formulated and were colored with haematoxylin and eosin.

Histological preparations were examined with the Optical Microscope (D-Sight Menarini) in the Department of Pathological Anatomy of the Brindisi “Perrino” Hospital (Italy).

The histological analysis conducted, allowed us to evaluate the extent of vascularization, bone hyperaemia, and the compactness of bone tissue near the implant used.

Results

From microscopic analysis, only a few implant companies (Immediate Load, Alpha Bio) maintained a good erythrocyte infiltration in the nearby bone tissue (Figure. 3, 4).

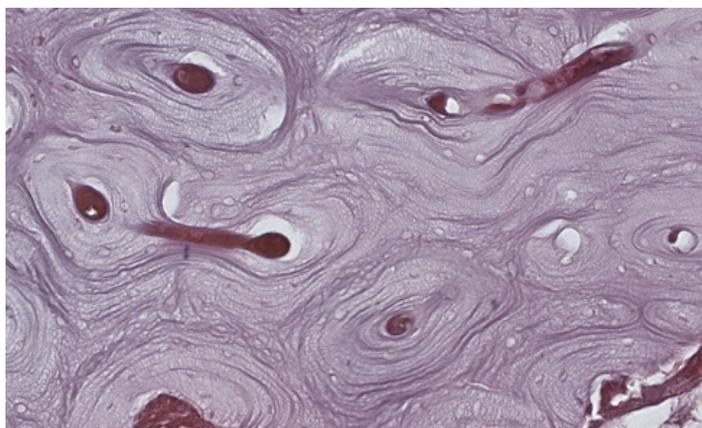


Figure 3

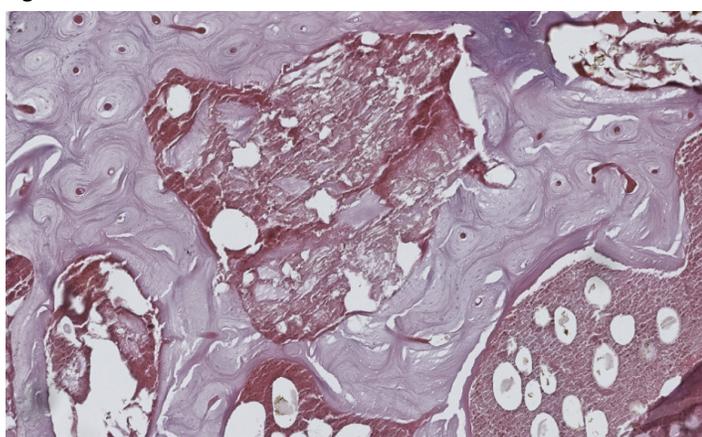


Figure 4

The Miss system presented a histological examination of compact bone tissue with no vascularization (Figure. 5). Moreover, Friadent and Branemark implants with the height and diameter comparable to the other companies, presented the Bone tissue with poor vascularisation (Figure.6).

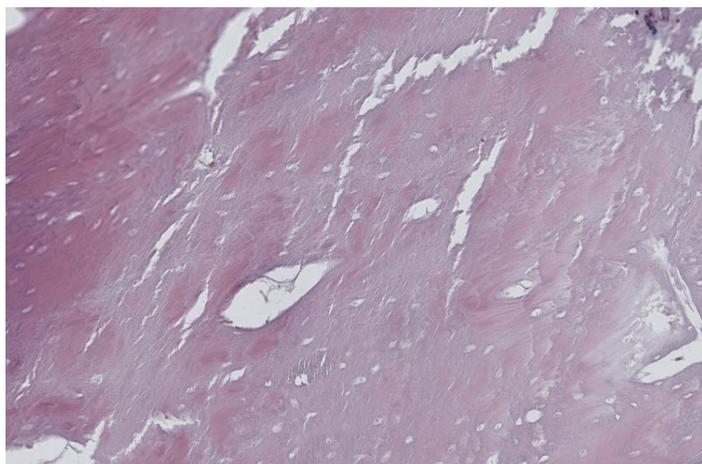


Figure 5

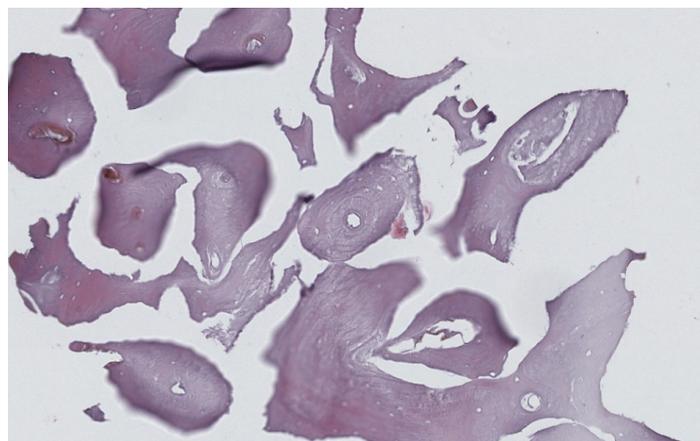


Figure 6

Table 2 summarizes the specific results for each company. To make the results more reliable, all implants introduced had similar diameters and heights, they were placed at equal distances in bovine bone and the operator was the same.

Table 2

Implant company	Diameter, height	HistologicalResults
1.Friadent	11 x 3,4	Bone tissue with poor vascularization (Fig 6)
2. Branemark	12 x 3,75	Bone tissue with poor vascularization (Fig 6)
3.Immediate Load	11,5 x 5	Compact bone with numerous hyperemic vessels
4.Immediate Load	6 x 6	Hyperemic bone canals (Fig 3)
5.Immediate Load	11,5 x 4	Hyperemic bone canals (Fig 3)
6.Miss	13 x 3,3	Compact bone tissue with no vascularization (Fig 5)
7.Miss	13 x 4	Compact bone tissue with no vascularization (Fig 5)
8.Immediate Load	10 x 4	Intravenous hemorrhagic straves (Fig 4)
9.Immediate Load	11,5 x 4	Intravenous hemorrhagic straves (Fig 4)
10.Alphabio	16 x 3,3	Lamellar amorphous material in a hemorrhagic context

Discussions

This study is directed to the oral surgeon for a more precise choice of the type of implant to use depending on different clinical situations. In fact, not all implant companies behave in the same way as surrounding bone tissue. Among these Alphabio and Immediate Load have good erythrocyte infiltration.

The healing of perimplant bony tissue has been the subject of numerous studies both in dental and orthopedic fields. The bone

is a rigid structure of connective, vascular and dynamic nature and is undergoing lifelong remodeling [6]. From a structural point of view, there are two types of bone: cortical bone and marrow bone.

The insertion of an implant causes a bone trauma that triggers a healing process (characterized by formation and remodeling phenomena), leading to an intimate adhesion between the implant and the bone structure, namely the attainment of the Osteointegration [7].

The bone healing phases following this surgical maneuver, be alike those of bone tissue development.

Hematoma formed as a result of the traumatic event invokes mediators from the tissue itself and the bloodstream, leading to accumulation of inflammatory and mesenchymal cells, with subsequent formation of granulation tissue [8,9].

After this substitution of this tissue by macrophages and giant cells, there is a differentiation of mesenchymal cells into osteoblasts and a formation of new bone to which will be followed by remodeling processes [10].

Based on these assumptions, the blood supply and subsequent bone repair that will follow the introduction of the implant are essential, also in the presence of good primary stability [11].

From the conclusion of this study, it can be seen that bone tissue near the implant has a different histology depending on the implant company.

In fact, double-acting implants, such as Immediate Load, cause the discontinuation of bone blood vessels, with subsequent bleeding; this determines the contact between the biological fluids and the surface of the implant just inserted.

The Absorption on the implant surface of ions and macromolecules of blood origin is immediate and crucial also for the same platelet adhesion and subsequent osteogenesis [12-14].

This work wanted to study what happens in the surrounding bone tissue immediately after the introduction of the implant. In literature, no other author analysed the per implant bone histology with the respective vascular contribution of these different five implant companies. This peculiarity makes our work even more unique and particular. Histological examination led us to ascertain which company has a greater erythrocyte infiltration and therefore which implant has a greater contact with the titanium surface.

Conclusions

The surface of dental implants, associated with its geometry, plays a primary role in bone growth interactions.

This initial mechanical integration is closely related to several factors that can affect quantity and quality: implant geometry, histological bone quality, and preparation of the surgical site.

There are so many implant companies and so many surgical techniques that are available to us.

With this study, it wanted to compare 5 different companies and study the best bone interactions with the implant. Double Spirals of Immediate Load are a winning combination at the time of implantation. However, further and more in-depth studies will be needed to observe healing processes and confirm the success of Implant with definitive prosthetic rehabilitation.

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