TRANSITIONAL IMPLANTS RESEARCH STUDY. HISTOLOGIC STUDY IN NON-HUMAN PRIMATES.

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ABSTRACT.

The aim of this study was to examine wound healing events around transitional titanium implants. Two monkeys with four inserted implants in maxilla, after a healing period of 12 months with functional loading were analyzed; the implants with surrounding tissue were removed and specimens, studied in decalcified sections.

Studying the results we found that the bone support of the implant loaded functionally showed progressive maturation and remodelling areas, resulting in the formation of a dense mature bone, vascularized, of the ankylotic type, compact with osteocytes embedded throughout. The rigid osseous interface is present on the surface of spires, with isolated areas of fibrous connective tissue, preferably in the interspires zones.

The bone support presented no morphological significances respect to that of osseointegrated implants, in spite of being the transitional, a one stage implant. On the other hand, the difference was found in the soft tissue interface, that is of the fibrous-connective tissue type.

INTRODUCTION.

The osseointegration requires a long time period of submerged healing, in order for integration to take place and assure satisfactory clinical performance and definite esthetic final implant prosthesis.

Beginning "a new temporary status", the transitional phases of implant treatment. The provisional prosthesis is an important factor in clinical success. The fixed provisional prosthesis is preferable to a removable, but is not always possible. The Transitional implants are the new alternative for support and retention during healing and integration of definitive implants, which allow the use of fixed prosthesis.

The objectives of the present study are:

- Evaluate the osseous biocompatibility of a relatively simple and unexpensive temporary titanium implant.
- Determine the healing period, type and quality of interface and bone support that can resist a continuous load.
- Evaluate the minimal integration requirements for anchorage provisional prosthesis.

MATERIALS AND METHODS.

The non-human primate, Macaca Fascicularis, used in our studies has been worked on for insertion of the Transitional Implants in anterior and posterior segments of maxilla, with identical methodology as in humans and under carefully controlled conditions. (1). Fig. 1 & 11.

The animals are in systemic healthy conditions. The selection was based more on other parameters; similar age of 10 years, males, fully conditioned and overall dental status.

Four autoclaved implants of 18 and 22 mm in length, 1.8 mm in diameter were screwed in the surgically prepared site, previous special calibrated drill irrigated with isotonic saline solution according to instructions with the Sendax insertion and reconstructive protocol. (2).

Monkey #1: Posterior segment, upper maxilla. Bone density D3. About 1 cm apart.

Monkey #2: Anterior segment upper maxilla. Bone density D2. The two implants were placed bilaterally and the prosthesis splinted to natural teeth. (3).

The implants were loaded immediately, placing a fixed metal-acrylic bridge. Fig. 2 & 12. Occlusal adjustment was completed in centric relation specially of lateral forces, which are essential to preserve periimplant bone integrity.

The provisional prosthesis can be made directly intraorally, or by indirect technique in the laboratory. Regarding the method, the end result should be a well passive fitting (critical for maintenance of the implant/osseous interface) and functional. Independently of the method used, mounted diagnostic casts are mandatory. (4).

Immediate postoperatory X-rays were performed. Fig. 3 & 13. After a period of 12 months, the implants with surrounding tissue were removed with a Trephine (Fig. 4 & 14) and were fixed in Karnovsky solution for posterior processing, decalcified in 10 % trichloroacetic acid for 10-14 days.

Tissue sections were obtained in the longitudinal and transversal orientation. Standard paraffin embedding procedures, 8-10 μm thick steps serial sections. Resultant sections were selectively stained with Hematoxyline Eosine, Masson's Trichrome, Mallory's Trichrome, Sirius Red, and Van Gieson, and subjected to light microscopic examination for descriptive analysis.

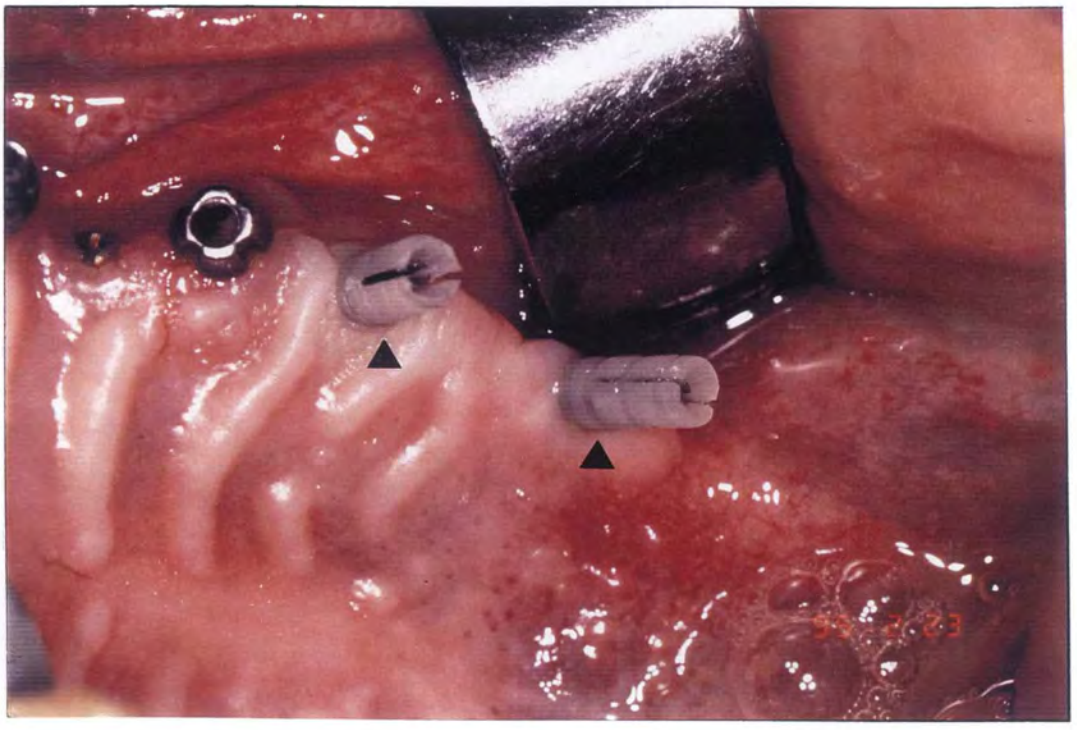

Fig. 1: Right upper maxilla, posterior segment, Transitional Implants, about 1 cm. apart.▲

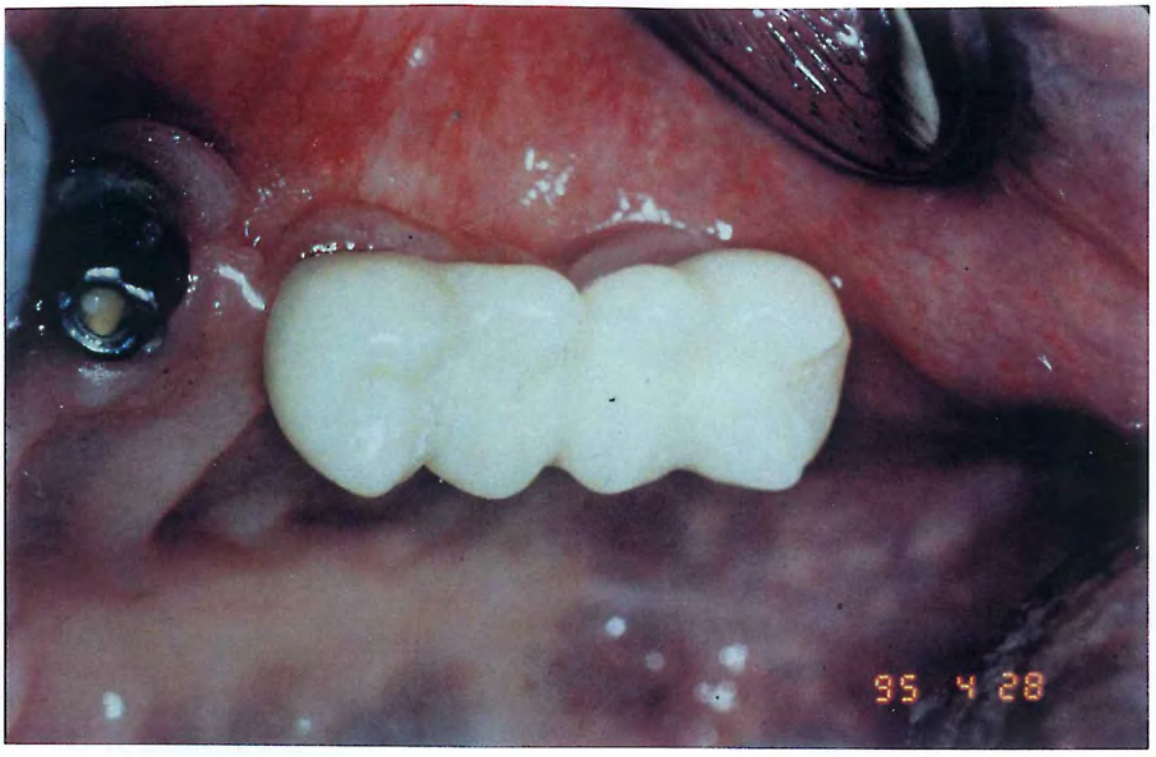

Fig. 2: Fixed metal acrylic bridge on two Transitional Implants - post support.

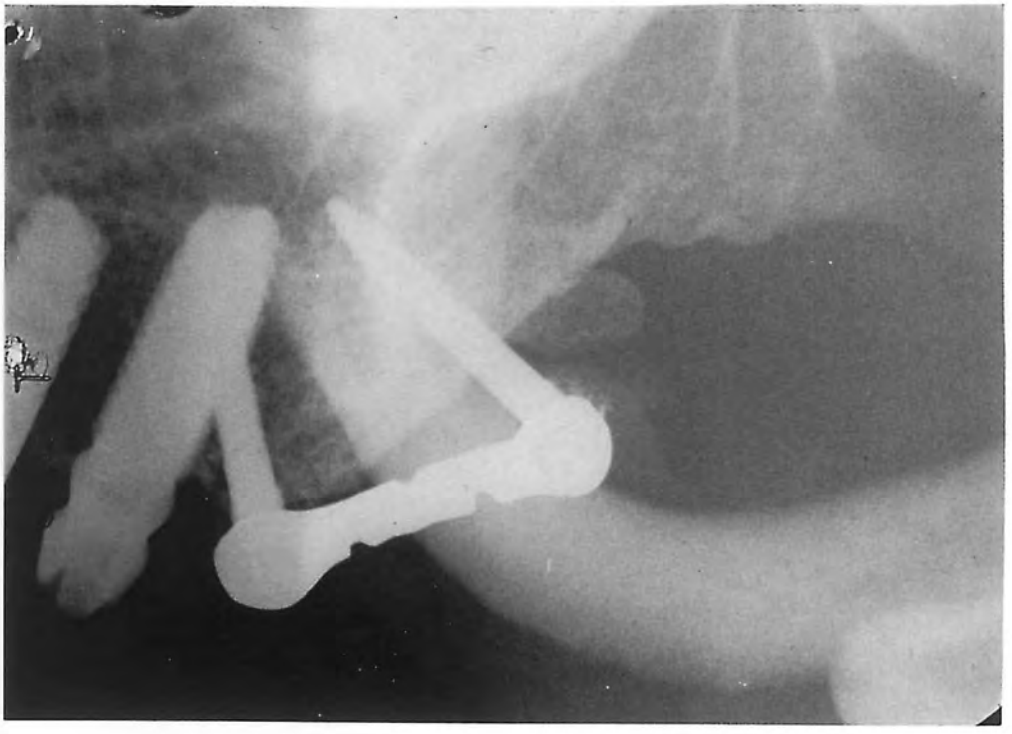

Fig. 3: X-ray control of post, with provisional bridge.

RESULTS.

The present study is based on histological findings in two non-human primates, with four inserted Transitional implants in the upper maxilla with functional loading.

HISTOLOGIC FINDINGS.

GINGIVA.

The gingival epithelium structures showed a parakeratinized oral and sulcular epithelium with numerous layers of epithelial cells forming rete pegs.

The connective tissue is well organized, with fibers oriented paralell to the implant in the superficial corion. The deep corion is less fibrous.

The fibrous corion shows no infiltrate. None of the sections exhibited epithelial downgrowth to the bone. FIG. 5

FIG. 13 (X-ray) Appears one of the implants with the threads in direct contact with the surface area of the gingiva.

On the histologic section we observe the same geometry of the implant in contact with the soft tissue. FIG.15

FIG. 16 shows a squamous stratified epithelium within normal parameters ; parakeratinized on both external and implant slope, becoming thinner abruptly when delimiting the gingival sulcus with normal structures.

Following the gingival sulcus we find the junctional epithelium, that keeps a stable width and migrates over a surgically traumatized corion. This inmature , long junctional epithelium ends abruptly.

The corion shows two different areas well delimited reacting in different ways to the same stain.

- The deep corion shows circular bundle fibers respect the body of the implant. The width of the fibers and the morphology of this layer was no affected by the insertion of an implant of 1.8mm. We can oberve fibrocytes and no other cellular type.

- The superficial or periimplant corion, shows thin collagen bundles in a pale pink stain oriented parallel to the implant separated by a wide band of loose connective tissue and the junctional epithelium.

In this newly formed band is easy to detect fibroblasts, different types of infiltrate cells macrophages, plasma cells and lymphocytes as a result of a mild moderate supra and subgingival plaque.

It is important to mention that this animals are on a hygiene program that includes brushing and topical applications with clorhexidine once a week during the study.

BONE.

In spite of the different bone densities the body response is similar in the two monkeys.

The microscopic findings reveal lamellar compact bone of the ankylotic type, highly vascularized with abundant osteocytes. There is a high percentage of bone rigid interface with isolated areas of fibrous connective tissue that cover the threaded area , not observing this in areas between the threads.

We observe Volkman´s canals, fibrous marrow spaces that open to the interface originating the appearance of the connective tissue that is present in the bone- implant interface . Confirming this finding with the constant relationship between vascular canals, fibrous marrow spaces and connective tissue in the interface.FIG. 6-7-8

On FIG. 7 we observe the disposition of lamellar bone responding to load concentrations delimiting wider marrow spaces.

In the bone arquitecture we observe mainly areas of secondary mineralization over primary mineralization. We can also visualize the presence of hialine material and fibrovascular connective tissue with it's origin in the vascular canals.

With the stain technique Sirius Red, that is considered an specific histochemical technique for collagen study, we can observe areas of connective tissue with organic material , and this is the reason of the relationship between fibrovascular connective tissue and bone implant interface, fatty fibrous marrow, coarse compact and trabecular with remodelling areas and fibrous interface.

The microphotographs with Van Gieson stain shows bone support surrounding the implant surface resembling cortical bone, with primary osteons, abundant osteocytes and richly vascularized.

The remodeling areas show the presence of active bone with a high turn-over (Bone Remodeling) FIG. 9-10

We observe in previous microphotographs isolated areas of fibrovascular connective tissue covering bone surface at the interface.

Fig. 17. In a panoramic longitudinal section that shows bone support type tissue, ankylotic, lamellar with osteocytes included and a good vascularization, i.e. bone that has undergone remodelling cycle, lamellar compactation of the non vital bone at the interface and bone support. This process has been completed with the secondary mineralization of the new bone. This demonstrates a dynamic healing and maturation sequence of the bone around an implant under functional loading (7) (8). In this figure we can distinguish three areas: Area 1: with a high magnification, we describe cortical bone support over the threads' surface and fibrous connective tissue between the threads, and also abundant remodelling areas. Fig. 18.

Area 2: Abundant fibrocelullar interface at the edge of the thread with areas of remodelling. Fig. 19.

Area 3: Compact bone type, ankylotic, with few lamellas and cells, organic material and fibrous connective tissue in the interface. Fig. 20.

In a transversal panoramic view -Fig. 21- we can appreciate very important elements: Periimplant bone with patchs of fibrous tissue that meet with preexisting trabecular bone conforming a "scaffold" to withstand loads. With a higher magnification (delimited area), bone support with high activity that reorientates, changes size as a result of micromodelling; bone with high remodelling (turnover), fibrous and adipose bone marrow.

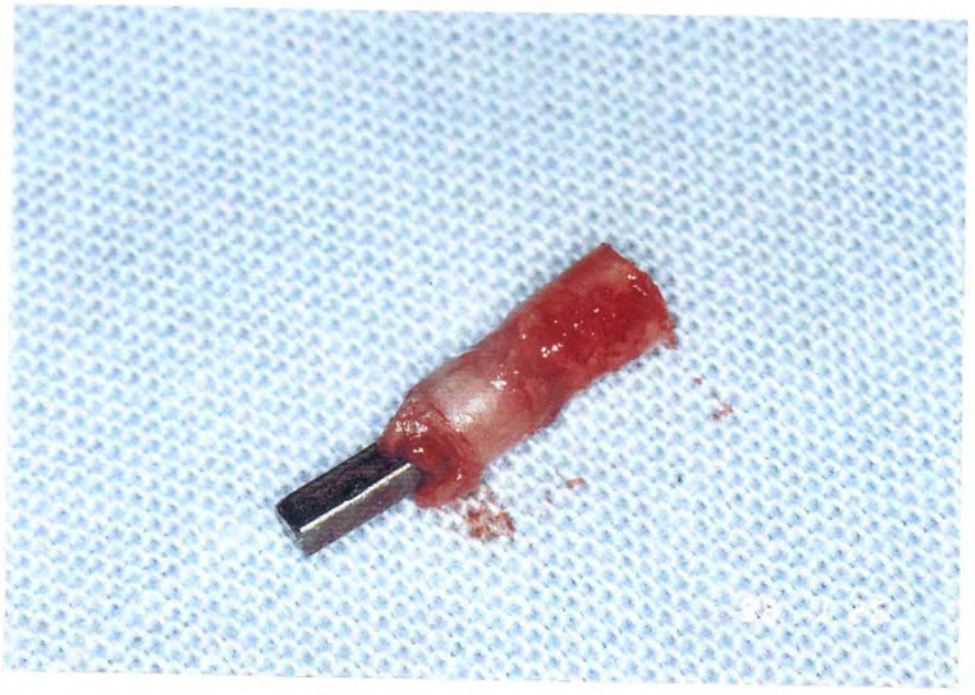

Fig. 4: The implants with surrounding tissue were removed with a Trephine. (Biopsy).

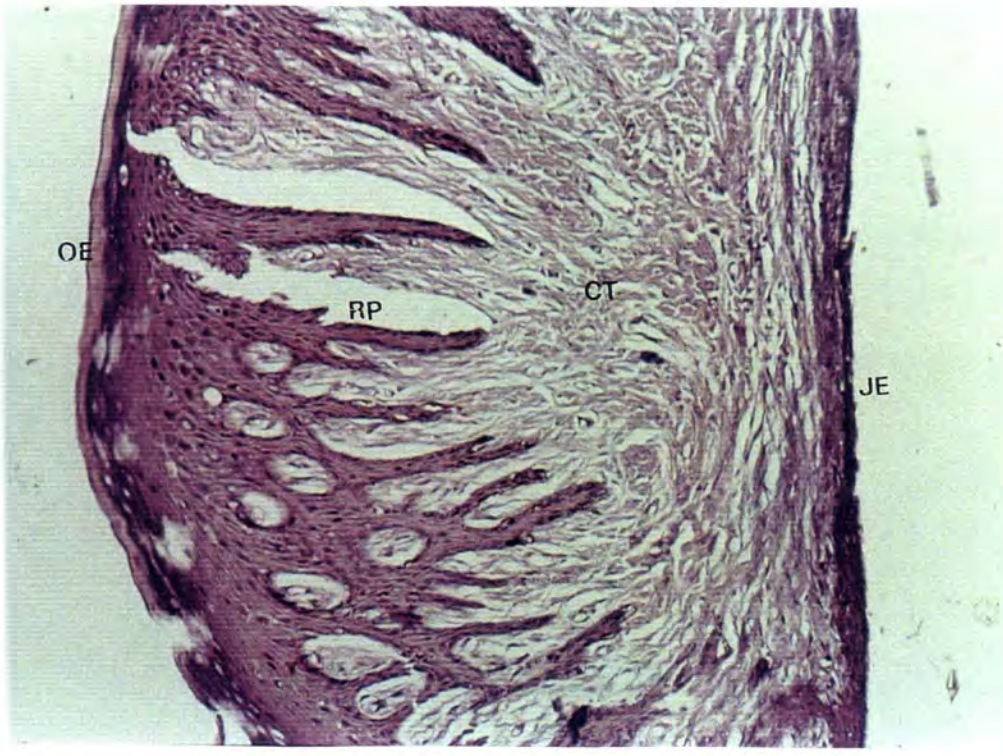

Fig. 5: Original magnification X 20. Masson Trichrome. O.E.: Oral Epithelium, stratified, squamous, parakeratinized. Papillae and rete pegs. J.E.: Junctional Epithelium. C.T.: Connective tissue.

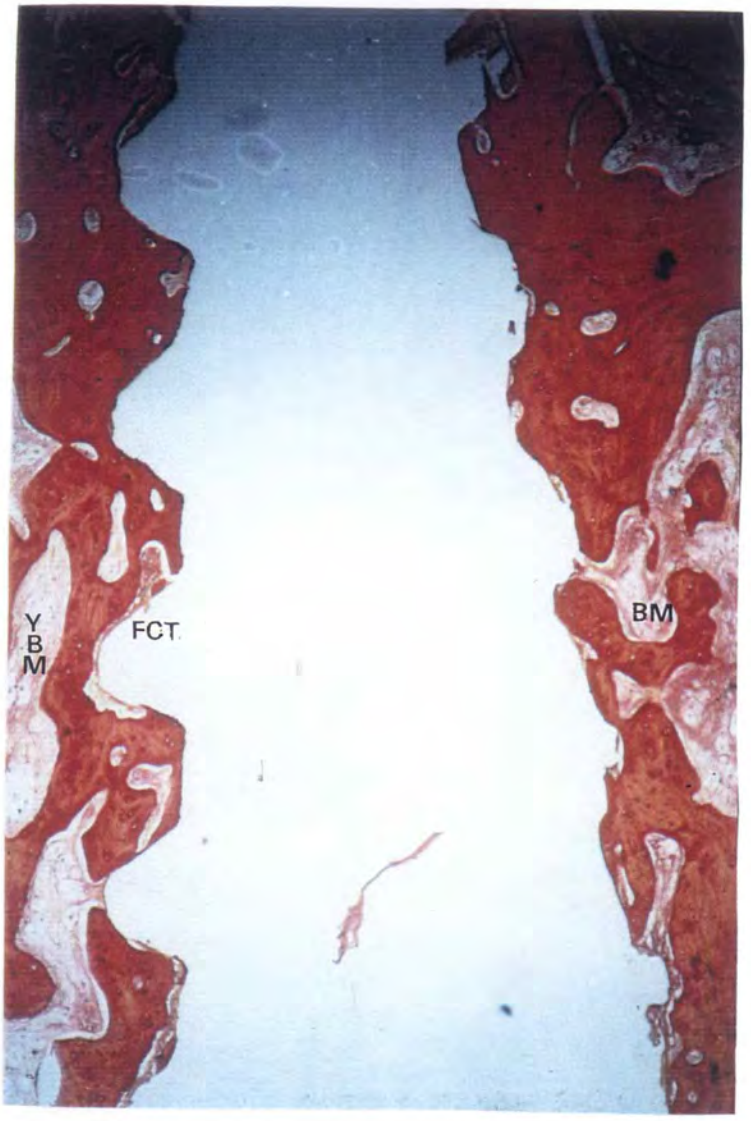

Fig. 6: Original Magnification X 25. Sirius Red. Y.B.M.: Yellow Bone Marrow. F.C.T.: Fibrous connective tissue. B.M.: Bone marrow.

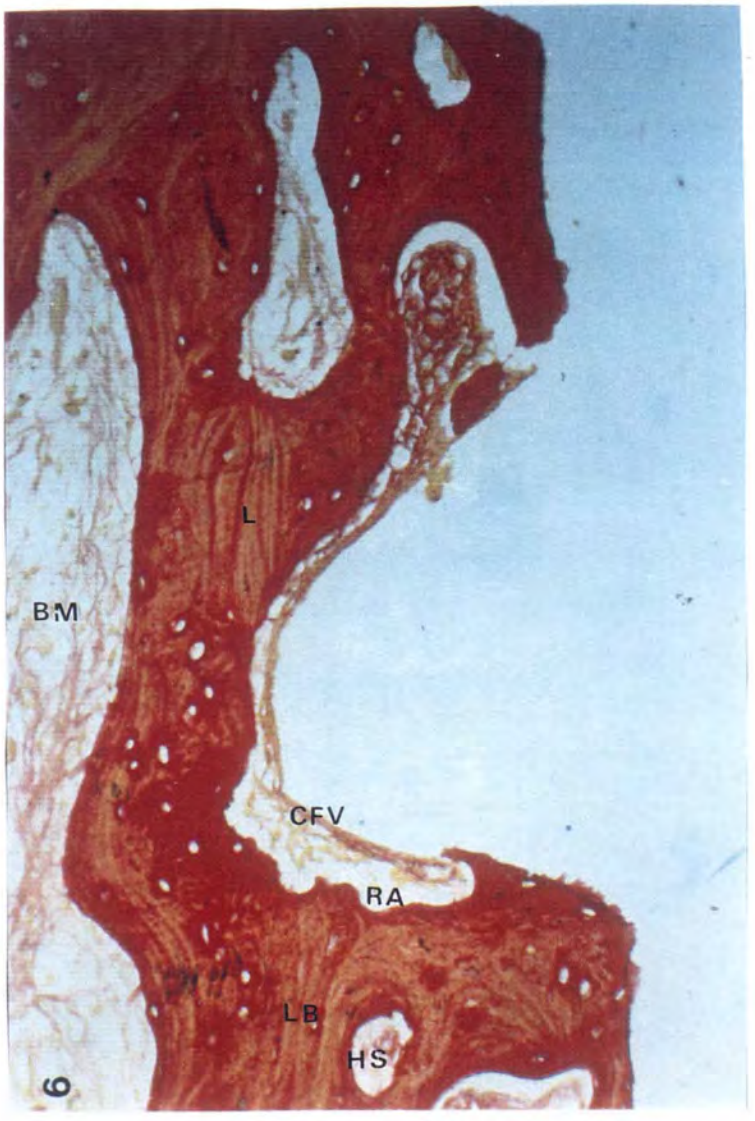

Fig. 7: Original Magnification X 100. Sirius Red. Organic material at interface. Lamellar bone. B.M.: Bone marrow. H.S.: Haversian system C.F.V.: Connective fibro-vascular. R.A.: Remodelling area.

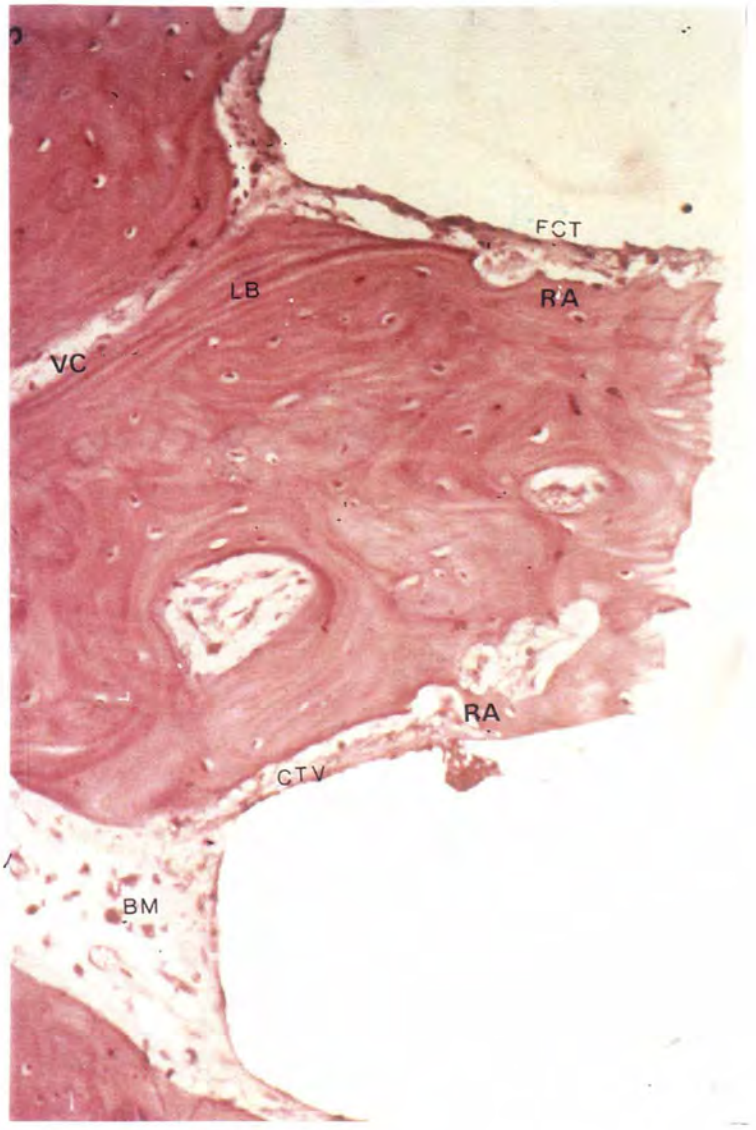

Fig. 8: Original magnification X 100. Hematoxyline Eosine. Secondary bone architecture. Lamellar bone. L.B.:Lamellar bone. F.C.T.: Fibrous connective tissue. C.T.V.: Connective fibrous vascular. R.A.: Remodelling area. V. Ch: Volkman channel. B.M.: Bone marrow.

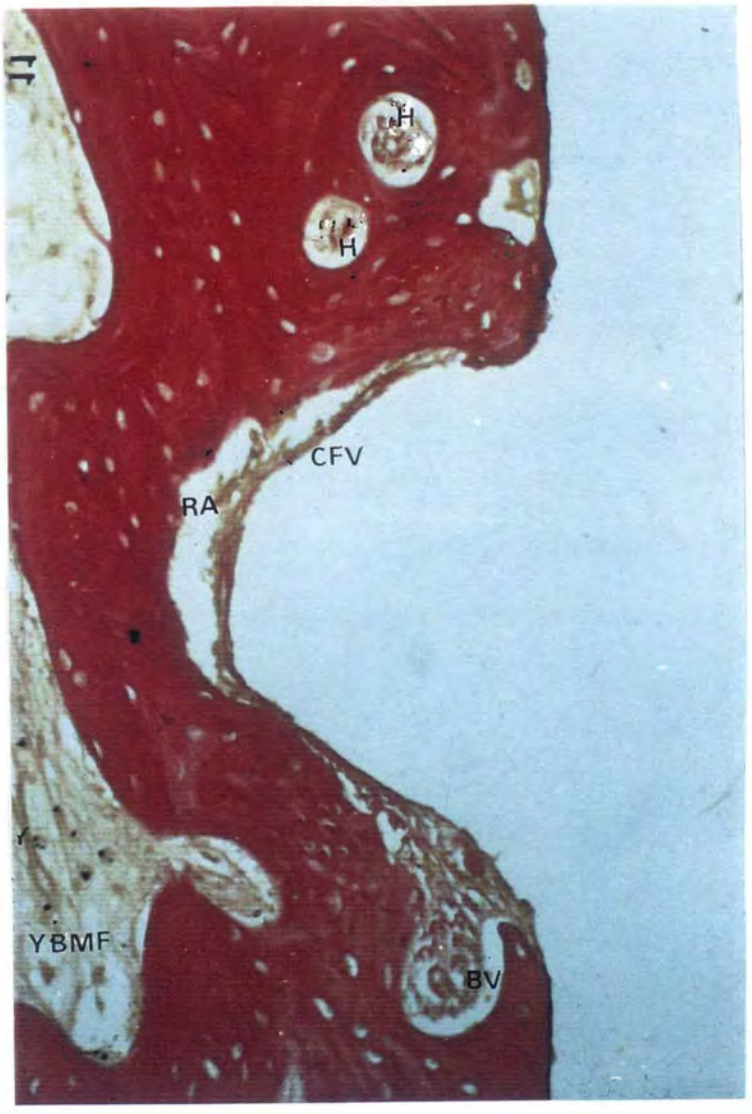

Fig. 9: Original magnification X 100. Van Gieson. R.A.: Remodelling area. Y.B.M.F.: Yellow bone marrow fibrous type. C.F.V.: Connective tissue fibrous vascular. H.: Haversian system. B.V.: Blood vessels.

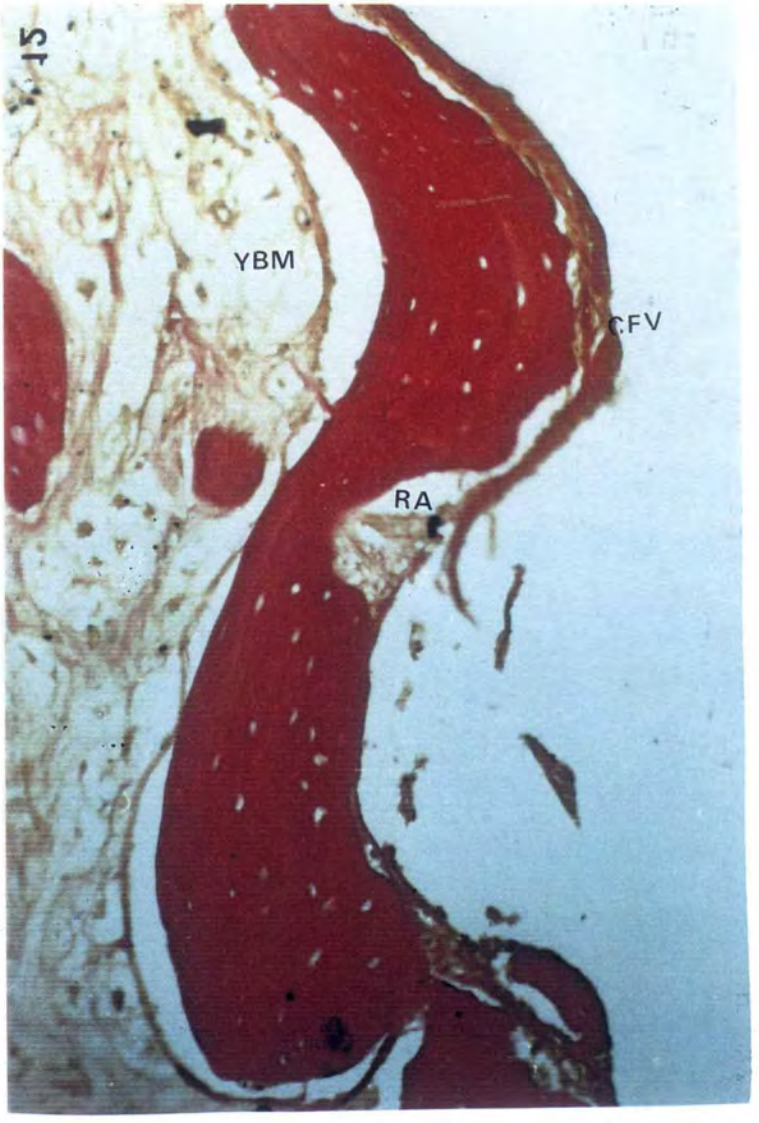

Fig. 10: Original magnification X 100. Van Gieson. R.A.: Remodelling area. Y.B.M.: Yellow bone marrow. C.F.V.: Connective tissue fibrous vascular.

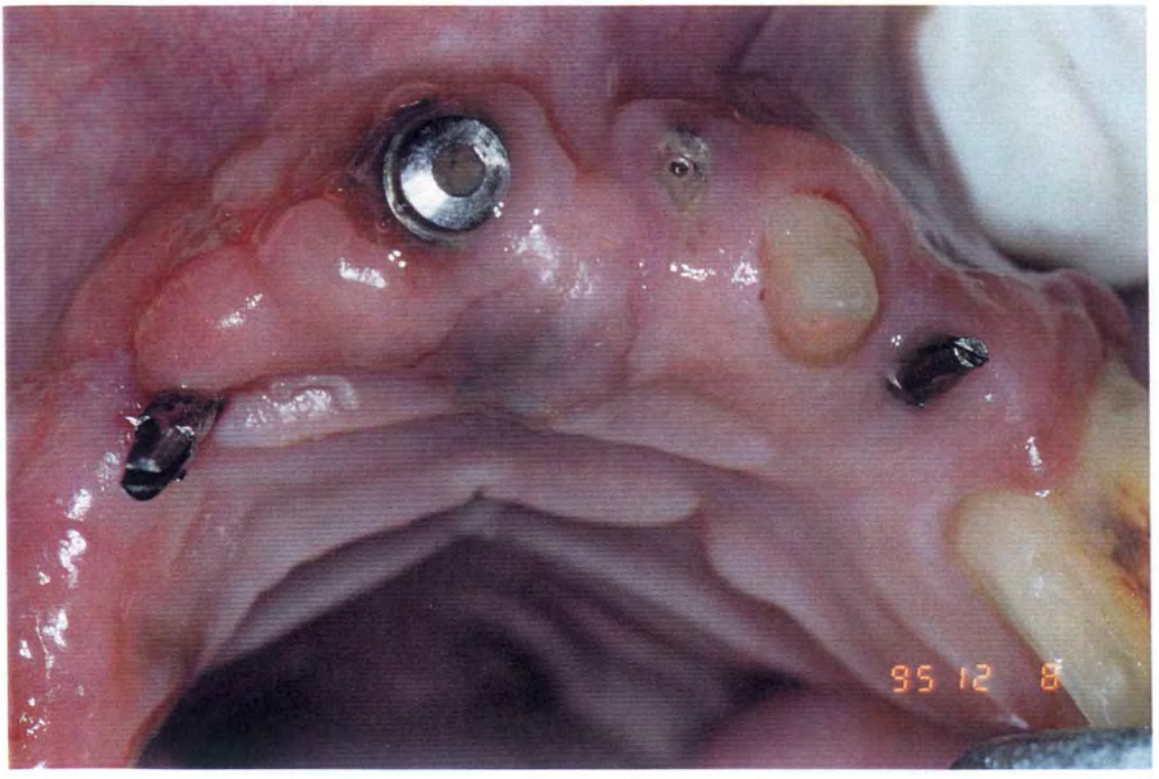

Fig. 11: Upper maxilla - anterior segment. Transitional Implants placed bilaterally between canine.

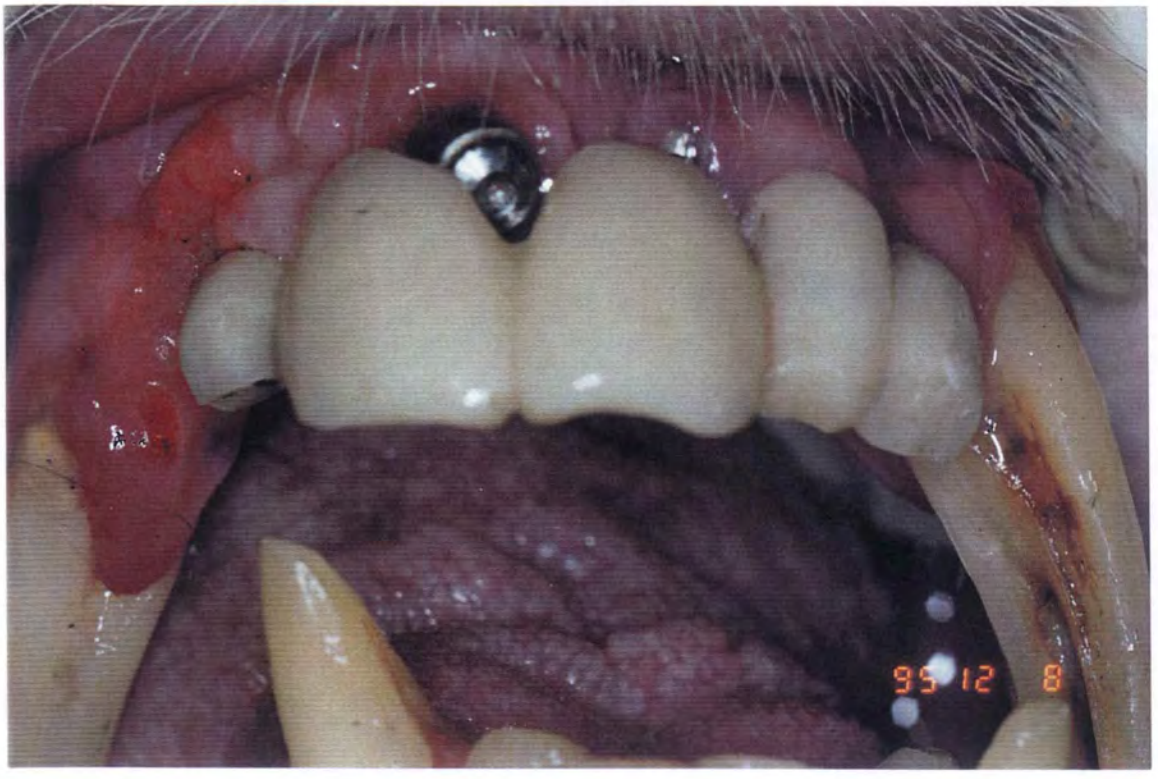

Fig. 12: Facial view of processed provisional bridge on two Transitional Implants - post support and natural abutment.

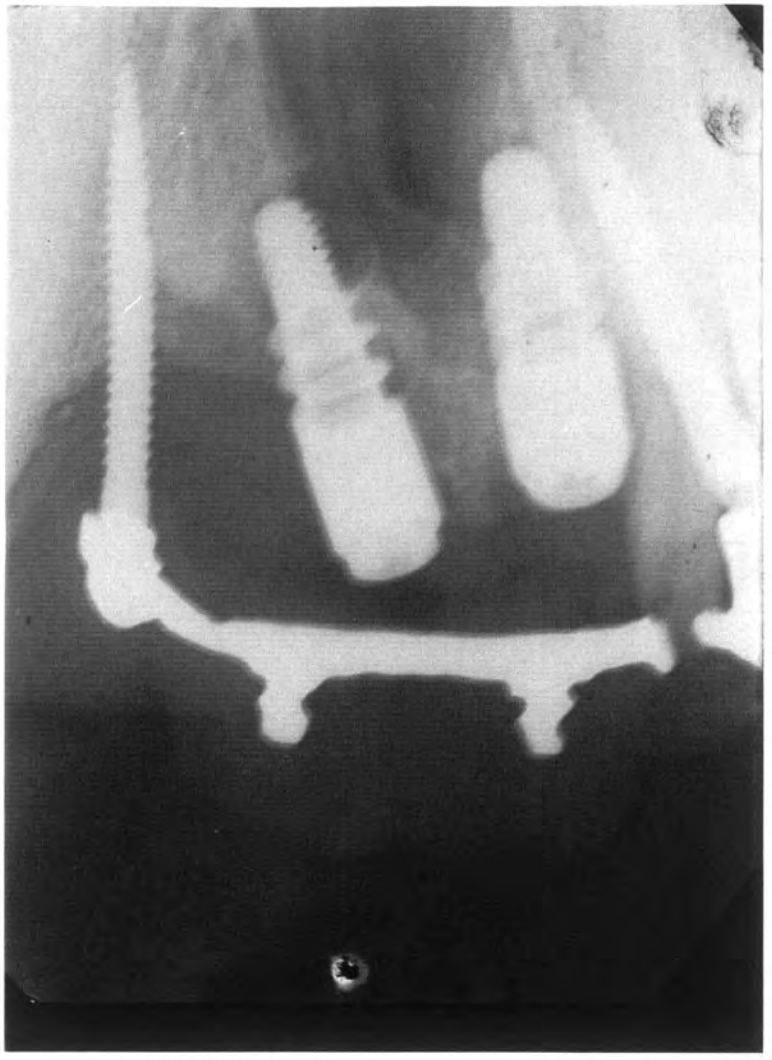

Fig. 13: X-ray control of post, with provisional bridge.

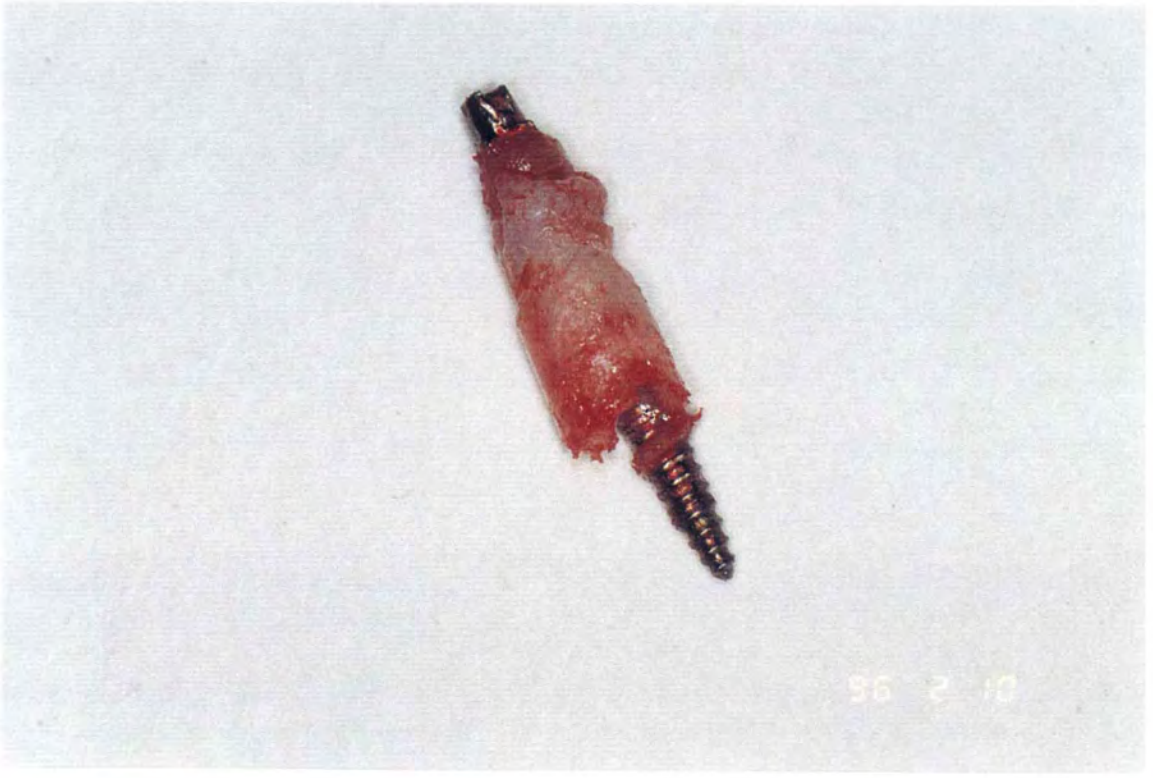

Fig. 14: The implants with surrounding tissue were removed with a Trephine. (biopsy)

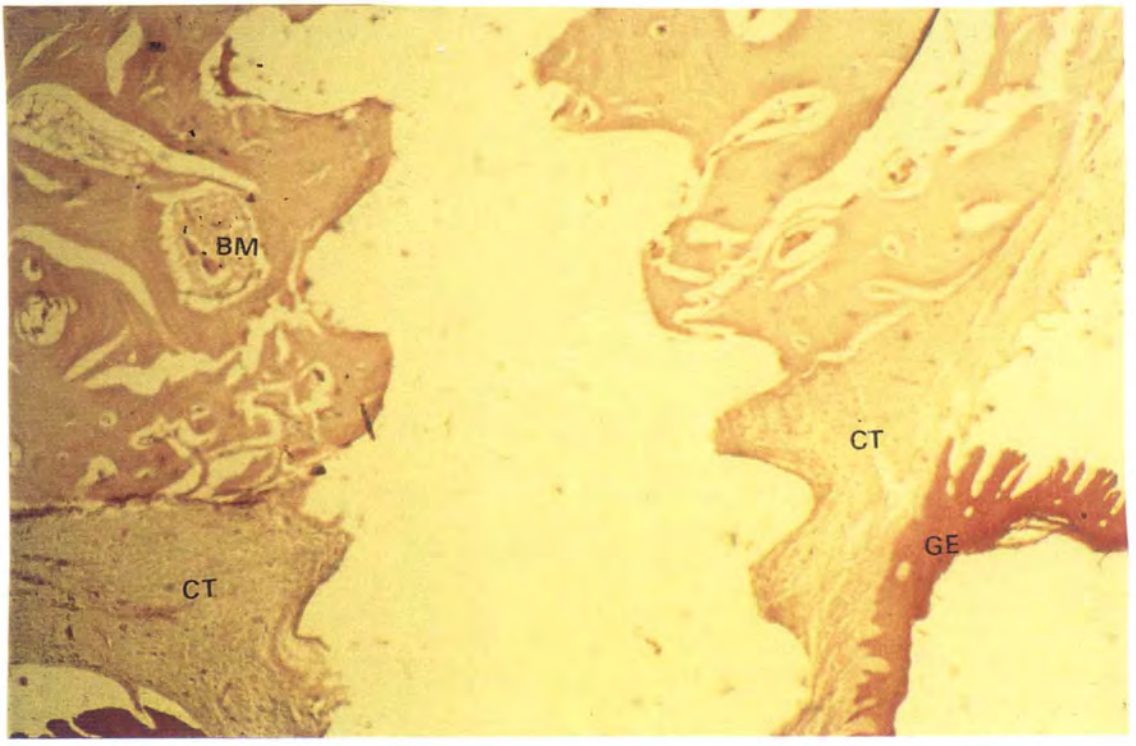

Fig. 15: Original magnification X 10. H.E. Panoramic view. G.E.: gingival epithelium. C.T.: Connective tissue. B.M.: Bone marrow.

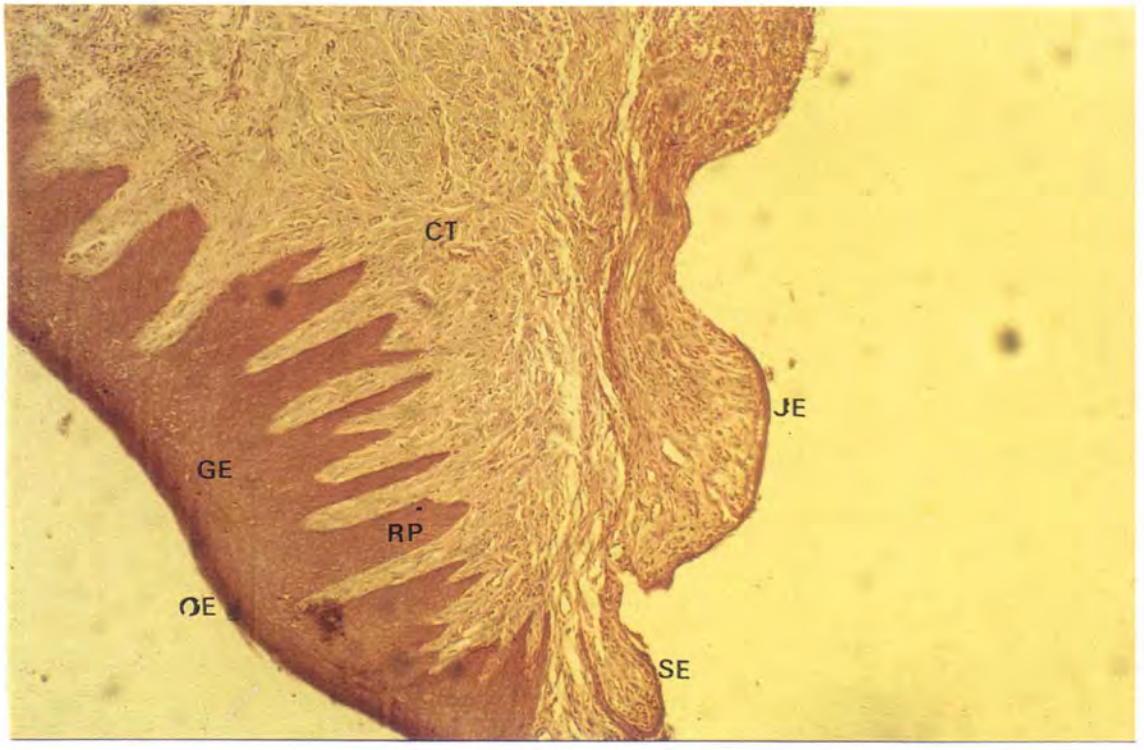

Fig. 16: Original magnification X 80. H.E. Gingiva. O.E.: Oral epithelium. S.E.: Sulcular epithelium. J.E.: Junctional epithelium. C.T.: Connective tissue. R.P.: Rete pegs. Junctional epithelium adapted at geometry of spires.

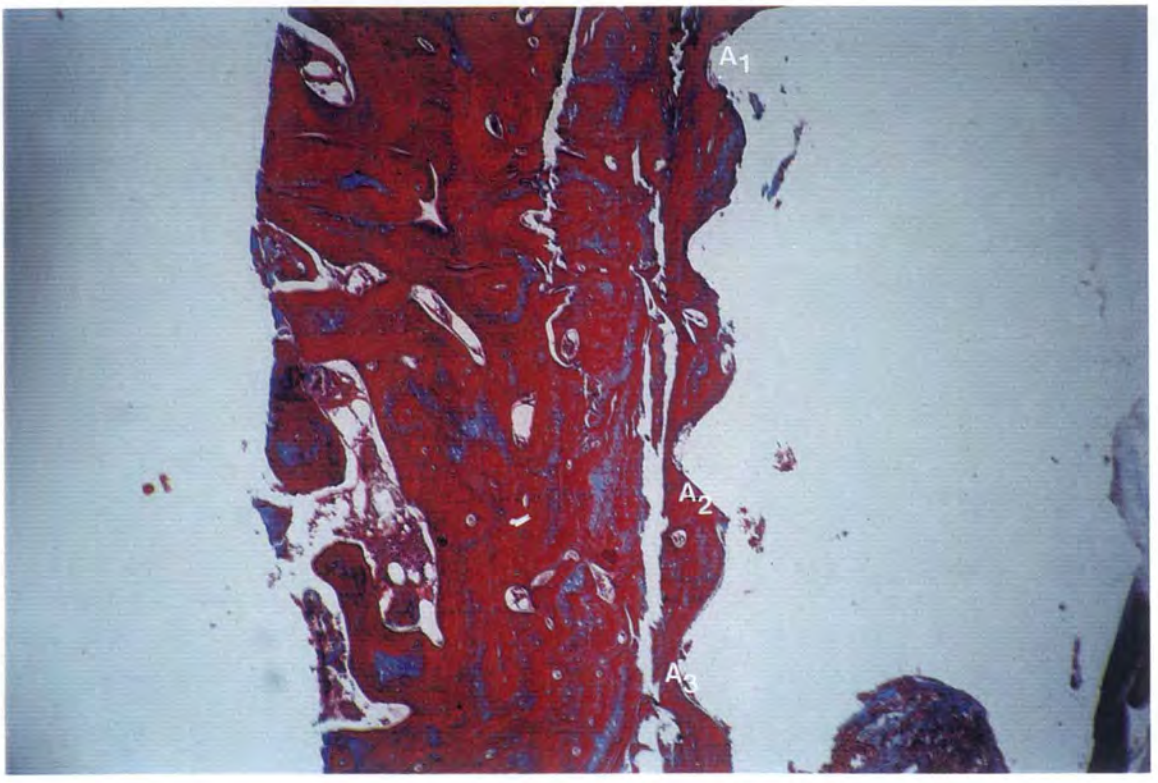

Fig 17.: Original magnification X 20. Mallory Trichrome. Longitudinal section. Panoramic view of compact periimplant bone, highly vascularized, in intimate contact with implant surface. Isolated areas of fibrous connective tissue. A1, A2, A3: Areas that will be described at high power.

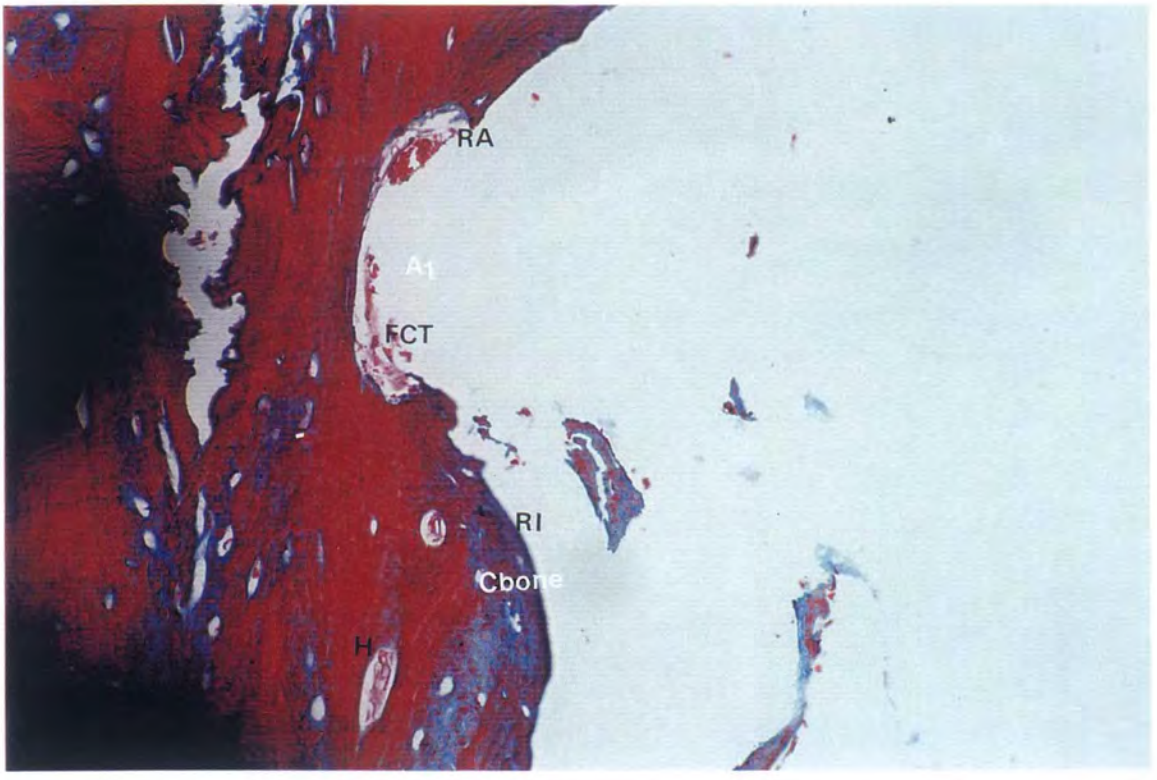

Fig. 18: Original magnification X 100. Mallory Trichrome. High power, Area 1. F.C.T.: Fibrous connective tissue. C.B.: Compact bone ankylotic type. R.A.: Remodelling area. R.I.: Rigid interface. H: Haversian system.

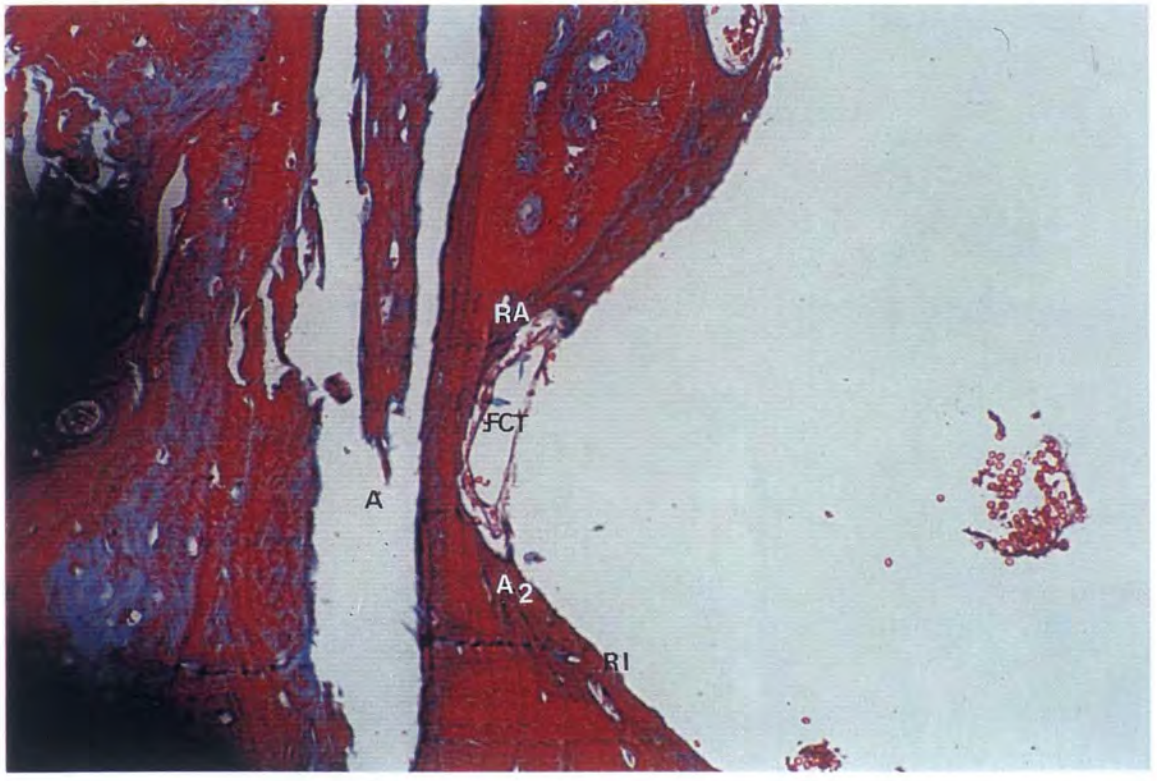

Fig. 19: Original magnification X 100. Mallory Trichrome. Periimplant compact bone - Lamellar bone. High power, Area 2. A: Artifact. R.I.: Rigid interface. F.C.T.: Fibrous connective tissue. R.A.: Remodelling area.

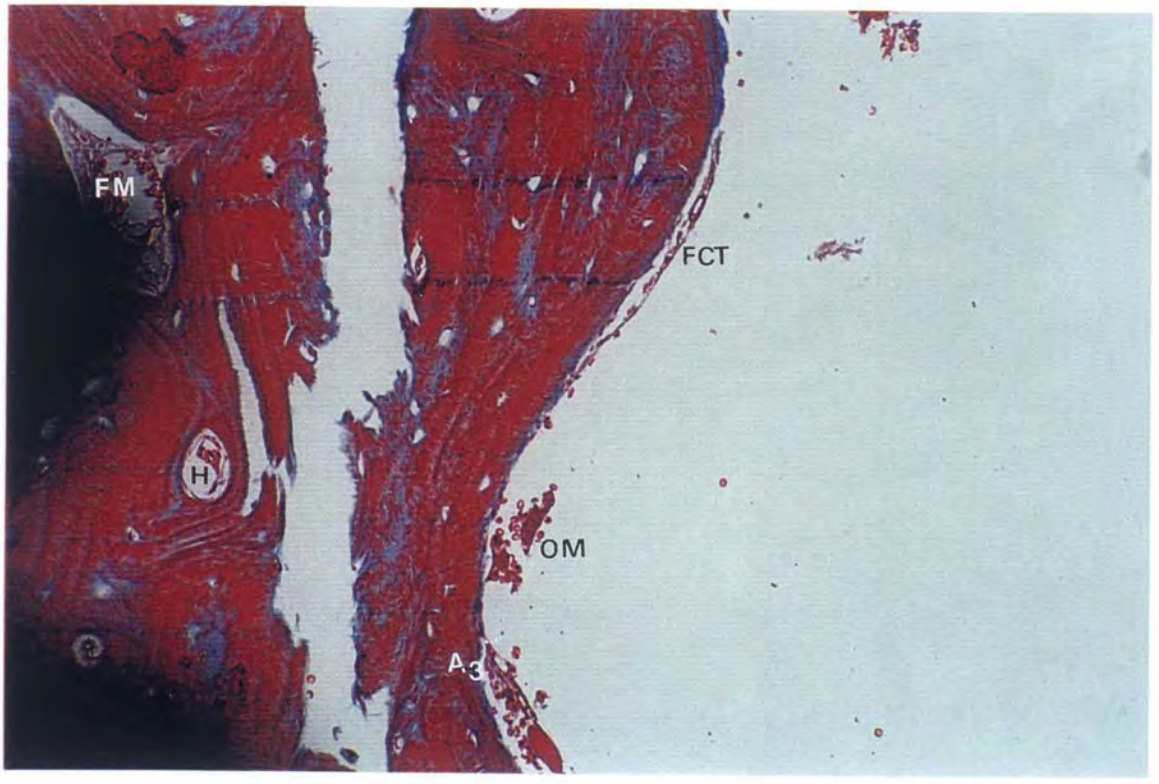

Fig. 20: Original magnification X 100. Mallory Trichrome. High power, Area 3. Lamellar compact bone. F.C.T.: Fibrous connective tissue. F.M.: Fibrous bone marrow. O.M.: Organic material. H.: Haversian system.

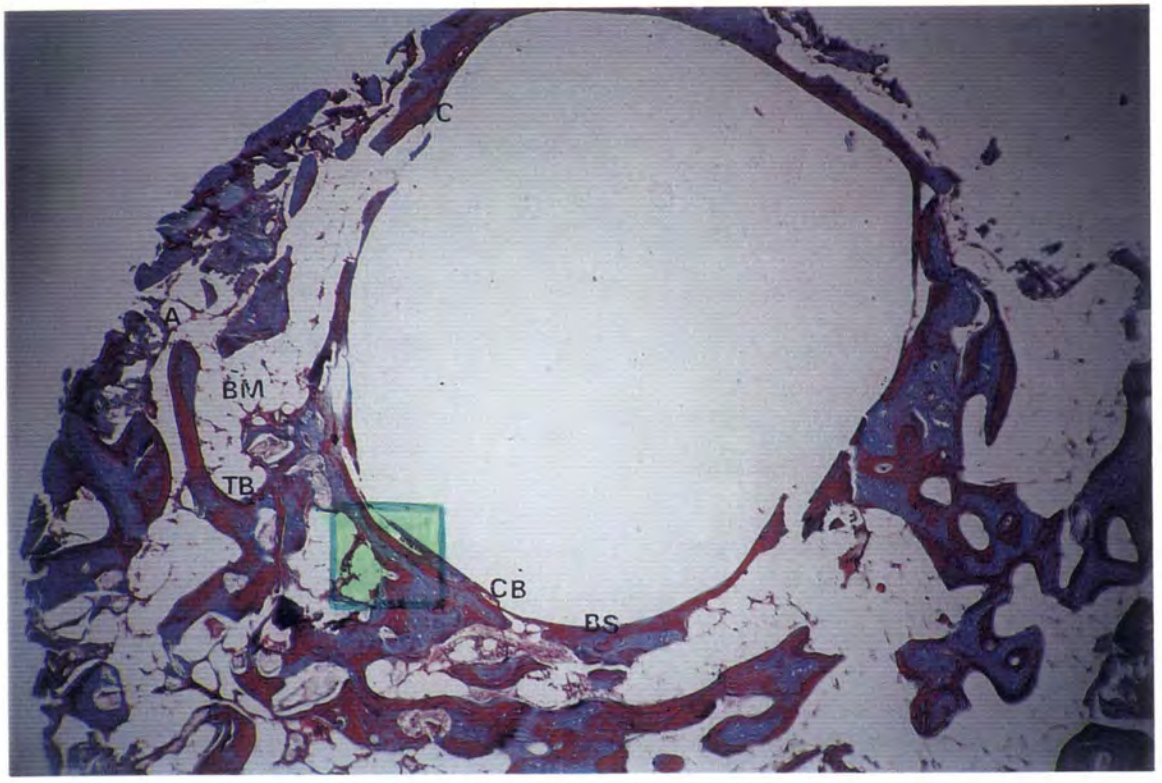

Fig. 21: Original magnification X 20. Masson Trichrome. Transversal section. T.B.: Trabecular bone. B.S.: Bone support. C.B.: Cortical bone. B.M.: Bone marrow. Trabeculae reorientate and change in size (micromodelling) to resist functional loads.

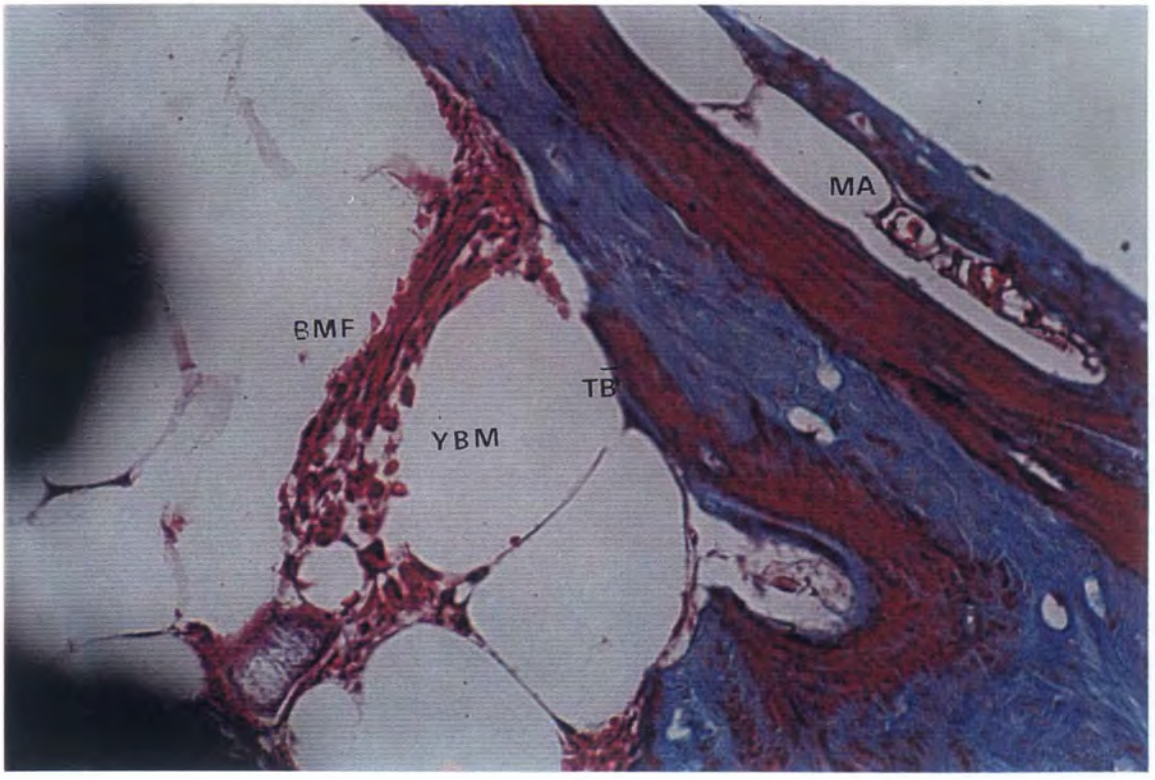

Fig. 22: Original magnification X 100. Masson Trichrome. High power of anterior figure. T.B.: Trabecular bone. B.M.F.: Fibrous bone marrow. Y.B.M.: Yellow bone marrow. M.A.: Modelling area.

DISCUSSION.

The clinical success of an endosteal dental implant, is attributed to the osseointegration system: a direct bone to implant adaptation described in submerged implants (9) as well as in non submerged implants. (10)(11).

But this criteria for implant success cannot be considered unique; in fact different types of implants have showed an interface with more bone, more fibrous than osteogenic with important success. (12)(13).

The authors of the present study confirm that the Transitional implant inserted in the cortical bone, shows physiologic stable fixation retention. In the osseointegration system, we can have rigid osseous fixation with sectors of loose connective tissue (loose stroma type), so the formation of fibrous tissue surrounding endoosseous implants has been proved to be predictable. (14)(15).

CONCLUSIONS.

1. Progressive maturation and remodelling resulting in the formation of a dense mature bone, with osteocytes embedding throughout, complete with secondary mineralization period.

2. Osseous rigid interface with isolated areas of fibrous connective tissue. (Pseudo periodontal ligament.)

3. Bone quality is lamellar compact bone, ankylotic type in implant loaded functionally.

4. Vascular channels, specifically Volkmann, and bone marrow is the origin of the soft connective tissue interface.

5. Our microscopic finding with the Transitional implants loaded functionally, demonstrated generally a satisfactory clinical performance.

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