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Clinical Estimate of the Efficacy of Osteoplastic Material Osteon Collagen 3 in Filling Jawbone Defects by Socket Preservation Method

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Abstract After the extraction of a tooth in the alveolar ridge the mechanism of irreversible changes is triggered, in particular, the ridge itself in the area of the tooth socket begins to decrease in volume and morphologically transform. These changes subsequently create unfavorable conditions for prosthetics procedures in the extraction site and sometimes the impossibility of installing the implant (2, 3). Preventive measures on the part of the dental surgeon and in particular the manipulation of the tooth socket, which help to preserve its volume, help not only to carry out the implantation procedure in this place, but also to achieve an excellent aesthetic and functional result when prosthetic on the implant. Such measures can be applied thanks to the modern development of technological production of modern technologies for the creation of materials for guide bone regeneration (GBR). The possibility of using the none resorbed and the resorbed barrier membrans with only one substitute material Osteon Collagen 3 for preserving alveolar ridge after tooth removal was disclosing in this article.

Keywords: socket preservation, extraction tooth, alloplastic material, dPTFE membrane, collagen membrane, Osteon collagen 3

Introduction. Loss of bone volume can occur due to a variety of causes, one of which may be failures in endodontic treatment, periodontitis, trauma to the occlusion, traumatic tooth removal. All these reasons lead to a general result to deformation of the alveolar ridge, expressed in a decrease in its height and width. Reducing the volume of the alveolar ridge can lead to aesthetic problems when using an implant-supported hybrid prosthesis or in the manufacture of removable a complete and partial prosthesis or to the absolute impossibility of installing an implant. These problems of bone volume deficiency occurring after tooth removal can be solved by filling the socket of extracted teeth with bone substitute material using barrier membranes or without them. This technique is called Socket preservation (4). The optimal modification of this technique is to fill the socket of the removed tooth with bone plastic material and cover it without fixing the dPTFE membrane, makes it possible to maintain the necessary volume of the ridge after bone regeneration and subsequently implant installation at the site of the removed tooth. This technique, due to the properties of the membrane material, makes it possible to leave it in the oral cavity in a soft tissue-uncovered condition.Two important components supporting the structure of the tooth-alveolar complex the wave bone and periodontal ligaments are completely destroyed at day 14 after tooth removal (3) .Schropp et al. showed the end of the socket healing of the removed tooth occurs 12 months after

removal. During this period loss of about 50% of the bone thickness of the alveolar crest (5-7 mm) can be observed, with the first two-thirds occurring in the first three months.(fig.1)

Fig.1Condition of alveolar ridge in the case using Socket preservation procedure (path low) and without it (path up)

These morphological changes lead to a recession by the soft tissues of the alveola and resorption of the buccal wall of the alveola to varying degrees of severity, which greatly complicates the subsequent rehabilitation of secondary adentia. (1,2) Elian et al. (5) proposed their classification of socket types in the post-extraction period:

Type 1 - intact or normal level of facies soft tissues and buccal plate, the most preferred morphotype, which provides a predictable aesthetic and functional result after installation of the implant

Type 2-intact or normal level of facies soft tissue, but there is a minor defect in the buccal cortical plate. This morphotype provides a dubious aesthetic and functional result in implant reconstruction of a lost tooth.(fig.2)

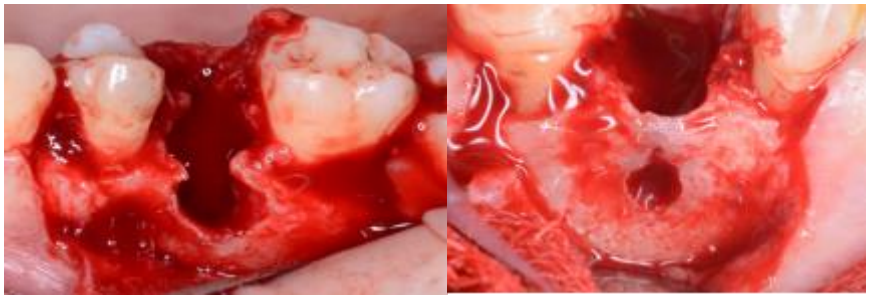

Fig.2 Case with dehiscence of buccal wall of socket (left) and fenestration (right)

Type 3- has a reduced level of facies soft tissues, as well as a destroyed buccal bone plate. This type of socket requires the GBR procedure to restore bone deficiency.(fig.3)

Fig.3 Broken buccal wall of tooth socket

The GBR procedure with type 3 socket requires the use of bone replacement and barrier materials with fixing elements for the latter. Bone-substituting materials include: autogenic, allogenic, xenogenic and alloplastic bone materials (5). (Table 1) Barrier materials include various types of resorbed and non-resorbed membranes (Table 2)

One of the main alternatives in using the method of preservation of the socket is the procedure of immediate implantation after tooth extraction - Immediate implantation. However, this method of treatment often becomes impossible for the following reasons:

1) unfavorable orientation of the tooth axis (fig.4,blue line) along which the implant is planned to be installed, which can lead to fenestration of the buccal wall of the socket and the incidence of perimplantitis, but there are presence enough bone for implant installation is worse path for sequel prosthodontic reconstruction (fig.4,red line).

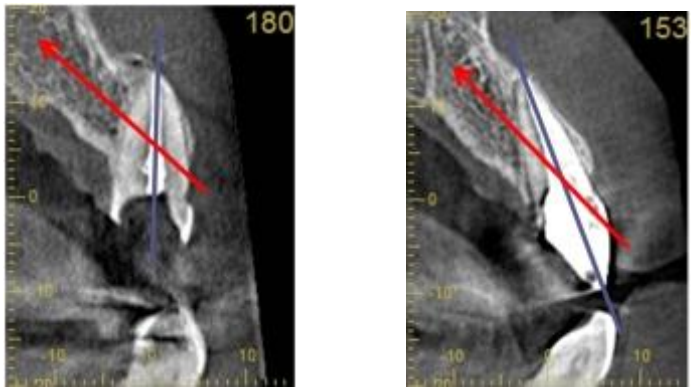

Fig.4

2) Presence of periapical chronic lesion with disturb of bone tissue, which leads to deficiency of bone tissue volume in the apical or buccal direction. There are risks of stable implant fixation or recession soft tissue.(fig.5)

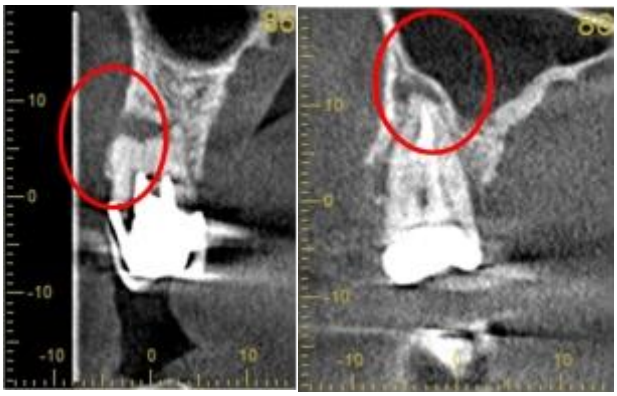

Fig.5

The problems of bone volume deficiency that occurs after tooth removal can be solved by filling the socket of extracted teeth with osteoplastic material using membranes or without them. This technique is called Socket preservation (4). The socket preservation technique is a type of guide bone regeneration (GBR) technique that aims to preserve the volume of the socket of the jaw after tooth removal by filling it with osteoplastic material and coating the protective membrane. The basis of this technique is to fill the socket of the extracted tooth with bone substitute material and cover it without fixing the PTFE with a membrane, which makes it possible to maintain the necessary volume of the ridge after bone regeneration and subsequently implant installation at the site of the removed tooth. This technique due to the properties of the membrane material makes it possible to leave it in the oral cavity in a soft tissue-uncovered state. Later modifications of this technique included the use of a new type of PTFE membrane-dPTFE, as well as a collagen membrane. The

GBR procedure with type 3 socket requires the use of bone substitute material and barrier materials with fixing elements for the latter. There are substituting materials include: autogenic, allogenic, xenogenic and alloplastic bone materials (5). (Table 1) Barrier materials include various types of resorbed and non-resorbed membranes (Table 2)

Materials and methods research

1. View of materials

Alloplastic bone replacement material Osteon Collagen 3 manufactured by South Korea was prepared to fill bone defects in clinical research. Osteon collagen 3 is a new synthetic material comprising 60% hydroxyappatite and 40% calcium phosphate (CaP) with collagen coated particles. (fig.6) This material also has high hydrophilic properties and structure porosity, high regenerative and osteoconductive properties. It is used in all operations of the GBR.

Fig.6 alloplastic bone substitute material Ossteon collagen 3

Two types of membranes of South Korean production were used as barrier materials: absorbable and non-absorbable.A dense polytetrafluoroethylene membrane (dPTFE) BIO-MEM was selected from the non-absorbable membrane (fig.7)

Fig.7 dPTFE membrane BIO-MEM (S.Korea)

Of the resorbing collagen membrane, Colla-D with a resorption period of 6 months (Fig.8)

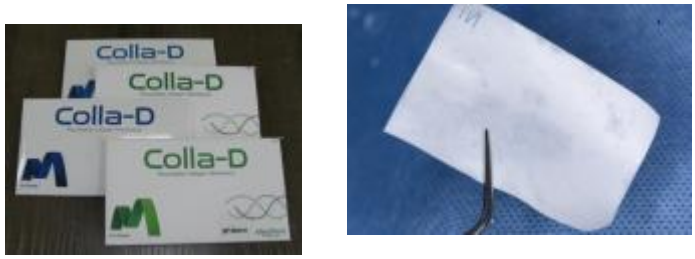

Fig.8 collagen membrane Colla-D

Microscew for osteoplasty procedure from the SurgiDent kit were used as fixing elements (Fig.9)

Fig.9 SurgiDent kit for osteoplastic procedure

2. Specificity of the operation of applying osteoplastic material to the tooth socket (Socket preservation)

All procedures were performed under local anesthesia with 0.01% Articaine hydrochloride solution. In the clinic similar procedures were carried out in the field of socket defects for each of the Edlan type, while for better restoration of the crest volume in class 3, the use of micro-screws as Tent Screws was proposed during the operation. (screws supporting the space under the membrane),but for the 2nd type a modification of the classical method according to Tarnow et al. was proposed using a collagen membrane and soft tissue graft. And we used both types of membrane in the case of the first type.

2.1 Socket Preservation Technique by Edlan type 1 (clinical case)

Patient A., 38 years old, went to the clinic of surgical dentistry, where generalized chronic paradontitis 45,46,47 was diagnosed according to the diagnostic data.

After the diagnostic procedures the patient was offered a treatment plan, that included removal of all dental roots and preservation of the wells (Fig.10).

Fig. 10. Intraoral photo upper and lower jaw, right lower segment 45-47

Fig.11 Panorama X-rays

During the operation, the patient has taken mandibular and local anesthesia (Articaine Hydrochloride 1:100000 7 mL). The 45,46,47,48 roots were removed after anesthesia by using an atraumatic technique in order to preserve the socket with periotomes and elevators,. The sockets of the extracted teeth were carefully subjected to curettage and irrigation with a 1% Chlorhexidine bigluconate solution. Defects in the edges of the sockets of the extracted teeth with characteristic irregularities and notches often occur after removing the periodontic teeth. To eliminate these shortcomings it is necessary to smoothing the edges of the wells using various tools. In our work we

used a diamond rotating bur. After preparation of the dental sockets a dPTFE membrane was prepared for subsequent coating of these sockets with filled bone-substituting material. After the membrane was fixed to the buccal wall of the alveolar crest, the sockets of the teeth were then filled with bonesubstituting material of alloplastic origin. (Fig. 12)

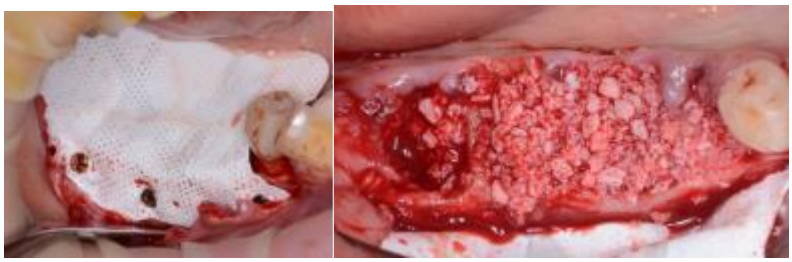

Fig.12 Fixation of the membrane to the buccal wall of the alveolar crest and filling of dental wells with bone-plastic material of alloplastic origin.

After filling the dental wells with bone-substituting material of alloplastic origin, the opposite edges of the membrane are fixed to the lingual cortical plate (Fig. 13)

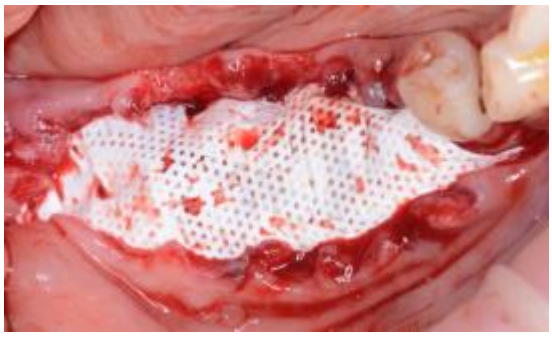

Fig. 13. Final fixation of the membrane on the lingual side.

After the membrane has been stably installed in place, the edges of the flap are tightened without incision of the periosteum due only to the elasticity of the soft tissue flap fibers themselves. Thus we prevent the need for subsequent soft tissue procedures to enlarge the oral cavity vestibuloplasty. The operating field is re-treated with an antiseptic (Betadin) and dispensed to the patient, having previously informed him of the oral hygiene rules and the course of administration of antibacterial, analgesic and antiseptic agents. In the third week after performing the procedure of Socket preservation and removing the sutures we observe a partial healing process between the edges of the flap and a partial exposure of the membrane. There was no inflammation or exudation from the augmentation site. The patient was prescribed a more thorough hygienic care of the membrane exposure sites. At the 8th week the patient went to the clinic with symptoms of periosteal inflammation and infection. After examination of the site of augmentation of the sockets poor hygiene on the part of the patient was revealed. As a result of this it was decided to remove the membrane and tighten the edges of the flap (Fig. 11). After removal of the membrane the presence of granulation tissue covering the surface of augmentate was founded . Then the inner edges of the flap were deepitalized with a scalpel blade and approximated with resorbable suture (Fig. 14)

Fig. 14 Removal of membrane and contraction of flap edges with resorbed sutures (Vicrill 6-0)

After that the patient was released home with additional recommendations for the care of the augmentation site.

At 9 months after the operation Foto taking (fig.15) and an X-ray examination was performed and a biopsy (fig.17) was taken from the 45.46 tooth area for observation of bone regeneration in the socket.

X-ray analysis data (3D) showed a dense homogeneous area of newly formed bone tissue. (Fig.16)

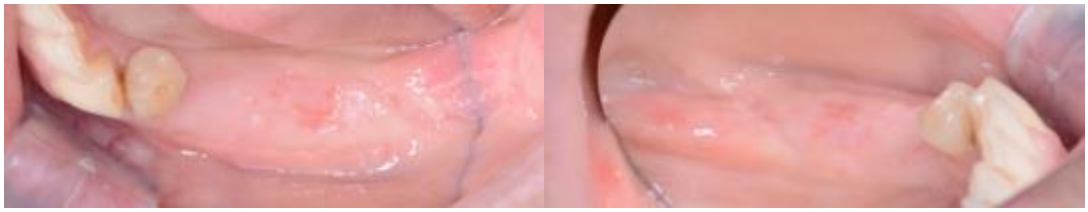

Fig.15 Intraoral view of ridge at 9 month after augmentation

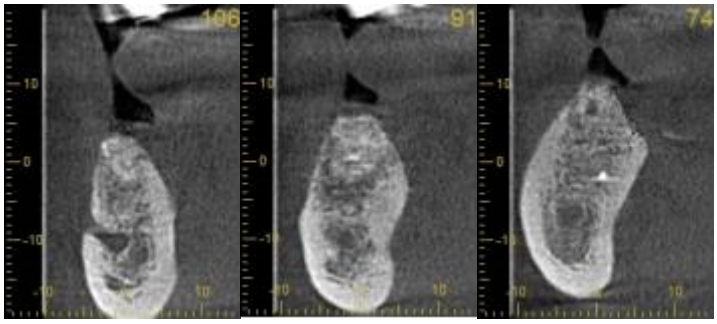

Fig.16. Sectional images 45,46,47 (from left to right, respectively)

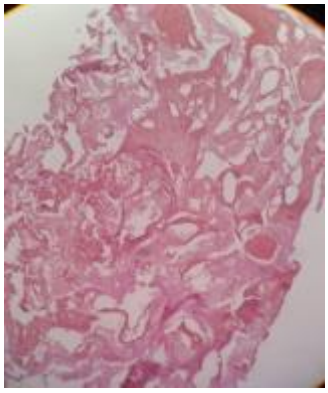

Fig.17 Histologic slice of the bioptat from area 46 (hematoxylin-eosine, enlarged by 100 (on the right)

2.2 Socket Preservation Technique by Edlan type 2 (clinical case)

Patient A., 41 years old went to the clinic of surgical dentistry, where according to the diagnostic data chronic periodontitis and vertical root crack 11 were diagnosed. The tooth was endodontically previously treated, the percussion was positive, the bite test was also positive(fig.18). After the consultation the patient was offered a treatment plan, which included an atraumatic tooth removal procedure and GBR procedure to prevent loss of alveolar crest volume after removal in the aesthetic zone. Subsequently, implantation was planned, which the patient could not agree to immediately after the tooth removal due to financial difficulties.

Fig.18. (from left to right) Alveolar process with swelling and fistula in tooth area 21 and Computed Tomogram Section of Tooth Region 21

After removal of the tooth the socket of it was carefully subjected to curettage in order to remove all soft tissue remains before the GBR procedure. The buccal wall of the socket was measured by a periodontal probe to determine the size of the bone deficiency vertically. For bone defects greater than 5 mm the sockets were defined as type 2 defects. The collagen membrane was cut to the shape of a cone resembling an ice cream cone and inserted in the socket along with the Osteon Collagen 3 material. A significant difference of the proposed modified technique lies in the absence of fixation of the "cap" of the occlusive part of the collagen membrane to the surrounding soft tissues and the application of a free connective graft over the bent cap of the collagen membrane and fixation of this complex simultaneously to the surrounding soft tissues. The purpose of using this graft is to better protect the collagen membrane from exposure to the oral environment, as well as the possibility of using different types of collagen membranes with reduce the risk of micro-ruptures in the penetration area of the suture needle. The patient was prescribed prophylactic antibiotics (Amoxicillin 500 mg) before and after surgery 3 times per day, as well as the use of antibacterial solutions and ligaments based on Chlorhesidine Bigluconate (Loraben and Metrogil Denta)

Before performing surgical manipulations in the area of the socket to be removed all prosthodontic constructions must be removed. Then the root is cut in the labially-lingual direction to preserve the buccal wall of the socket. Tooth extraction is carried out atraumatically with the help of elevators and luxators; after removal of the root a thorough curettage of the socket is carried out (Fig 19) The next stage of this technique is the preparation of a free gingival flap, which is taken from the palate from the patient and contoured under the shape of the socket (Fig. 19). After that the formation of a collagen membrane structure resembling an ice cream cone begins (Ice cream cone) (Fig.20). In parallel to this step Osteon Collagen 3 an alloplastic material packed as a cylinder in physiological saline is soaked (Fig.20) The contoured membrane is then placed in the tooth socket adjacent to the buccal wall of the well and filled with osteoplastic material Osteon collagen 3.(Fig. 21), the edges of the membrane are folded in the form of a "lid" and cover the occlusive part of the socket. (Fig.21). Further the membrane is not sutured to surrounding soft tissue as is customary in the classical version of this technique, but is covered with a free connective duct graft, which is then fixed with sutures together with the membrane in the form of one complex. (prolene 6-0) to the surrounding gingivae (Fig.22) The patient is re-prescribed for histological and X-ray examination of the preserved socket after 9 months (Fig.23,24,25)

Fig.19. Taking and countering FGG for closing the hole of socket

Fig.20.Prepared and contoured collagen membrane Colla-D. Fig 10.Soaked in isotonic solution Osteon collagen 3 material

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Fig.21. Placing of the collagen membrane in the socket and its filling with osteoplastic material

Fig.22. Location of the free gingival graft over the occlusive surface of the collagen membrane and fixation of this complex to the surrounding gingival tissues.

Fig.23 View of the operating area in 9 months

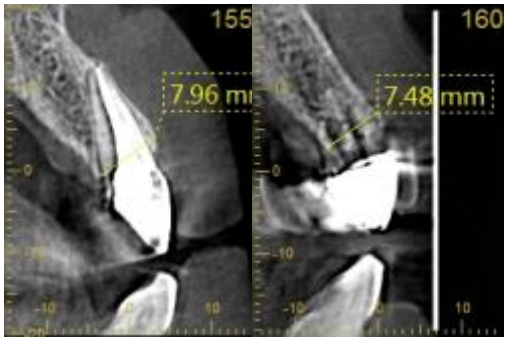

Fig.24 X-ray slice of tooth 21 after 9 months showing stable dimensions of alloplastic augmentate

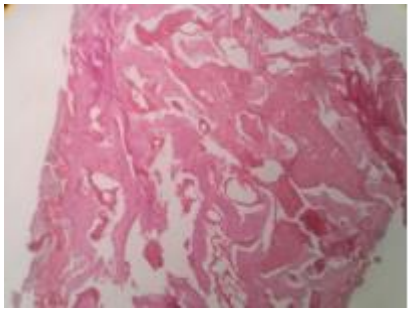

Fig.25 Histologic slice of the bioptat from area 11 (hematoxylin-eosine, enlarged by 100);

2.2 Socket Preservation Technique by Edlan type 3 (clinical case)

Patient A., 58 years old, went to the surgical dentistry clinic, where the diagnosis showed chronic pariodontitis 36. Due to damage to the buccal wall of the socket (Fig.26,27,28,29)

Fig.26 Intraoral photos of the patient

Рис.27 Patient panorama’s

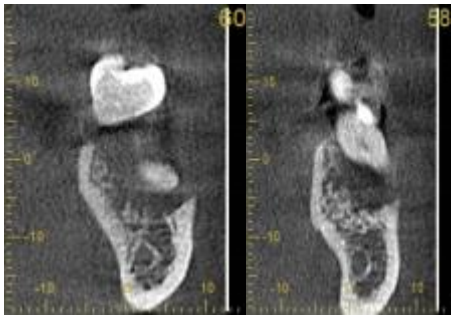

Fig.28 Section image of tooth 36

Fig.29 Intraoral photographs of individual tooth segment 36

The patient was offered a treatment plan that included the removal of 36 and the preservation of wells with the GBR method.

Operation Process:

1. During the operation the patient underwent mandibular and local anesthesia (Articaine Hydrochloride 1:100000 7 mL). After anesthesia using an atraumatic technique to remove tooth roots in order to preserve the remaining walls of the socket with periotomes and elevators roots 36 were removed. The socket of the removed tooth made thoroughly curettage and irrigated with Chlorhexidine bigluconate 1% solution

Removal of 36 revealed a severe defect in the buccal wall of the socket, which provided for additional measures to eliminate further soft tissue collapse into the hole defect (Fig.30)

Fig.30 Buccal wall defect of tooth socket 36

2. The GBR procedure provided for the installation of tent-screw-micro screws to hold the membrane dome and create a space for filling the graft (Fig.31)

Fig.31 Installation of tent screws in the lingual wall of the alveolae, attach and final fixation a membrane .

After fixing the tent screws the dPTFE membrane is dissected according to the shape of the hole defect and bone substitute material of alloplastic origin is prepared (Fig.31)

3. fixing the membrane from the buccal side and filling the defect with alloplastic material. The membrane attached from the buccal side restores the lost wall of the socket itself, as well as its configuration (Fig.31)

4. The membrane is fixed with a micro-screw on the opposite side of the well. (Fig.31)

5. The membrane is covered with gingivae flaps, but not tightly sutured, bringing only their edges closer. The surgical field is re-treated with an antiseptic (Betadine) and the patient is dispensed having previously informed him of the oral hygiene rules and the course of administration of antibacterial, analgesic and antiseptic agents.

Fig.11Approxmation edges of the flap without flap edge stretched and without using flap mobilization technique by periosteal dissection.

15 days after the procedure, there is a loss of some sutures and a greater opening of the membrane compared to the moment of approximation of edges of the flaps in the postoperative period. (Fig. 32)

Fig. 32 Membrane condition on day 15 after surgery

After 25 days, the patient's appointment showed stabilization of the dehiscence of the wound. There were no signs of inflammation or complaints from the patient. After 2 months (on day 56) the patient complained of inflammatory infiltrate and tenderness on the part of 36. The examination revealed the presence of inflammatory infiltrate and the event exudation from augmented place . A large amount of plaque and food remnants were observed on the membrane surface, that is indication of poor hygiene. It was decided to remove the membrane(fig.33).

Fig.33 Membrane condition for 2 months after operation and exposed bone augmentate with its covering rich granulation tissue.

After removal of the membrane in the operation site cavity filled with osteoid with rich granulation tissue on the surface was revealed. (Fig.33)

The wound after membrane removal was closed by resorption sutures (Vicril 6-0) After 9 (on day 63) months from the day of the operation histoanalysis was performed, a sample of area 36 was taken, and a cone-beam computer radiograph was performed (Fig. 34,35,36)

Fig.34 Intraoral photo 9 months after surgery

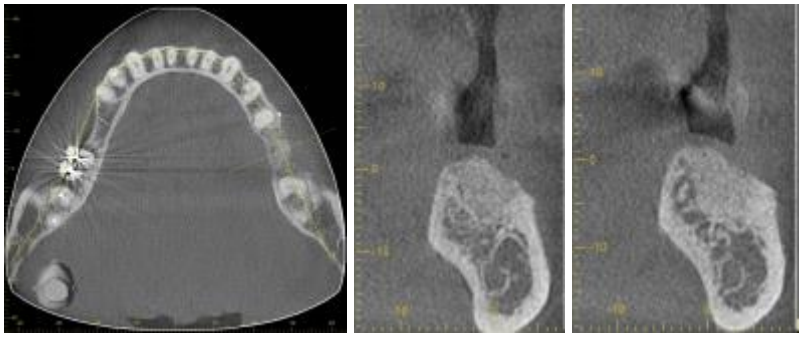

Fig.35 Section X-rays of tooth area 36

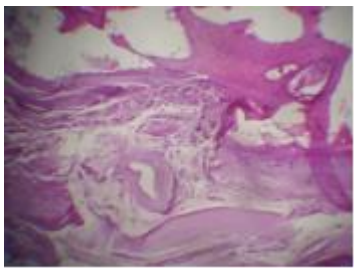

Fig.36 Histologic slice of the bioptat from area 36 (hematoxylin-eosine, enlarged by 100);

Result

According to the results of X- ray research we observed stable sizes of sockets of extracted teeth preserved by various techniques of the Socket preservation method.

Histology results showed the presence of partially mature and decorated bone tissue with a large number of osteoblasts on the surface of the bone trabecules, fibroreticular tissue.

X-ray and histological results allow us to recommend this Osteon Collagen 3 material for use in the Socket preservation method.

Summary:

According to research, we can conclude that:

1. that the use of the dPTFE membrane in its exposed state by the Socket preservation technique gives a predictable result.

2. using only one alloplastic material Osteon Collagen 3 makes it possible to obtain of full value augmentate.

3. Covering one large membrane with adjacent sockets gives savings in time for manipulating it and in the cost of the procedure itself

4. the use of free connective tissue graft in the Socket preservation technique proposed by Tarnow et al. as additional element makes it possible to use all types of membranes, both elastic and non-elastic

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