REVIEW ARTICLE

A CASE REPORT WITH IMMEDIATE FUNCTIONAL LOADING CORTICAL IMPLANTS: MULTIMODAL CLINICAL APPROACH ENCOMPASSING ORAL SURGERY, ORTHODONTICS, IMPLANTOLOGY, AND PROSTHODONTICS.

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ABSTRACT

Rehabilitation of teeth by implant placement has been now a routine treatment modality in dental practice. However, the traditional protocol for implant therapy essentially demands many preconditions like quantity and quality of alveolar bone, long waiting period for achieving osseointegration, and sometimes adjuvant bone augmentation surgeries or sinus lifting with or without bone grafting. Above all the question of initial stability through placement of implant into alveolar bone dictates the ultimate decision to load the implant for successful immediate functioning. Impaction of permanent teeth subjacent to over-retained deciduous teeth especially in aesthetic zone poses a different challenge to the clinician. The step-by-step clinical procedures of surgical removal of impacted teeth, creation of arch space by orthodontic treatment, if needed, and finally the placement of cortical implants followed by immediate loading are the only choice of treatment strategy. A young female patient with maxillary bilateral canine impactions is hereby reported for immediate loading functional cortical implants preceded by surgical removal of impacted teeth and orthodontic therapy.

KEY WORDS

Rehabilitation of teeth, cortical bone, cortical implant, canine impaction, orthodontic treatment, immediate loading, prosthodontics.

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INTRODUCTION

Ever since Prof. P.I.Branemark advocated the strict protocol for placement of dental implants into alveolar bone, the dentistry started gaining its clinical success in the management of dental rehabilitation.[1-2] But sufficient alveolar bone in quantity and quality are the prerequisites for optimal housing of implants.[3] If sufficient bone is not available, the deficiency of alveolar bone is compensated through time-consuming, expensive and precision-driven surgical endeavours like bone augmentation or bone transplantation.[4] Maxillary posterior areas pose a different challenge where caudal expansion of sinus floor becomes very close to alveolar ridge resulting in no bone situation for implant placement.[5] The only option left is to lift the sinus membrane with bone grafting.[6] These clinical procedures are very technique-sensitive and, thus, not always success-oriented.[1] Another clinical situation which comes in the way of implant placement is the impacted tooth which will not allow implant to pass through. In addition, traditionally, implants once placed in alveolar bone require a long healing period of 4-6 months for osseointegration to take place. Patients somehow do not appreciate such a long period of waiting and also additional expenses, if any, to be spent for ridge development.[6] On the contrary, they want rehabilitation of teeth immediately with no additional hassle of bone growth surgery. Moreover, patients having severe degree of atrophy of jaws, diabetics, heavy smokers are usually labelled as contraindicated for conventional implant therapy.[7] All these limitations can effectively be handled with a very unconventional implant system. The philosophy of this implant system is based on medical Traumatology and Orthopaedics. These implants are known as Cortical Implants[8-10]; these do not depend on the alveolar bone for its housing. The spongy alveolar bone is porous in architecture and unable to offer proper initial stability to the implant substrate it receives instantly upon insertion. The cortical implant does pass through the healed alveolar bone (ridge-top being known as 1st cortical) and reaches the corresponding subjacent denserbasal trabeculae, and then, radiologically highly opaque cortical bone (known as 2nd cortical) (Fig.1). It perforates about 1-2mm inside. In some instances, in maxillary bone, it may even reach after perforating 1st and 2nd cortical

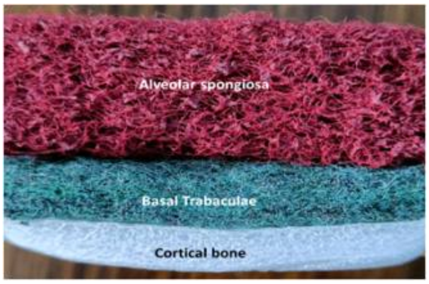

Figure 1. Representation of vertical section of an edentulous mandible showing alveolar spongiosa of the alveolar bone (Red), denser basal trabeculae (Green), and densestcortical bone (Green).

Figure 2. Orthopantomographic view of various cortical implants engaged in different cortical bones of cranio-maxillo-facial interest.

Figure 3. Panoramic radiograph of maxilla shows bilateral impaction of permanent canines. Note the distal migration of the root of left lateral incisor.

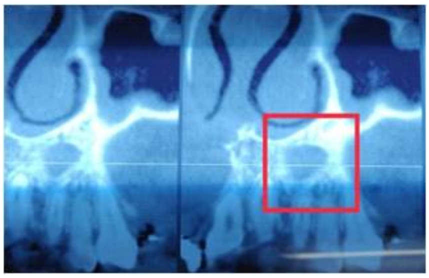

Figure 4. CBCT radiograph of two consecutive coronal sectional views of periapical areas of 12 and 22 showing the bone void (within red bordered box) created upon surgical removal of impacted maxillary canines.

bones, to a suitable peripheral cortical bone (3rd cortical) of cranio-maxilla-facial interest (Fig.2). Normally, the 3rdcortical bones are (a) the Lateral plate of Pterygoid Process of Sphenoid bone, (b) Zygomatic buttress of Zygomatic bone, and (c) Infraorbital rim.[11] This implant system is very effective in highly resorbed alveolar ridge even in `no bone` situation.[12-18] Both the jaws, thus, have different strategic areas of either basal trabeculae or the cortical bones where the implants upon insertions can achieve a very satisfactory level of initial stability for immediate functional loading .

CASE REPORT

A young woman, aged 30 years, reported with the unsightly small teeth in upper aesthetic smile zone which used to be visible upon smiling and speaking. She wanted to have a good look of her smile. On clinical examination, it was revealed that she had over-retained 53 and 63 and absence of corresponding permanent canines 13 and 23. On radiographic examination (OPG), it was revealed that she had maxillary bilateral impaction of 13 and 23 almost lying horizontally (Fig.3). Her general health was good and routine tests for blood revealed no abnormalities. In order to give her a good aesthetic-look, two experts were consulted for; one, Oral Surgeon for the removal of impacted canines and the other, Orthodontist for up-righting the lateral incisors. A definitive treatment plan was chalked out by the author as an implantologist. The detailed therapy was discussed with the patient. The patient agreed upon the treatment procedures and relevant consent was secured. Accordingly, following extraction of deciduous canines 53 and 63, the surgical removal of impacted 13 and 23 were performed under general anaesthesia. After initial healing of the surgical wound, she was advised for Orthodontic treatment for up-righting the roots of 12 and 22 which were tilted distally encroaching upon the possible passage of implants. The tooth 22 was greatly in need of up-righting compared to 12. However, during the time-consuming orthodontic therapy, the voids (Fig.4) created on removal of impacted teeth were gradually filled up with new bone. Meanwhile, lateral incisors were made to take at its right positions (Fig.5). The patient was then considered for implant therapy for rehabilitation of teeth[16,19].

THE IMPLANT PROCEDURE

(a) ***Implant selection***

At the end of orthodontic therapy, OPG revealed the mesio-distal width of cancellous bone between the roots of 14,12 and 22,24 were 4 mm and 4.2mm respectively. Two cortical implants, each 2.7 mm blade diameter and 23 mm length, were selected to pass through this space between lateral incisors and first bicuspids for engagement into the 2nd cortical bone which formed the nasal floor.

(b) ***The cortical implants***

The implants were essentially made up of

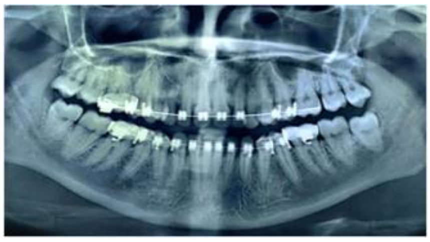

Figure 5. OPG shows that the patient is undergoing orthodontic treatment and lateral incisors are up-righted.

Figure 6. Cortical implant. Note the abutment (Head) and the sharp blades at the end of the shaft

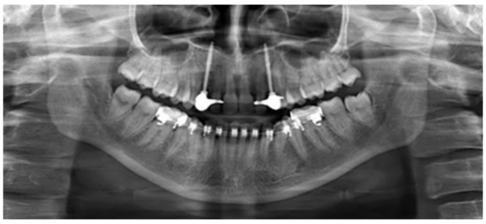

Figure 7. Placement of cortical implants done after removal of orthodontic wire and brackets. Note the tips of the implants have pierced the cortical bone of nasal floor. The PFM crowns are cemented on abutments. The radio-opaque cast claps are also seen.

Figure 8. PFM crownwith anti-rotational cast claps on model (A) shown on palatal side(B)

Figure 9. Smiling patient with finished prosthesis

Titanium ELI alloy (Monoimplant™, Switzerland)[15] (Fig. 6). It was a single piece implant with a very smooth shaft of 2mmdiameter. Over a length of 5.5 mm at the end (leaving approximately 2 mm from the tip) of smooth polished slender shaft, there were 5 very sharp spiral blades. The diameter of these aggressive blades was available from 2.7 mm to 9 mm. The abutment portion was the head of the implant and slight conical in shape (Fig.7). It was the part by which the implant was inserted into the bone with the help of inserting tools manually and/or with power driven hand piece. At the junction region of shaft and abutment, bending was given at an angle of 7◦ for straightening or aligning of the implant with the neighbouring teeth as per the requirement.[17] A special characteristic feature was seen at the tip; it was made in such a way that the tip was not too sharp for the reason that while inserting manually, very sharp tip-end could tend to go out of the osteotomy and would jeopardise important neighbouring anatomical structures or it might land up in a different location into 2nd and 3rd cortical bones. These blades were very efficient in cutting the cancellous bone with a feeling of "incising bone" and remained engaged into basal and cortical bone very tightly. The very smooth tip of 2 mm remains outside of the cortical bone after perforation. From the stand point of Orthopaedic views, submerged implant tip within mucosa of nasal floor did not elicit any untoward pathological reaction.

(c) ***Surgery***

Under infraorbital block anaesthesia using 2% Lignocaine Hydrochloride with Adrenalin 1:80,000 with the help of a sharp 2 mm pilot drill (Monoimplant,™ Switzerland) fitted in a straight hand piece of 1:1 ratio (Kavo™) at 25,000 RPM from a Physio-dispenser (Surgitek™, NSK) osteotomy was made and reached the underneath of corresponding 2nd cortical bone by a feeling of hard resistance. The cortical bone was just perforated with caution. The implants were then dipped into Providine Iodine solution (Betadine 5% Sol.™) and then inserted into the osteotomy sites using a manual driver along the path created by pilot drill and fixed into cortical bone allowing 2 mm of the implant smooth tip to cross the floor of the nasal bone (Fig.7). The implants were clinically tested to be very stable. The bending of about 7 degrees at the neck region was given and necessary trimming of the abutments were done as per the need from prosthetic point of view. Proper antibiotics and analgesics were prescribed with necessary instructions. Weekly post-operative check-ups for first 1 month and the then, monthly check-up for next 3 months was advised.

(d) ***Prosthetic work*** [20]

Impressions of both the jaws were made with rubber base impression materials and sent to the laboratory for porcelain-fused-to-metal crowns. Shade matching was done carefully. Registration of occlusion was recorded on Aluminium impregnated wax wafer (Aluwax™). A special instruction was given to the laboratory technician for constructing of cast clasp at the back of the neighbouring teeth along cervical margins at the palatal side (Fig 8). This prevents any possible rotational motion of the implant as well as labial movement of prosthesis under gnathodynamic excursions.

(e) *Loading of implant*

This implant technique mandatorily demands immobilization within 72 hours; more so when 1st cortical is missing. The PFM crowns were cemented onto the abutments using Glass Ionomer restorative material (Fuji II)[4] and occlusion was checked with bite papers (30-40µ thickness) both for static and dynamic movements of mandible. Palatal anti-rotation claps were also checked for its proper position (Fig 9). The patient was advised for chewing normal food and barred from consuming any extraordinarily hard food stuff for next 3 months. The patient was very happy.

DISCUSSION

Rehabilitation of teeth is required to any person who has lost tooth or teeth for a number of reasons. It becomes crucial in the maxillary anterior area (smile zone) where patients generally insist on replacement of teeth for cosmetic purpose. The functional need comes next. Both of these two criteria are very difficult task to fulfil through the conventional implant system. Cortio-Basal Implantology brings about the facility of achieving the superb initial stability by engaging the implant into the 'rock-solid' cortical bone and then, by being engaged firmly with many folds higher than the required torque, the implants become capable of withstanding the masticatory load and start immediate functioning[4,8-10]. This particular uniqueness of implant technique aiming to achieve tremendous initial stability is the backbone for its growing popularity. Not every case with such a high patient's demand can be dealt satisfactorily with Branemark's traditional protocol without additional and time-consuming adjuvant surgeries with/without grafts.

In the present case, the osteotomy was done by 2mm drill and no further tool was engaged either to enhance smooth passage of the implant shaft or to facilitate easy entry of tip-blade into cortical bone. The outer diameter of blade was 2.7 mm and, therefore, while passing through the 2 mm osteotomy hole within cancellous bone the implant screw widened the hole additionally 0.7 mm at the cost of the compressing the trabeculae. This perhaps, together with the heavy compression of the cortical bone, gave rise to mechanical fixation of implant and brought about the extra-ordinarily high initial stability to the implant. The material properties of these two members, Titanium alloy and cortical bone, were the final determinants as to how and which material would give the strength to whom! The stiff and hard implant material was forced manually to torque into cortical bone and the rotational movement at the abutment head was translated into linear motion of implant into basal and cortical bone, and ultimately could displace weaker cancellous bone as well as harder cortical bone. By being stressed, the implant material transferred the torque force to comparatively lesser strong bone around and the bone became under strain; the strained bone, in turn, gave the force (compression) back to the implant body and the implant achieved the high degree of initial stability.

The healing of the extraction socket heals on natural way[21]; neither the implant shaft comes on the way of healing nor does it do any favour to arrest the usual phenomenon of bone resorption. On immediate loading, the transmission of masticatory load passes through the shaft and distribute to the cortical bone with which it is fastened. The cancellous bone, unlike Branemark's principle, does not take part in sharing the masticatory load. However, on functioning, there is definitely a favourable mechanical stimulus acting at implant-cortical bone interface to produce a primary callus. The goal of achieving a successful optimal bone-implant interface has been approached by optimization of implant micro-rough surface, chemical composition, surface energy and wettability etc. The application of mechanical stimulus, in this context immediate occlusal loading, also was experimented in different modes on various animals and found to be very encouraging. Bone is a hierarchical substance and at same time anisotropic in nature. The elementary constituents (collagen I fibres, laying down of osteoid matrix, mineralization and orientation of Calcium Hydroxyapatite micro-crystal along collagen fibres) that are essentials to be assembled at the site of surgical trauma should, therefore, be initiated right from beginning. For this purpose, the loading of implant is necessary at the earliest before the cell members of team known as Basal Metabolic Unit (BMU) start acting. Normally, within 72 hours, the osteoclasts (diameter 50-100 micron with 4-20 nuclei) of BMU are generated from monocytes/macrophage series at the face of the cutting cone under the stimulation of RANKL and M-CSF from bone lining cells/pre-osteoblasts and then start line up along bone surface with its ruffled border switching on their proton pump. There is intense acidification of bone surface to cause demineralization due to production of H+ ions and chlorides.[22] Loading of implant is, therefore, essential so that as per the need of occlusal load and its directions, quality and quantity of the collagen-I fibres can better be arranged within osteoid matrix in anisotropic fashion maintaining its hierarchical nature. This satisfies the Wolff's law of 1891 also. This cascade of events at the implant-cortical bone interface takes place under varying degrees of masticatory force and form the foundation of ultimate formation of osseointegration between these two members as a natural phenomenon. At all length of the implant new bone formation is observed.

The perforation of periosteum on the 2nd cortical bone is mandatory in this technique of implant placement for the two main reasons. Firstly, the implant needs to be fastened or fixated to the strongest bone for the immediate loading mentioned earlier. Secondly, this initiates the cellular layers (Cambium) of the periosteum to be stimulated and incorporated forcefully to take part in the healing process. These cells have got tremendous potential to be transformed into osteoprogenitors/osteoblasts to actively come in front to initiate the repairing process chiefly thorough biochemical signalling.

The majority of conventional implants, especially with rough surface body, are found to suffer from peri-implant mucositis or peri-implantitis after a brief period of service[23-25]. Radiographically, a crater-shaped radiolucent area is seen in the cervical region encircling the body of implant which clearly indicates that the inflammatory process creeps along the length of the implant. Technically, these implants are well placed following rigid surgical and prosthetic norms; but because of certain inherent characteristics of surface roughness and also the potential space at implant-abutment interface for two-piece implant, the colonization of bacteria is very common. The consequence is the infection of the adjacent soft tissues resulting in Peri-implant diseases. This is a very alarming situation in conventional system. The basal and cortical implants essentially have a very slender shaft of 2 mm diameter which are highly polished. The highly polished surface(Ra value =0.1 to 0.05 μ) is generally not attacked by bacteria; and even if some degree of inflammation takes place, it does not usually travel along the smooth surface to reach the remote 2nd cortical bone. There is no evidence of cortical implant being lost due to such catastrophic disaster.

CONCLUSION

Management of rehabilitation of a case of bilateral canine impactions with immediate functional loading cortical implants has been presented. The removal of impacted canines coupled with adjuvant orthodontic therapy for up-righting the lateral incisors were done preceding the implant placement.

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