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Advances in Dental Implantology: Role of Corticobasal system

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Abstract

Recent years have seen remarkable progress in the field of dental implantology, marked by the advent of innovative techniques and materials aimed at enhancing the predictability and success of implant procedures. Among these advancements is the introduction of corticobasal implants. These are meticulously designed to closely mimic the natural structure and function of teeth, offering a more anatomically and physiologically compatible solution for tooth replacement.

This comprehensive review provides a detailed overview of the corticobasal system in dental implantology, encompassing its developmental trajectory, key design principles, and clinical applications. Emphasis is placed on the unique biomechanical properties of corticobasal implants, underscoring their distinct advantages over traditional implant systems.

In conclusion, corticobasal implants represent a paradigm shift in dental implantology, promising enhanced stability, superior osseointegration, and improved patient outcomes. While the preliminary results are promising, further rigorous research and extensive clinical trials are imperative to fully ascertain the long-term efficacy and benefits of this transformative approach.

Keywords: Edentulism, Implant Procedures, dental implantology, Corticobasal Implants

Introduction

Edentulism is a devastating, lifelong ailment described as the "final marker of disease burden for oral health".[1] The World Health Organisation has considered edentulism as an overall physical impairment. While total tooth loss has been less common over the past ten years, edentulism is still a serious global health concern, particularly for elderly persons.

The ever-increasing speed of life puts forth a need to improve the effectiveness of the rehabilitative procedures. [2] This improvement is primarily focused on simplifying the procedures, reducing the number and extent of interventions, reducing the time taken for treatment, maintaining, and improving the durability and quality of the rehabilitation without compromising on patient safety. [3] Thus came the advent of implant dentistry.

Basal implantology also known as bi-cortical is a modern innovative implantology system which utilizes the basal cortical portion of the jaw bones for retention of the dental implants, which are less prone to resorption and are infection free. Basal implants enlarge the scope of implant dentistry without requiring adjunctive complex techniques such as distraction, bone splitting, grafting, etc. prior to implant installation. They can also be used with more intrusive procedures like sinus elevation, lateral displacement of the inferior alveolar nerve, calvaria bone graft, iliac bone graft, pedicled fibula bone graft, etc. [4] Corticobasal Implants offer both versatility and durability to cater to all kinds of clinical scenarios which cannot be managed by conventional implants and or require extensive adjunctive procedures. [5]

Corticobasal Implantology

Yadav et al., (2015) defined Basal implantology also known as bicortical implantology or cortical implantology/ Strategic Implantology as a modern implantology system that utilizes the basal cortical portion of the jaw bones for retention of the dental implants. [6]

They are designed in a way such that they engage both the cortical plates of the jawbone, providing excellent stability and support, especially in cases where the bone quality or quantity is compromised. The strategic placement of these implants allows for immediate or early functional loading, reducing the overall treatment time justifying its name of Strategic implantology.

Brief History

Basal implants have been used since the 1970s, primarily by the French and Germans. Dr. Jean-Marc Julliet developed the first single-piece implant in 1972, but its lack of a surgical kit limited its use. Three years later, Dr. Clunet-Coste created the T-shaped single unit implant, marketed by Eugen Kuhlman and Zerca. However, production ceased after Julliet's death. Gerard Scortecci improved the basal implant system in the 1980s, introducing "Diskimplants" with matching surgical tools and connections for prosthetic superstructures. Despite this advancement, Scortecci's concept had issues with compromised blood supply, leading to inflammatory osteolysis. Then in the 1990s, German dentists further developed Scortecci's Diskimplant, capable of transmitting masticatory loads vertically and basally. Dr. Stefan Ihde began manufacturing basal implants in 1997, improving upon previous designs with round base plates and introducing bending zones in the vertical shaft to prevent early rotation before integration. From 2005, screwable designs and one-piece abutment designs were developed i.e Basal Osseointegrated Implant (BOI) and Bicortical Screw Implant (BCS). [7,8,9]

Classification of Basal Implant

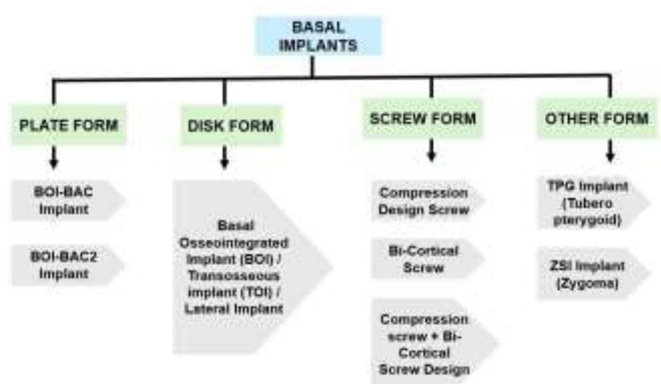

Figure 1

Parts of Basal Implant

The basal implants are single-piece implants in which the implant and the abutment are fused minimizing the problems that occur due to this interface. The basal implants have 3 main parts:

- Implant body: The implant body is thin with wide threads which helps in increasing implant bone contact area and the vascularity around the implant.
- Implant neck: Connects the implant and its abutment. The abutment can be bent to an angle of 15-25 degrees at the neck depending on the length of the implant.
- Implant Abutment: The part of the implant that aids in tooth replacement and mimics the crown structure.

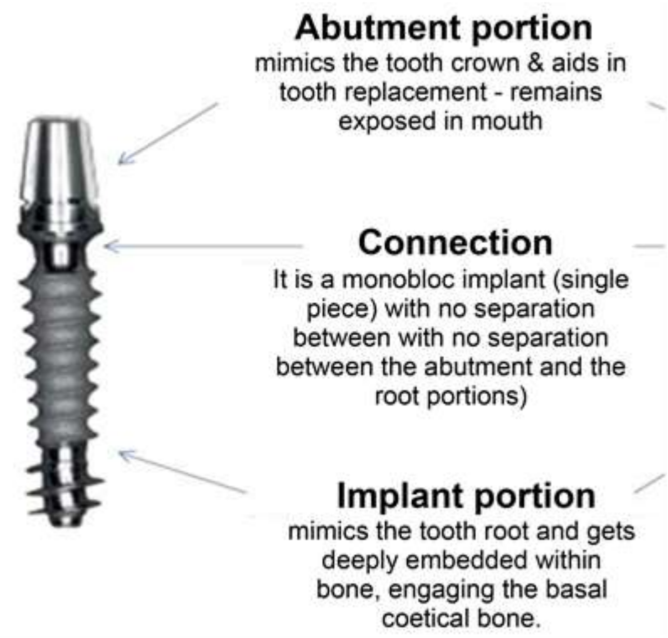

Figure 2

Anatomical Considerations In Basal Implant System

The concept of basal implantology originates from the presence of two distinct parts of jaw bone:

a) The tooth bearing alveolus also called the alveolar bone

b) Basal bone

Alveolar Bone

The alveolar bone, which supports the teeth, is a highly specialized structure that develops and functions in conjunction with the teeth. It gradually diminishes after tooth loss. Positioned above the basal bone, the alveolar bone lacks distinct anatomical landmarks. It is seen to diminish due to periodontal disease, tooth extraction, trauma, or agenesis. An osseointegrated implant, anchored directly in the alveolar bone, remains stationary and does not shift.[10]

Basal Bone

The basal bone is the skeletal bone that remains after the loss and complete resorption of the alveolar crest. It is primarily composed of a mineralized matrix, mainly hydroxyapatite crystals which provides strength and rigidity to the bone. The organic matrix of basal bone contains collagen fibers, primarily type I collagen. This provides flexibility and tensile strength to the bone, complementing the mineral component. Various cell types like osteoblasts, osteocytes, and osteoclasts are present aiding in bone formation, bone maintenance, and bone resorption respectively. Basal bone has a rich blood supply, which is essential for providing nutrients and oxygen to the bone cells and for removing metabolic waste products. The outer surface of basal bone is covered by a connective tissue membrane called the periosteum, which plays a role in bone growth, repair, and nutrition. More importantly, the basal bone has a very low turnover rate (about ten times less) which is advantageous when an implant placement is being planned.[9]

The term "Osseointegration" used in conventional implantology is referred to as "Osseoadaptation/ osseofixation" in basal implant terminology. This occurs as bone adapts to continuous functional loads by remodeling over the implant surface. Basal implants are anchored in cortical bone, a process termed "osseofixation," with later expected secondary osseointegration into spongy bone areas where the implant projects. Primary stability and treatment success require macro-mechanic anchorage in the 2nd or 3rd cortical bone layer. [11]

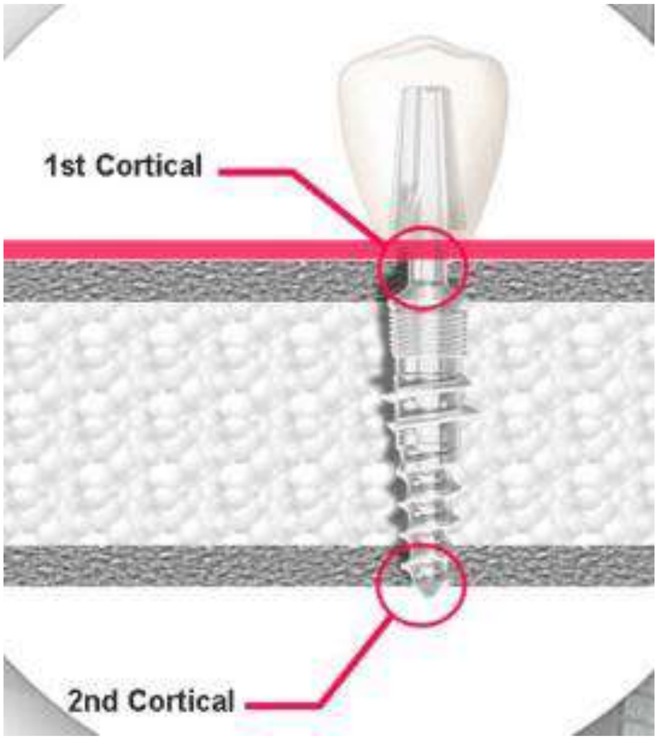

Figure 3

Osseoadaptation

According to philosophy of basal implantology the process of Osseoadaptation is carried out by a "Bone Multicellular Unit" (BMU). It is said to be like a cutting cone with a tail. The cutting cone comprises of osteoclastic cells that eat away the peri-implant bone and the tail comprise of osteoblastic cells that lay down the bone. As this unit moves in the bone, the osteoclastic activity is subsequently followed by osteoblastic activity. The formation of this BMU takes place when the BOI and BCS implant are subject to immediate loading which leads to remodelling of bone under functional stresses leading to development of this unit, and thus initiates the healing phase and leads to formation of a dense peri-implant bone. [7,12]

The series of processes involved are (4)-

1. Activation Phase: In this phase the precursor cells/human mesenchymal stem cells develop into osteoblasts and osteoclasts.
2. Resorption Phase: During this phase osteoclastic activity reveals soft and porous bone. Osteoclastic activity occurs at a rate of 40µm/day.
3. Reversal Phase: In this phase osteoblastic activity takes place. The osteoblasts lay down new bone in the haversian canals at a rate of 1-2µm/day.
4. Progressive Phase: This phase involves the osteoblasts forming concentric lamella in haversian canals, which leads to reduction in diameter of the canal and increase in bone density. At this stage the diameter of the haversian canal is 40- 50µm. The bone formed is a Non-Mineralized Matrix Osteoid.
5. Mineralization Phase: After osteoid formation mineralization phase begins. This phase involves two stages

a) Primary Mineralization Stage: This stage imparts primary hardness to the osteoid and accounts for 60% of all mineralization.

b) Secondary Mineralization Stage: This stage imparts final hardness and final morphology of bone.

6. Dormant Phase: In this phase osteoblasts develop into osteocytes and line the haversian canals and take up mechanical, metabolic and homeostatic functions.

Implants are under functional loads throughout all the phases and because of which there is a continuous stimulation of the BMU throughout the life of the implant, which causes the peri-implant bone to become dense (which increases throughout the implants life) and to adapt over the surface of the implant, thus the term "Osseoadaptation", and this is how remodeling plays a key role and is called as the "4th Dimension" [7]

Why Basal Implants

Starting right from the armamentarium, basal implant surgical kit is simple with very few instruments compared to the complex – wide array of instruments that are required for placement of two-piece conventional implants. Simple surgical kit comes with the perks of being less expensive. [12]

Next up is the implant planning. Basal implant planning is comparatively less burdening. Conventional implant placement usually poses challenges due to presence of vital structures like the sinus, nasal cavity, inferior alveolar nerve and nasopalatine canal often necessitating extensive augmentation procedures that are cost-intensive and time-consuming.[12] Even after this, the success rates are low with high chances of morbidity. Basal implants, due to their modified design are preferred in such conditions, thus combating these anatomical limitations and offering enhanced support. They can be placed even when very little vertical bone is present. They are anchored in the tough cortical bone which ensures that the stress transmitted during mastication is evenly distributed across the bone-implant interface thus being beneficial in patients with compromised bone quality. [13]

Speaking of the implant design, surface enhanced endosseous implants are still susceptible to peri-implantitis, which may lead to progressive ridge resorption. This is not present in basal implants because usually the disease stops as it reaches basal (resorption resistant) bone areas. Bicortical implants are designed to be long and slender aiding in bi cortical anchorage thus reducing the implant micromotion. Implant being produced today have a smooth and polished surface making them less prone to inflammation (mucositis, periimplantitis) than rough surfaces owing to the fact that in crestal implantology peri-implantitis occurs in 5% to 8% of implants placed against 0.01% in basal implantology.[12]The smooth surface and smaller neck of bicortical implants also reduce the risk of bacterial accumulation and facilitate easier maintenance, which is crucial for preventing infection and peri-implantitis.[14,12] Moreover, the implant areas where the load transmission takes place are integrated in such a way that the osteogenic and osteoprotective properties of the cortical bone are utilized.[7] Conditions like congenital anodontia, trauma or atrophy due to the aging process leads to poor quality and quantity of bone. Basal implants can be the treatment of choice in such conditions. Though short implants are an alternative to the conventional implants and yield acceptable results, it still requires at least 5mm of vertical bone at the site . However these implants cannot be used in immediate loading procedures and due to their two-stage design the demand for attached gingiva in the mucosal penetration area and the demand for meticulous cleaning limits its use.

Though the above said conditions favour basal implants, considering primary stability for immediate loading of implants is also crutial. Adequate primary stability determines the loading protocol. Following primary stability, secondary stability happens through periimplant osteogenesis. Like it is said earlier, since bicortical implants derive anchorage through the cortical bone, greater primary stability is achieved favouring the immediate loading protocol. They are connected to a prosthesis in occlusion with the opposing arch within 72 hours subsequent to implant placement. This protocol aims to provide predictable outcomes and a high survival rate of 99% in patients.

In diabetetic patients, evidence states that increased glucose levels tends to decrease collagen production during callus formation. This also inhibits osteoblastic activity and increases osteoclastic activities. Presence of extensive inflammatory meditators induce apoptosis of bone cells thus degrading bone matrix formation. [12,15] Such conditions limit the usage of conventional crestal implants. In case of basal implant, diabetic conditions is not a huge concern, provided that it is in control.[15] Evidence suggests that if diabetic is in control, there is no significant difference in survival rate of dental implants. Even in case of old diabetic patients 100% survival rate has been achieved.

Conclusion

Finally, it can be seen that corticobasal implants have shown promising outcomes regarding patient satisfaction and oral health-related quality of life too. Studies indicate that patients with compromised ridge support, such as those with diabetes, smoking habits, and periodontitis, have reported high satisfaction levels after receiving corticobasal implants. The use of corticobasal implant-supported prostheses meets the patient's demand for an immediate, fixed treatment modality, leading to higher satisfaction compared to conventional implants. Additionally, corticobasal implant-supported prostheses are a feasible treatment modality for rehabilitating patients with maxillofacial trauma, with high success rates and satisfaction levels reported in these cases as well.[3,16,17]

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