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Review Article

Dentistry Section

# Basal Implants: A Narrative Review on Restoring the Unrestorable Ridges

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## ABSTRACT

One of the most innovative developments in dental implantology is the basal implant, also known as a bicortical or cortical implant. Anchored in the strong cortical bone, basal implants provide instant loading capabilities and superior primary stability, in contrast to conventional implants that depend on the integrity of the alveolar bone. Basal implants adhere to the principle "Primum nil nocere" which restricts unwanted treatments such as bone augmentation and grafting. Their unique design and placement technique make them suitable for full-arch rehabilitation of edentulous jaws, providing a viable solution where conventional implants might not suffice. The present article explains the history and classification of basal implants, how they work and briefly discusses osseointegration, peri-implant healing, as well as the success of various studies conducted on basal implants.


**Keywords:** 2nd cortical bone, Basal bone, Basal cortical implants, Immediate loading, Osseofixation

## INTRODUCTION

The only methods to replace a partially edentulous region are removable or fixed partial dentures. Fixed partial dentures require circumferential tooth reduction on either side of the edentulous region, with a metal ceramic bridge used to restore the teeth [1]. Dental implant placement is one of the best options to replace a missing tooth without compromising the nearby teeth. Dental implantology offers a promising approach to restoring missing teeth in cases where the stomatognathic system has been compromised [2]. Nowadays, patients are increasingly reluctant to deal with the pain and inconvenience of traditional dental implant placements, which can sometimes require multiple sessions and lengthy waiting times. Over the past few decades, implant dentistry has advanced significantly and there has been a noticeable rise in demand for dental reclamation.

For a conventional implant, sufficient bone must be present (5-7 mm in width and at least 13-15 mm in length) to enable smooth and effective implant placement [3]. Conventional implant placement may fail if these conditions are not satisfied. To overcome anatomical and mechanical limitations, further surgical procedures such as sinus lifting, Distraction Osteogenesis (DO), Block Bone Grafting (BBG) and Guided Bone Regeneration (GBR) are required to restore the alveolar ridge and generate sufficient bone volume [4]. These procedures necessitate delayed functional loading of the implants and may be cost-prohibitive for the patient.

The anchoring of disk-form implants or screwable implants in the basal bone of the jaws is termed Basal Implantology, Strategic Implantology, or Cortico-basal Implantology [5]. The basal bone lies below the alveolar bone and acts as a framework for the maxilla and mandible. It is a stable structure that is stress-bearing and resorption-free. Basal implants derive support from this basal bone, making them more successful than conventional implants.

The primary applications for Basal Osseointegrated Implants (BOI®, Diskos®) are in atrophied ridges and for immediate functional loading [5]. The principle of Orthopaedic surgery is that fractured bone can be subjected to load immediately after treatment. Thus, basal implants follow the same principle and can be loaded immediately within 72 hours; therefore, they are also referred to as Orthopaedic implants, distinguishing them from conventional implants [6]. Even in the absence of adjacent vertical bone, sufficient horizontal bone is available for implant placement. This improves outcomes for implantologists experienced in this technique. Although basal implants are designed for fixed restorations, they can also be utilised for removable dentures, provided that stiff connections are employed to adequately separate them [5,6].

Unlike typical conventional implants, which transfer load to and around the crestal bone (which is more prone to bacterial invasion), basal implants transfer stress deep into the infection- and resorption-free basal bone [7]. The basal bone, which consists of high-quality cortical bone, provides good anchorage for the implants. Osseo-fixed (macro-mechanical anchoring) basal implants have excellent retention rates as they reduce the risk of infection in the peri-implantitis area, thereby improving oral health and enhancing patient satisfaction [8].

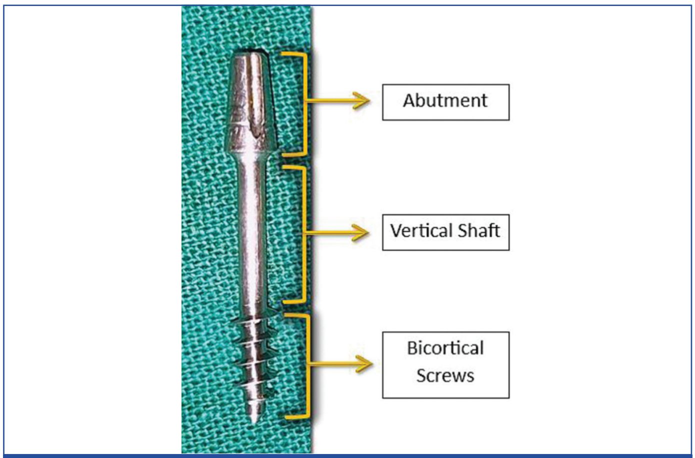
## REVIEW OF LITERATURE

The initial evolution of basal implants was primarily conducted by German and French scientists [5]. The evolution is as follows:

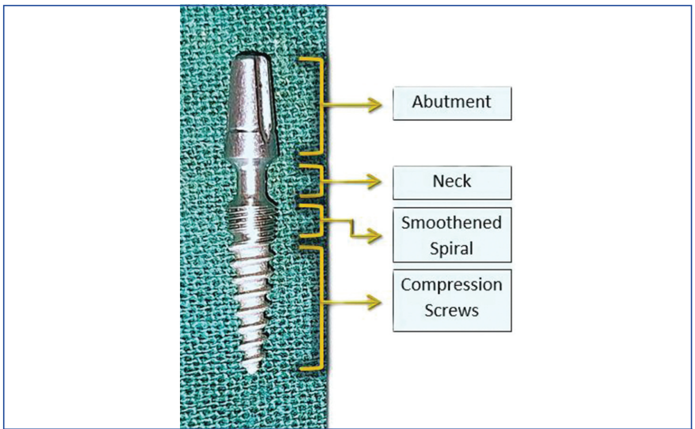
- In 1972, Dr. Jean-Marc Julliet developed single-piece implants that featured a welded joint between a threaded pin and the basal plate; however, the necessary surgical kit was lacking [5].
- Three years later, in 1975, Dr. Clunet Coste applied for a patent for the manufacturing of a single T-shaped implant, which exhibited certain design characteristics as explained by Julliet (1972). This design was granted a French patent, which remained effective until 1996 [5].
- This was further improved by French dentist Scortecci G in the mid-1980s, who developed an enhanced basal implant system known as "Disk implants." This system was accompanied by complementary surgical tools that featured internal and external connectors attached to the prosthetic superstructure. He is also regarded as one of the "founding fathers" of lateral implantology [5].
- In 1997, Ihde S used lateral basal implants that were round in shape and had a roughened surface [9]. Lateral disk implants were manufactured and sandblasted to produce a roughened vertical shaft component, which was thought to increase retention and osseointegration.
- By 2000, lateral disk implants were produced with a fully polished surface. The lateral disk with a rough surface was found to cause crater-like bone loss in a case study conducted by Ihde S and Ihde A. In the same study, it was observed that disks with a polished vertical component did not cause bone loss and it was also demonstrated that a thin diameter of the implant at the

mucosal penetration region provided a better environment for the implants to survive even after several years [10].

- The lateral disk implants were further improved by adding edges to the round basal plates, which prevented the previous issue of early rotation of the implants within the bone before integration [11].
- In 2005, screwable designs {Basal Cortical Screw (BCS)} were introduced [Table/Fig-1] [12].
- This was followed by King of Compression Screw (KOC) implants [Table/Fig-2].




**[Table/Fig-1]:** Bicortical screw implants [12].



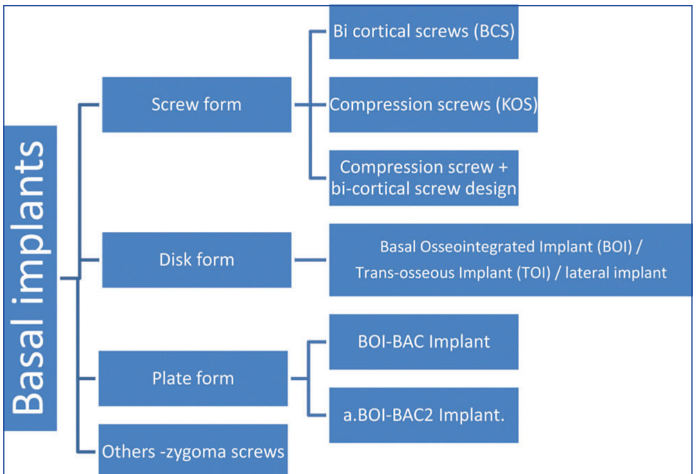

**[Table/Fig-2]:** KOC implants.

## BASAL IMPLANTS

Classification of basal implants is described in [Table/Fig-3] [9].

### Clinical Aspects of BOI Implant Placement [5,13]

- BOI implants are always placed where the bone volume is optimal.




**[Table/Fig-3]:** Classification of basal implants [9].

- Intraoral bending is not an option with internal thread BOI designs.
- If the bone volume is insufficient above the inferior alveolar nerve, the load-transmitting disk can be placed below the nerve.
- Implants along the maxilla are inserted after augmentation of the sinus floor or are placed inside the sinus after partial removal of the Schneiderian membrane.
- Probing along the threaded pin of BOI implants is strictly contraindicated, as it can lead to bacterial intrusion.

**Indications [14]:**

1. Failure of bone augmentation;
2. Atrophied ridges;
3. When the bone above the mandibular canal is flat and shallow.

### Advantages

1. Immediate loading- within 72 hours [15];
2. Basal-cortical bone support, which resists resorption, allowing masticatory forces on the implants to be directly distributed to the cortical bone [16];
3. Load transfer with basal implants is expected to occur predominantly in the basal area, away from the source of bacterial infection in the oral cavity [16];
4. Minimally invasive- flapless [17,18];
5. Basal implants are an excellent choice for severely atrophied ridges [17];
6. They reduce the risk of peri-implantitis [17].

### Surgical Technique

Basal implants differ from regular implants in their surgical technique. The procedure is straightforward and does not require significant drilling of the bone, thereby preventing heat damage. During the surgery, external irrigation is employed. For KOS, KOS Plus and BCS implants, a single pilot osteotomy with a "Pathfinder Drill" is typically sufficient. The kit also includes manual drills for controlled osteotomy preparation [19,20].

Raising a flap for these implants is discouraged by basal implantologists due to the decreased blood supply and the design of the implants. Additionally, immediate loading of these implants is not recommended for sutured sites [21,22].

To insert the BOI implant, a flap is raised laterally and disk drills of the appropriate size are used to create a "T"-shaped osteotomy. The implant is placed laterally and the flap is then closed over it [23-25].

These types of basal implants were used in the clinical trial conducted by Omar MM et al., Warda SM et al., and Gaber AE et al., which is discussed later [26-28].

### Restoration of Atrophied Jaw

There are two concepts that have been developed:

1) **The multiple implant concept:** This concept, founded by Scortecci G, often recommends placing 8-14 basal implants in each arch. According to this concept, bone stiffness is achieved and realignment stresses in the jaw system can be managed by combining basal and crestal implants. However, the implant body may undergo overload osteolysis, leading to implant failure as a consequence of the immense forces generated by the nearly impossible task of reversing mandibular torsion [5].
2) **Strategic implant positioning concept of german school:** This concept was presented by Ihde S. In this approach, four implants are inserted in the canine and second molar regions of the mandible, which allows for torsion and reorientation of forces that are compensated for by the flexibility of the prosthesis, while avoiding osteolysis and implant fractures [29].

## DISCUSSION

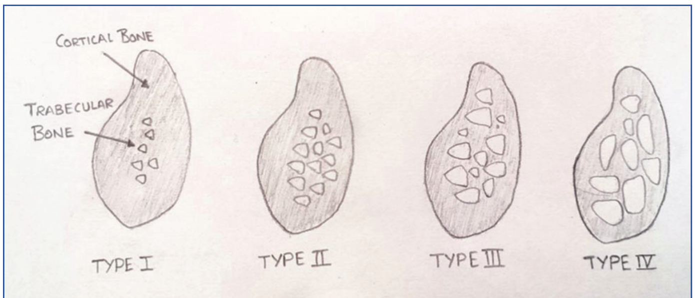
Implants are used to restore both partially and completely edentulous ridges. For patients who do not prefer removable prosthesis or fixed partial dentures, implants are the preferred choice. Completely edentulous patients wearing dentures for the first time often experience several problems, such as poor retention, denture soreness, gag reflex and decreased taste perception due to increased palatal coverage. Most of these patients prefer fixed restorations, making implants their only viable option [30].

As patients age, restoring the ridges with conventional implants becomes challenging due to poor quality and atrophied bone. Severe atrophy is commonly observed in the distal maxilla, particularly with increasing age due to the expansion of the maxillary sinus. Type 3 and Type 4 bones are frequently encountered in the maxilla, where achieving implant stability can be difficult. Consequently, bone augmentation procedures such as sinus lifting and bone grafting are performed to increase height in the posterior maxilla [31]. The sinus lifting procedure is the most commonly used method to enhance vertical height posteriorly. However, these procedures come with drawbacks, as the grafted bone is not as strong as native bone, implant stability can be difficult to achieve and they typically require a delayed loading protocol [32].

In the mandible, resorption is observed above the mylohyoid ridge due to the mylohyoid muscle attachment. The constant tension from this muscle prevents resorption in the region below the ridge. Bone types are classified using the Lekholm and Zarb classification (1985), based on radiographic bone quality and quantity [Table/Fig-4,5] [31,33].

| Types | Description |
|---|---|
| Type I | Entirely homogenous cortical bone |
| Type II | Thick cortical bone surrounding, dense trabecular bone |
| Type III | Thin cortical bone surrounding, dense trabecular bone |
| Type IV | Thin cortical bone surrounding, less dense trabecular bone |

**[Table/Fig-4]:** Lekholm and Zarb classification [33].

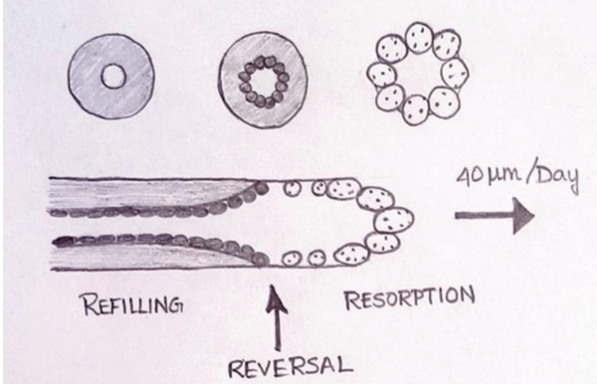



**[Table/Fig-5]:** Lekholm and Zarb classification [31].

According to Wolff's law, when bone is subjected to increased load or stress, it tends to adapt and strengthen. In basal implantology, this concept is utilised to bend basal implants to increase stress and also to load a basal implant within 72 hours so that the bone and implant surface area experience functional stress, leading to bone deposition and regeneration [34].

In the case of basal implants, cortical bone anchorage is known as 'osseo-adaptation'. Osseo-adaptation occurs through the 'Bone Multicellular Unit' (BMU) [Table/Fig-6] [9,35], which remodelling bone under constant functional load is referred to as the "fourth dimension" [36]. Histological findings from Iezzi G et al., indicated that bone-to-basal implant contact increased after functional loading and reparative osteogenesis led to mineralised bone formation at the interface [37].

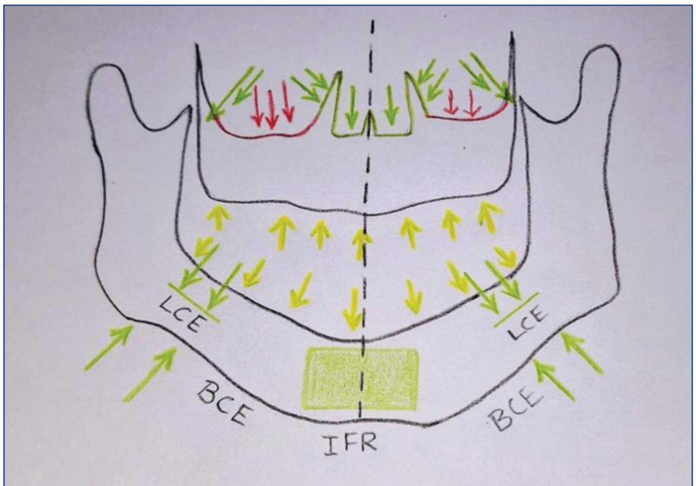
The BMU generates the cutting cone in close proximity to the neuro vascular bundles. The BMU is made up of osteoclasts and osteoblasts, which combine their bone resorption and deposition activities. The reversal zone is the area that lies between cutting and deposition. Tunneling progresses at a rate of 40 micrometers each day. BMU is an age-related phenomenon caused by hormones. It is found to be highest during childhood (upto 60 BMU/mm$^2$/year) and lowest in aged (down to 1-2 BMU/mm$^2$/year) [16].




**[Table/Fig-6]:** Bone Multicellular Unit (BMU) [9,35].

Conventional implants typically include a single cortical anchoring that is limited by anatomical features such the mandibular canal in the distal jaw, the sinus in the maxilla, or the floor of the nasal cavity. Such a need does not arise in basal implantology since implant anchorage only happens in the second corticals.

"1-2-3" Denomination of Corticals [Table/Fig-7] proposed by Ihde S et al., stated that the abutment positioning is in the 1$^{st}$ cortical while the osseofixated implants are placed in the 2$^{nd}$ and 3$^{rd}$ corticals [29]. Sometimes the load transmitting threads project out of the maxillary bone and anchor into adjacent neighbouring bone, like the zygomatic bone, pterygoid plate of the sphenoid bone and infra-orbital rim which are referred as 3$^{rd}$ corticals. Supporting polygon term is used to describe the strategic position of implants in the canine and 2$^{nd}$ molar region. Within this polygon load distribution can be maintained. Implants on the polygon's corner or ends- that is, the region around the canines and second molars in both jaws- are its significant places. These positions are known as "strategic positions". The entire situation is susceptible to failure if these locations are not adequately implanted, or if one or more of the implants in the strategic position are not securely fastened in the second or third corticals [29].




**[Table/Fig-7]:** Schematic overview on the corticals in connection to the maxilla and the mandible [29].
Yellow arrows- 1$^{st}$ corticals; Green arrows: 2$^{nd}$ corticals; Red arrows: Resorption prone areas; LCE: Lingual cortical engagement; BCE: Basal cortical engagement; IFR: Inter-foraminal region

Restoring posterior maxilla with implants is a challenging process, it is mostly composed of trabecular bone. Gaber AE et al., conducted a prospective clinical trial evaluated the success rate of basal implants in posterior maxilla, concluded that basal implants tend to increase the marginal bone from 7.3 mm to 7.7 mm between 3 months and bone density also was increased in the surrounding bone [28].

Warda SM et al., and Patel K et al., in their study, stated that basal implants can be placed in extraction sockets when atraumatic extraction is performed. The retained periodontal fibres assist in faster healing after implant placement, thereby increasing the success rate of the implants [27,35]. Hence, it has been demonstrated that basal implants can be placed in both healed and extraction sockets as they derive support from the second or third corticals.

Lazarov A, in a prospective cohort study involving 87 consecutively treated patients who received 1,169 immediately loaded one-piece Strategic Implants, reported that after an average follow-up of approximately 48 months, there was no incidence of peri-implantitis or mobility and proper healing was achieved. The survival rate for cortically anchored screw implants was found to be 95.7% [38].

Omar MM et al., concluded in their three-month follow-up study that basal implants featuring wide, sharp threads enhance primary stability by engaging with the resorption-free basal bone [26]. The implants displayed a primary stability measurement of -3.49 three months postoperatively. Furthermore, the long, polished vertical component of the basal implant helps prevent bacterial accumulation that can lead to peri-implantitis. Therefore, peri-implantitis-a common cause of implant failure in conventional implants-is not a significant concern with basal implants. Geramizadeh M et al., in a finite element analysis study, reported that the thread designs of basal implants, which feature wider depth and pitch, provide more surface area contact between the implant and basal bone, thus enhancing primary stability [39].

Garg R et al., stated in his study that basal implants can be loaded within 72 hours and that primary stability is good as they engage with the cortical bone in the mandible [40]. In the maxilla, both endosseous and basal implants showed similar survival rates, which may be attributed to the differences in bone density between the maxilla and mandible, as explained by Lekholm and Zarb. Postoperative pain (which is often severe) and mild bone loss are observed with immediate-loaded basal implants compared to delayed-loaded endosseous implants.

Oleg D et al., conducted a retrospective cohort study that included 394 patients treated with 4,570 immediately loaded single-piece implants. They concluded that basal implants have the same success rate when placed in extracted sockets as well as in healed bone. Additionally, they noted that bent implants exhibited a higher survival rate, confirming second cortical anchorage. No cases of peri-implantitis were observed and the cumulative implant survival rate was reported at 95.5% [41].

Awadalkreem F et al., conducted a questionnaire study involving previous removable and fixed denture wearers who transitioned to basal implant prosthesis [42]. Patient satisfaction was high, highlighting more aesthetic outcomes, improved comfort and enhanced masticatory function and speech, in line with the findings of Ihde S and Ihde A and Scortecci G [43,44].

Despite the numerous advantages of placing basal implants, there are also some drawbacks, such as overload osteolysis, which can lead to implant loosening. This is one of the major concerns associated with basal implants, as it arises from uneven distribution of masticatory loads and stress concentration on a particular implant, ultimately resulting in loosening [45].

If loads are appropriately reduced, basal implants can be successfully reintegrated with high mineralisation. Masticatory forces should be distributed in a bilaterally balanced and symmetrical manner, or occlusal adjustments should be performed along with vertical dimension corrections if necessary. Furthermore, basal implantology is highly technique-sensitive and requires surgical skills to successfully place the implants, which can only be acquired through experience.

### The Role of Basal Implants in Complex Cases

Hassan S et al., reported a case in which an immediate basal implant was inserted in the mandibular molar region following the extraction of a tooth due to condensing osteitis [46]. In a challenging case study, Gaur V et al., described a patient with rheumatoid arthritis who had mobile teeth in both jaws. After the extraction of these teeth, single-piece implants were inserted in the maxilla and mandible. A four-year follow-up revealed that delayed complications, such as abutment screw fracture or loosening, peri-implantitis and graft failure, were successfully avoided [47].

Konstantinović VS et al., presented a case report involving a patient who received a nasal epithesis following ablation of the midface due to squamous cell carcinoma. Basal implants were anchored in the glabellar region of the frontal bone, the upper portion of the right side of the alveolar crest and the lateral side of the maxillary bone to secure the nasal epithesis [48]. Ahmad AG et al., reported the first case of full-mouth rehabilitation using basal implants (Basal Cortical Screw implants) in a patient with Cleidocranial Dysplasia (CCD). Patients with CCD who have a limited bone foundation following tooth extraction may benefit from basal implant-supported prosthesis [49].

## CONCLUSION(S)

Basal implantology adheres to the concept of "Primum nil nocere" which means "first, do no harm." Basal implants are the first choice for addressing issues that would typically require traditional surgical procedures involving bone augmentation. Diagnosing and treating complications with basal implants necessitates specialised clinical skills, techniques and extensive knowledge of the basal implants themselves. This is why manufacturers restrict the use of basal implants to approved practitioners. Basal implantology effectively addresses the challenges and disadvantages of conventional implants, such as those presented by periodontally compromised cases and severely resorbed ridges. Compared to orthodontic therapy, the procedure takes less time, does not involve bone grafting, spares the patient from wearing poorly fitting dentures, lowers overall costs and enhances the quality of life.

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