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ROLE OF DEMINERALIZED FREEZE-DRIED BONE ALLOGRAFT AROUND IMMEDIATE IMPLANTS IN EXTRACTION SOCKETS - A REVIEW

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ABSTRACT: Implant insertion in a "fresh extraction socket" is reliable and effective. Often little discrepancy is there between the size of the implant and the wall of the socket, which needs to be filled before placing the implant. Hence, there is a need for graft material to fill this space. The main objective of this article is to review the role of “demineralized freeze-dried bone allograft” (DFDBA) in bone formation around immediate implants and how it affects the hard and soft tissues. Also, this review assessed the role of DFDBA on osseointegration associated with immediate implants.

INTRODUCTION: Implants in dentistry emerged from the evolution of thoughts, modern techniques and medical claims after years of fundamental research. After tooth extraction, the alveolar ridge undergoes physiological dimensional changes, with most of these changes occurring within the first three months of socket healing. Emilio Couso Queiruga *et al.* (October 2020) concluded that depending on the tooth type, a varied degree of alveolar bone resorption occurs following unassisted socket healing [1]. As a result, changes in apicocoronal height and buccolingual width in the residual alveolar ridge may have an impact on implant placement. Branemark was the first to place an endosteal titanium implant in 1965 successfully. Implant placement is the procedure of placing the implant in the extraction socket, which is healed after a waiting period of 5–6 months, per original protocols. Lazzara began placing implants at the time of tooth extraction in 1989.

In recent years, various studies have proven that placing implants at the time of tooth extraction is reliable. “Immediate implant placement, defined as placing a dental implant into a fresh extraction socket site immediately after tooth extraction, has long been seen to be a safe and predictable treatment (Schwartz *et al.*, 2000)”. Three main implant placement protocols were specified at the "Third International Team for Implantology (ITI) Consensus Conference" based on the waiting time period between the extraction of tooth and implant placement [2].

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In the immediate implant placement approach, placement of implants is done in new sockets immediately after extraction to engage the implants to the residual socket walls. Implants are inserted 4–8 weeks following tooth extraction in the early implant placement approach. The implants are placed in the early-delayed implant insertion approach when most changes in the dimensions of alveolar ridge have occurred (12–16 weeks).

The latter two protocols have been questioned, and recently the protocol to place implants immediately after tooth extraction is being promoted. This protocol, in which the implant is placed immediately after tooth extraction, is known as immediate placement. Immediate implant insertion has been found to have less than 5% of failure rate, similar to delayed or conventional implant placement [3, 4]. Osseointegration entails a primary interlocking of alveolar bone and the implant body, followed by biological fixation via continuous bone apposition and remodelling toward the implant. The main issue is, there is an empty region when the implant is being immediately positioned inside the socket, which is called "The Jumping Distance" around the coronal part of the implant. This gap is due to a mismatch between the size and shape of the implant and the extraction socket, which can result in the resorption of bone, especially in the labial region, followed by bone defects.

Therefore, bone graft materials have to be used, along with barriers, to occupy the space surrounding the implant and hence maintain the structure of tissues, both hard and soft, and to replace the bone that has been eroded in areas where bone defects are significant. Surgical techniques have been proposed. For decades, periodontists have been striving to find the right material for guided bone regeneration. Some of them include expanded polytetrafluoroethylene membrane (e-PTFE), bioabsorbable membrane, “decalcified freeze-dried bone allograft (DFDBA)”, freeze-dried bone allograft, hydroxyapatite, polymer meant to replace the hard tissues, around the implant. The gold standard in grafting is believed to be autologous bone graft because they maintain revascularization of the graft, maintain cell viability and have no potential for disease transmission. Despite the effectiveness of autograft in bone repair, it has significant disadvantages. Additional surgical procedures, higher infection risk, more loss of blood, less quantity-wise, and donor-site hypersensitivity or morbidity are just a few of them. Therefore, this review article aims to look into the impact of the DFDBA combination on the chances of survival of implants immediately placed at the extraction sockets.

Immediate Implants: “Immediate implant placement, defined as placing a dental implant into a fresh extraction socket site immediately after tooth extraction, has long been considered a safe and effective therapeutic option (Schwartz *et al.*, 2000)”. Implant placement immediately after extraction has a benefit when compared to conventional implant placement, which is that there is no need to wait for the bone to form following extraction for 4-6 months, and loss of bone structure in the crestal region is also seen to be decreased in implants immediately placed than the conventionally placed implants. There are sufficient scientific researches that make it evident to support immediate implant placement procedures compared to conventional two-step delayed implant protocols. In 2003, Schropp L *et al* compared bone healing and crestal bone alterations in extraction sockets after immediate versus delayed placement of titanium dental implants with acid-etched surfaces (Osseotite).

And they concluded that infrabony defects linked with promptly inserted implants in extraction sockets result in new bone growth. In 2015, Singh M. *et al.* determined that immediate placement of implants followed by immediate loading is a suitable treatment choice for patients demanding early prosthetic rehabilitation of extracted teeth. This procedure, however, is very technique sensitive and requires a skilled dental implant team to execute.

The keys to success include careful case selection, a well-planned treatment strategy, and strict adherence to surgical and prosthetic protocols [5]. Ericsson in the year 2000 as well as Hansson *et al.* in the year 1983 discovered that less surgical trauma of immediate placement reduces the chance of “bone necrosis” and permits the bone remodeling process to take place at a relatively faster rate i.e., the period for healing is short and reticulated bone eventually gets transformed to

form lamellar bone. Extraction socket is rich in cells of periodontal origin, which results in rapid and predictable healing. Autogenous bone can be taken from sites such as edentulous alveolar ridges or other intraoral sites, typically close to the immediate implant site, as graft material for small osseous defects. Clinicians have also employed other materials and methods to augment edentulous ridges and minor bony defects near the dental implant site.

Indications and Contraindications of Immediate Implants: Block and Kent (1991) summarised [6] indications and contraindications for implant placement in the fresh extraction sockets in **Table 1.**

TABLE 1: INDICATIONS AND CONTRAINDICATIONS FOR IMPLANT PLACEMENT IN THE FRESH EXTRACTION SOCKETS (BLOCK AND KENT-1991)

Sl. no.	Indications	Contraindications
1.	Traumatic tooth loss with minimal bone loss	Pus discharge while tooth extraction
2.	Tooth loss due to gross decay without purulent exudates or cellulites	Presence of nearby soft tissue cellulitis
3.	Inability to finish endodontic therapy	Absence of adequate bone just below the socket
4.	Moderate bone loss in the periodontal region with no purulent release	Unfavourable mandibular neurovascular bundle location
5.	Good health of soft tissue is required for primary wound closure	Unfavourable anatomical configuration of bone remaining

Clinical experience has established the following criteria for the success of immediate implant treatment: atraumatic tooth extraction, proper sterilization, the surgical technique must be minimally invasive, and primary stability of the implant [7]. The fresh extraction socket has an anatomy similar to the tooth's root, which imitates the "root form implants"; therefore, very little preparation is required for placing immediate implants. The implant needs to be placed 3 mm to the extraction site and 3 mm to the bone of the crestal region to achieve early stability. The implant's initial stability is a major determinant of immediate placement success. Whether or not the extraction site has favourable conditions for immediate implant placement must be assessed. There have been several articles on using barrier membranes or bone grafts in the extraction sockets during immediate implant placement [8]. According to several studies, delayed and immediate implant placements result in crestal bone loss. The bone in the crestal region was observed to be reduced in case of implant insertion in the fresh extraction sockets. Immediate implant placement and bone graft material to fill the gap between the socket wall and the implant resulted in superior results with less crestal bone loss.

Need for graft material in Immediate Implants: While immediate implants have become routine for replacing single-rooted teeth [9], immediate Molar Implants (IMI) are still uncommon due to their difficulty [9]. Large peri-implant gaps might be present between the peripheral region of the implant and extraction socket walls after IMI insertion. However, this is a major pitfall when immediate implants are being placed and are referred to as jumping distance **Fig. 1**. This causes bone resorption and the creation of bone defects preventing the implant from being stabilized. If this jumping distance exceeds 2 mm, it is recommended to use a bone graft [10]. When the jumping width was less than 2 mm, immediate implants placed with or without bone graft exhibited identical alterations in the hard and soft tissues of the alveolar bone [11].

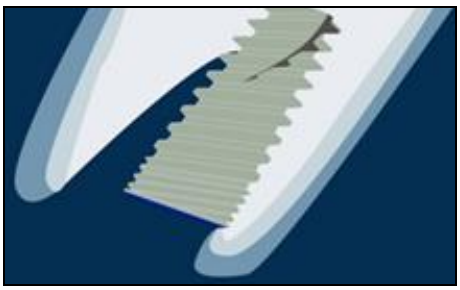

FIG. 1: SHOWS THE JUMPING DISTANCE BETWEEN THE IMPLANT

Following more research, it was shown that in the cases where gap size greater than 1.5–2 mm was present, there was a need to fill the osseous defect using bone graft materials which may include an allograft or xenograft material also covered by a membrane to prevent soft-tissue in growth in the region locally [12, 13]. Some researchers also advised that gaps greater than 0.5 mm be treated similarly

[14]. In understanding how to best manage these jumping distances, factors such as placement and morphology of the gap aside from their size also need to be considered. Schulte proposed no-wall, 3-wall, and circumferential defects in 1984 [15].

However, gap position concerning regions at the periphery of the implant can be important, especially in estimating future buccal plate bone thickness that will remain surrounding the implant. Classification of peri-implant "jumping distances/gaps" was given by Deporter D *et al.* [16] in May 2021, which can be enumerated as:

Type I: When the implant is placed, it leaves a horizontal gap between the implant screw and the buccal plate, known as "Buccal gap" (Fig. 2)**.**

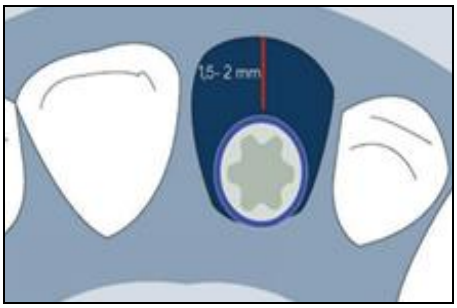

FIG. 2: BUCCAL GAP

Type II: When the implant is placed in close proximity with the buccal socket wall and a gap is left at the palatal aspect it's known as "palatal gap".

Type III: When the implant placement leaves a gap on more than one aspect, which can be palatal/lingual, buccal, distal or mesial is known as "semilunar gap" **Fig. 3.**

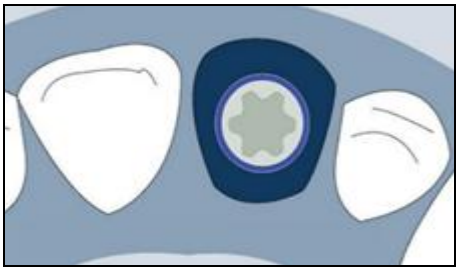

FIG. 3: SEMILUNAR GAP

Type IV: When there is a gap in both the buccal as well as lingual/palatal aspect of the socket wall after placing the implant successfully in the center of the socket it's known as "buccal/palatal gap".

Type V: When maxillary IMI is placed involving only the fresh extraction root socket of the palatal region, leaving both the buccal sockets empty it results in this type of gap.

Type VI: There are mesial and distal gaps after implant placement. This type is seen commonly at mandibular molar extraction sites where the implant is properly stabilized in the bone of the inter-septal region, it's known as "mesial/distal gap".

Type VII: Since mandibular teeth contain one mesial and one distal root socket, this type of gap is seen if a mandibular IMI is implanted in one of these two root sockets.

Selection of Graft Materials around an Implant: A bone graft is an implanted material that enhances bone healing through mechanisms of osteogenesis, osteoinduction, and osteoconduction **Fig. 4**, either alone or in combination with other materials.

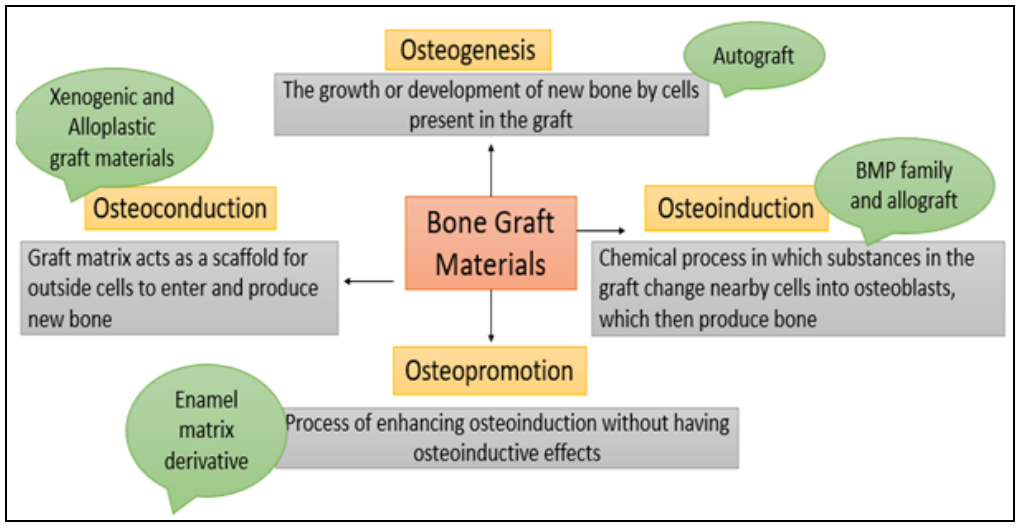

FIG. 4: DIFFERENT PROPERTIES SHOWN BY DIFFERENT GRAFT MATERIALS

Bone grafting is a surgical procedure that substitutes missing bone to repair fractures and other defects in the bone. The bone graft material can be obtained from one's own body (autogenous) or from a human tissue bank (allograft) or an animal tissue bank (animal tissue bank) (xenograft). Sometimes, the bone graft material used may be synthetic (alloplasts). Biological acceptability, predictability, clinical feasibility, minimal operational risks, minimal postoperative sequelae, and patient acceptance are the factors that influence material selection, according to Schallhorn [17]. The search for the ideal gap-filling substance is an ongoing process. Although growth factors including IGF-1 (insulin-like growth factor) [18], PDGF (platelet-derived growth factor) [19] and rhOP-1 (recombinant human osteogenic protein-1) [20] have been used to enhance bone production. The literature suggests that autologous bone grafts are the best option [21]. Surgical bur debris, the lateral bone borders of the implant site, maxillary tuberosity, retromolar area, or the chin can all be used to harvest bone. Despite the effectiveness of autograft in bone repair, it has significant disadvantages. Additional surgical procedures, higher infection risk, increased blood loss, limited quantity, and donor-site hypersensitivity or morbidity are some of them. Therefore, expanded poly tetra fluoro ethylene (e-PTFE) membranes, bioabsorbable membranes, demineralized freeze-dried bone allograft (DFDBA), freeze-dried bone allograft (FDBA), hard tissue replacement polymer, xenografts, hydroxyapatite (HA), growth and differentiation factors, particulate and block grafting are few of the graft materials that are available commercially which can be used around immediate implant. Evidence shows none of these materials performed better *in-vivo* [22, 23] **Table 2** and **3.**

"Demineralized Freeze-dried Bone Allograft": DFDBA's osteogenic potential has been shown by Urist's experiments. So, Urist *et al.* 1971 isolated bone-forming proteins from decalcified bovine bone. The components of bone matrix, which are closely associated with collagen fibrils and have been named bone morphogenetic proteins (BMPs), are exposed after demineralization in cold, diluted hydrochloric acid. Transplantation of decalcified bone powder into rat muscle resulted in bone-induced cartilage and bone formation.

The organic framework produced by demineralizing bones, teeth, and other calcified tissues acts as an inductive matrix for mesenchymal cell populations that can differentiate into cartilage, bone, and marrow [24]. This exciting task laid the foundation for using DFDBA in periodontal disease. Many studies evaluate DFBBA as a graft material [25, 26]. Demineralized freeze-dried bone allogeneic graft bone, is a graft material composed of decalcified bone matrix (DBM) of freeze-dried bone allogenic graft (FDBA) [24, 27–29]. Several authors compared the various graft materials with DFDBA (refer to **Table 2).**

DFDBA around Immediate Implants: Evaluations of immediate implants with different graft materials were done, and their survival rates were evaluated in **Table 3.**

TABLE 2: RESULTS FOR STUDIES COMPARING DIFFERENT TYPES OF BONE GRAFTS

Sl. no.	Author	Intervention	Outcome
1.	Libin *et al* (1975)	Clinical trials with cancellous DFDBA and cortical DFDBA	Cortical DFDBA produced more desirable outcomes
2.	Quintero G *et al* (Dec 1982)	Clinical evaluation of DFDBA in periodontal osseous defects	DFDBA has the potential as an osseous grafting material in periodontal therapy
3.	Mellonig JT (1984)	Implantation of decalcified bone powder into rat muscle	Bone-induced cartilage and bone formation
4.	Bowers *et al* (1989) [30]	DFDBA grafted in periodontal osseous defects	New attachment and periodontal regeneration found
5.	Mellonig *et al* (1992)	Compared autogenous materials in calvaria of guinea pigs and DFDBA	Both have comparable osteogenic ability
6.	Boeck Neto *et al* (March 2002) [21]	Compared autologous bone grafts in conjunction with both DFDBA and Hydroxyapatite Bone (HA)	Both are compatible biologically and osteoconduction was aided
7.	Ahmad Moghareh Abed *et al* (2011)	Comparison of two types of DFDBA (Cenobone with collagen membrane and Dembone with	The percentages of bone-to-implant contact measurement did not improve

		collagen membrane) in treatment of dehiscence defects	considerably when DFDBA was added
8.	William Becker *et al* (2017) [21, 31]	Compared DFDBA and autologous bone grafts to form bone in extraction sockets	Dead DFDBA particles and no indication of growth of bone on surface of transplanted region

TABLE 3: DIFFERENT GRAFT MATERIALS USED AROUND IMMEDIATE IMPLANTS

Sl. no.	Author	Type of Study	Intervention	Outcome
1.	Hassan *et al* (2008) [32]	RCT	Success rate of implant with autogenous versus synthetic guided bone regeneration	Autogenous bone graft showed asignificant superiority to synthetic bone graft.
2.	Hassan KS *et al* (2009) [32]	RCT	Autogenous bone graft with a synthetic copolymer polylactic and polyglycolic acid (Fisiograft) in buccal dehiscence defects around immediate dental implants	Autogenous bone graft and Fisiograft showed a slight superiority to autogenous bone graft alone.
3.	Col M. Viswambaran (2012)	RCT	Dembone (freeze-dried bone allograft) and G-Bone (modified hydroxyapatite) were employed as graft materials, and implants were put in new extraction sockets.	Both groups' graft materials have been determined to be equally effective.
4.	Viswambaran M *et al* (2014) [33]		Compared H Denbon (DFDBA) and G Bone (modified hydroxyapatite granules) with immediate implants.	Both DFDBA and HA had effective results.
5.	Venkatesh V (2016)	RCT	Compare and analyse alveolar bone development in the maxillary sinus following bilateral sinus lift surgeries utilising PRF alone on one side and DFDBA with bio membrane on the other, both with dental implants placed concurrently.	After 6 months, there was a higher proportion of new bone growth on PRF sites and more implants were firm on the PRF side compared to the DFDBA with bio-membrane side.
6.	Raghavendra S. Medikeri *et al.* (2017) [34]	RCT	Effect of PRF and the use of allogenic grafts for immediate implants of extraction sites	Additional application of PRF with DDFBA, bone resorption was greatly decreased

CONCLUSION: For many practitioners worldwide, immediate implant insertion after tooth removal has become the preferred treatment technique. Placing the implant directly in the extraction site prepared immediately after tooth removal, has many advantages that may improve the acceptance of the procedure by both the patient and operator. Benefits include elimination of alveolar bone ossification latency, reduced number of operative sessions required, reduced toothless arch time, overall cost savings, maintained height and width of the alveolar bone, decreased tissue trauma, and patient discomfort. The operation time is shortened by reducing the number of patient appointments. Simultaneous and immediate bone grafting of the jumping gap maintained the dimensions of tissues, both hard and soft. It is unclear whether bone graft-only, membrane-only, or a combination of both will result in the most stable hard and soft tissue profiles around the immediate implant. DFDBA and HA combined with autogenous bone graft were biocompatible and enhanced osteoconduction, which serves as a matrix for bone growth compared to other bone plug materials. In addition, combinations of growth factors with allograft and short-term preoperative and postoperative broad spectral antibiotics, improved the survival of implants one year after the recovery of the implant. More clinical and histologic research is needed to further understand the healing pattern of these biomaterials in conjunction with dental implants positioned at graft sites.

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