Original Article

A comparative study on efficacy of immediate and delayed placement of cylindrical and tapered dental implants: A clinical prospective study

ABSTRACT

Introduction: The study deals with improving the understanding of implant design in various situations.

Materials and Method: 40 implants were placed out of which 20 were tapered and rest were cylindrical. These were further divided into immediate and delayed settings. The patients were followed upto 6 months and the results were compiled.

Result: Statistically significant difference were found between tapered and cylindrical implants in terms of quality of osseointegration and maintenance of crestal bone height.

Conclusion: It has been gathered from the study that while delayed placement suggests waiting time period varying between 3 and 6 months, it offers a predictable procedure in terms of visibility, good implant-bone contact, and closure all of which, promote a better outcome for dental implant therapy. Immediate implant placement solution is very viable in reducing the time period involved in dental implant therapy. Apart from few to minimum contraindications, it can be predictably performed.

Keywords: Cylindrical implants, delayed placement, immediate placement, osseointegration, tapered implants

INTRODUCTION

Implant geometry and design are one of the main features in implant success, concerning both body and the collar of an implant.[1] There are two major design concepts. Cylindrical implants with parallel walls tend to be less stable at implantation but gain stability rapidly, due to the early formation of woven bone following the blood-clotted gap between the implant and osteotomy wall. Numerous implant designs are available each one of which is advocated for improving bone-to-implant contact and reducing crestal bone resorption. One of the main reasons that implant geometry keeps evolving is to obtain primary stability in fresh extraction sockets. This method known as immediate placement, a technique meant for shortening the period from extraction of a tooth until final restoration can be provided, sparing both time and surgical procedures. Cylindrical implant is less suitable for immediate placement due to distributed force load throughout the implant and because of the parallel walls, the coronal part of the osteotomy is at risk of being damaged by the preceding implant threads.[2]

The anatomic characteristics of the tooth socket after extraction are different from what it appears after proper healing. Implants placed immediately into fresh extraction sites engage precisely prepared bony walls only in their apex, due to the funnel shape of the socket, whereas the coronal

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space is filled only by the completion of the healing phase. Late implant placement after a healing period of 6–12 months has been traditionally considered the standard of care because a fully healed ridge will ensure implant insertion in a stable ridge dimension, but the bone availability for implant placement may have been hampered by the resorptive changes occurring in the ridge after tooth extraction.[2]

Primary stability is known to be a prerequisite and a useful predictor for achieving osseointegration. Original endosseous implants were parallel in design, which were, however, not suitable for all applications. Other designs including tapered implants were introduced. Tapered implants have been used to improve esthetics and facilitate implant placement between adjacent natural teeth. It was initially designed specifically to serve as an immediate implant placement after tooth extraction. The theory is to provide for a degree of compression of the cortical bone in a poor bone implant site. These implants distribute forces into the surrounding bone, creating a more uniform compaction of bone in adjacent osteotomy walls, compared with parallel-walled implants. Thus, tapered implants create a lateral compression of the bone, the advantages of which can be seen on ridges with concavities or narrow ridges especially. Cylindrical wide-bodied implants run the risk of labial perforation due to buccal concavities while the decrease in diameter toward the apical region of the tapered implant accommodates for the labial concavity.[3]

MATERIAL AND METHODS

A study was conducted following ethical clearance from the institutional ethical committee with reference no. IDST/ERBC/2019-22/11. A clinical, randomized, comparative, prospective study on the efficacy of immediate versus delayed placement of cylindrical and tapered dental implants was conducted in 40 patients (group A and B: 20 each) requiring replacement of missing teeth, who reported to the Department of Oral and Maxillofacial Surgery.

Forty patients were assigned to each group of tapered and cylindrical implants. Twenty patients in each group were further divided into immediate and delayed groups giving 10 patients in each group [Table 1].

For all cases prior to the commencement of implant surgery, a detailed history of the patients was recorded. The patients were appraised about the potential risks and benefits and the procedure and written consent was taken from all patients in their own language.

Table 1: Distribution of patients receiving dental implants

	Group I – Tapered	Group II – Cylindrical
A - Immediate	10	10
B - Delayed	10	10

The patients were examined at intervals viz immediately after implant placement, postoperatively 1st month, and postoperatively 3rd month for pain using Visual Analogue Scale (VAS) scale, improvement in gingival health by observing it with the help of gingival index, and radiographical evaluation with help of cone beam computed tomography (CBCT), which included quality of osseointegration and alterations in crestal bone height. All patients were followed up on immediate post op, 1 month and 3 months postoperatively. Complications like wound dehiscence, implant mobility, etc., were also recorded.

All patients were advised same routine investigations and all cases were photographed and logged for record purposes [Figure 1]. Patient with infected periapical site and those who refused to give consent were not included in the study.

RESULTS

Quality of osseointegration was observed radiographically and recorded in Hounsfield Unit. It was recorded and tabulated immediately, 1 month later and 3 months after implant placement. The mean difference of quality of osseointegration 1 month postoperatively of study groups IA, IB, IIA, and IIB were 48.00 ± 26.58, 28.00 ± 13.98, 44.44 ± 22.42, and 36.00 ± 22.71, respectively. The mean difference 3 months postoperatively of study groups IA, IB, IIA, and IIB were 61.00 ± 27.67, 49.00 ± 31.7, 74.44 ± 37.12, and 60.00 ± 24.49, respectively. Independent sample *t* test showed a statistically significant *P* value (0.05) between Groups IA and IB in the 1st month post op evaluation [Figure 2].

Crestal bone height was observed, radiographically recorded, and tabulated in millimeters, 1 month and 3 months after implant placement. One month postoperative mean standard deviation values for study groups IA, IB, IIA, and IIB were

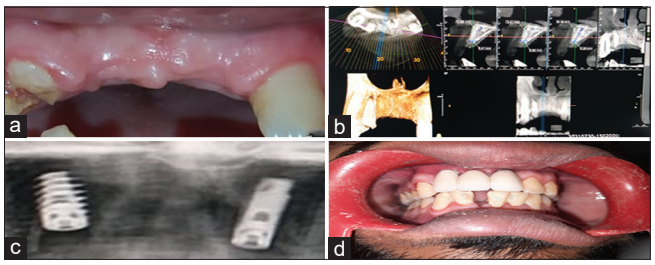

Figure 1: (a) preoperative view of maxillary anterior edentulous region, (b) CBCT study done to assess the bony parameters, (c) post operative radiographs of both tapered and cylindrical implants placed, (d) final prosthetic rehabilitation

1.65 ± 0.47, 1.45 ± 0.37, 1.39 ± 0.33, and 1.70 ± 0.54, respectively. Three months postoperative mean standard deviation values for study groups IA, IB, IIA, and IIB were 2.05 ± 0.37, 1.65 ± 0.41, 1.85 ± 0.53, and 2.05 ± 0.49, respectively. The same has been shown graphically in Figure 2. The mean difference in crestal bone height 1 month postoperatively of study groups IA, IB, IIA, and IIB were the same. Independent sample *t* test showed statistically significant *P* value (0.034) between Groups IA and IB in the 3rd month post op evaluation [Figure 3].

DISCUSSION

In our study, we compared the efficacy of immediate and delayed placement of cylindrical and tapered dental implants in 40 patients who were randomly placed in four separate groups. Ten patients were under Group IA = Immediate Tapered, 10 patients under Group IB = Delayed Tapered, 10 under Group IIA = Immediate Cylindrical, and 10 under Group IIB = Delayed Cylindrical. All the tapered implants were Alpha Bio—SPI Dental Implants and all the cylindrical implants were Alpha Bio—DF I Dental Implants. Spiral™, Alpha-Bio Tec's implant is used for immediate implantation and immediate loading. It has exceptional self-drilling capabilities and a unique spiral body design, which enables it to change its position during placement and obtain very high primary stability also in very complicated clinical cases. Its clinical advantages are bone condensing properties and high primary stability, self-directing during insertion, enables the changing of direction for optimal restorative position, enables a smaller osteotomy, resulting in minimal bone loss and reduced trauma, enables narrow ridge expansion, reduces the risk of damaging neighboring teeth, and reduces the risk of perforating the lingual or buccal cortex. DFI implant is used in single tooth restoration as well as full mouth restoration and is easily stabled and controlled during placement. Its clinical advantages include that it is suitable for all bone types, ideal for use in bone types II and III, bone condensing properties, and has high primary stability and enables smaller osteotomy resulting in minimal bone loss and reducing trauma.[4]

Osseointegration occurs in two levels: primary and secondary. Primary osseointegration is associated with the mechanical engagement of an implant with the surrounding bone after implant insertion, whereas bone regeneration and remodeling offer secondary osseointegration (biological stability) to the implant. Primary stability, defined as the biometric stability immediately after implant insertion, is a critical factor that determines the long-term success of dental implants.[5] Osseointegration is a direct structural and functional connection between ordered, living bone, and the surface of a load-carrying implant is critical for implant stability and is considered a prerequisite for implant loading and long-term clinical success of endosseous dental implants. Osseointegration occurs in two levels: primary and secondary. Primary osseointegration is associated with the mechanical engagement of an implant with the surrounding bone after implant insertion; whereas bone regeneration and remodeling offer secondary osseointegration to the implant.[6,7] During implant healing, a micromotion between 50 and 150 mm may negatively influence osseointegration and bone remodeling by forming fibrous tissues at the bone-to-implant interface thereby inducing bone resorption.[8,9] Performing a clinical mobility test and finding that the implant is mobile is definite evidence that it is nonintegrated. Radiographs demonstrating direct contact between bone and implant are also evidence of osseointegration. Primary stability of an implant mainly comes from mechanical engagement with compact bone. Implant stability, an indirect indication of osseointegration, is a measure of the clinical immobility of an implant.[4] In all, our patients we achieved an insertion torque of 35 Ncm.

Bone quality is assessed to check implant stability achieved after implantation. The primary stability of dental implants

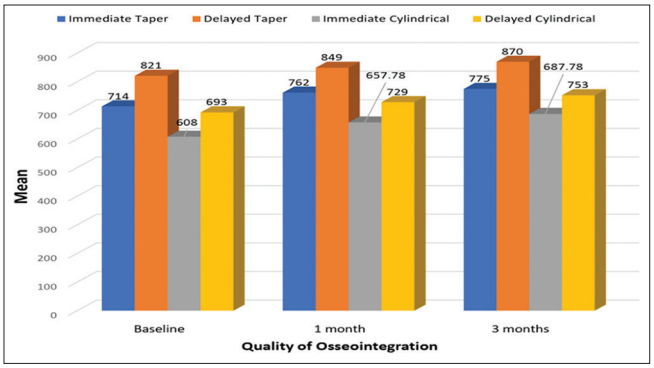

Figure 2: Assessment of quality of osseointegration

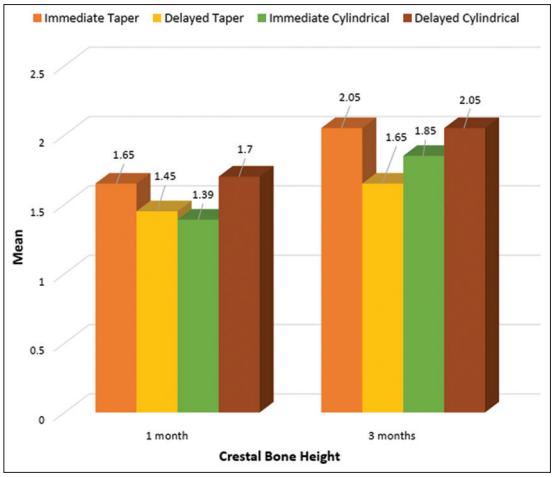

Figure 3: Variations in crestal bone height

has been reported to be determined by initial bone-implant contact.[10] With the exception that there was a 0.23 mm gain in the mean radiographical bone level in one study, immediate implants in most studies experienced marginal bone loss after being in service. In our study, by the last follow-up period (i.e., 3rd month), Group IA had an increase of 0.4 mm bone height, 0.2 mm increase in Group IB, 0.46 mm increase in Group IIA, and Group IIB had a 0.35 mm increase in bone height.

Diverse implant designs are available; each one is advocated for improving bone-to-implant contact and reducing crestal bone resorption by minimizing biomechanical stresses to the bone.[11,12] There are two major design concepts: cylindrical and tapered, they differ in the healing sequence that follows the implantation.[11] Tapered, root-form implants, generates an intimate contact between the osteotomy wall and the implant surface. The tight contact provides excellent primary stability but also may undergo localized bone necrosis near the implant surface before bone apposition ensuring its biomechanical fixation. The tapered geometry diverts forces from the dense cortical bone to the resilient trabecular bone, leading to higher forces in the apex, a desirable virtue in respect of immediate placement.[11,13] O'Sullivan *et al*.[14] demonstrated higher resonance frequency analysis and insertion torque values for tapered implants than for nontapered implants, suggesting increased stability in tapered implants. Lozano-Carrascal *et al*., in their study, reported higher primary stability in tapered implants that was measured through implant stability quotient and insertion torque. Simmons *et al*.[15] in their study did not find the same findings. Mijiritsky *et al*. after 6 years of follow-up period in their study on tapered implant placement achieved a 95.8% success rate. Cylindrical implants, parallel walls, tend to be less stable at implantation but gain stability rapidly, due to the early formation of woven bone following the blood-clotted gap between the implant and osteotomy wall. Cylindrical implant distributed force load throughout the implant and because of the parallel walls, the coronal part of the osteotomy will be damaged by the preceding implant threads, making a cylindrical implant less suited for immediate placement.[2,16] Chong *et al*.[3] pointed out that the design of the entire implant surface, not just the apical third is important for initial implant stability insertion depth and bone density have stronger association with initial stability than implant design. Thus, when an adequate amount of high-quality bone surrounds the implant, it may compensate for design inadequacy. In our study, tapered implants showed better quality of osseointegration hence primary stability—both immediate and delayed (775 HU and 870 HU, respectively), than cylindrical implants (687 HU). By the end of the 3rd month follow-up, however, delayed cylindrical implants also performed well in terms of osseointegration (753 HU). Hence, we can say that the implant designs or timing of placement did not make much of a difference in crestal bone height and quality of osseointegration.

In terms of all the parameters discussed above, along with checking for complications like wound dehiscence, infection, and cover screw exposure all but three patients fulfilled the criteria of "implant success," which were assessed both clinically and radiographical at immediate postoperative, 1 month later and at 3-month follow-ups. All those three cases belonged to the immediate cylindrical implant group, i.e., Group IIA. The implant survival rate of our study was 92.5%—three out of 40 implants could not survive. In one of those three cases, the patient reported paraesthesia on the 3rd day after placement, though the radiograph showed that the implant was at a safe distance from inferior dental canal (2 mm). The second case was of a patient who never reported back for follow-up. The third failure was attributed to implant mobility, which was reported on the 3rd follow-up. After 1st week, there was wound dehiscence that led to cover screw exposure. We followed it up to 3rd month but found increased probing depth and implant mobility, which ultimately led to failure.

We conclude that immediate implant placement has advantages as well as some challenges when compared with conventional (delayed) placement. The design of implant, either taper or cylindrical, produced no significant difference in terms of outcome and success after the completion of our study. It seems that cylindrical implants may not be ideal for immediate implant placement. Since our sample size was small and the study period was short, it is difficult to be absolutely certain as to which timing of implant placement and design of implant is better than the other, but our study provides a platform for other studies to be conducted in future with a much longer study period and larger sample size should definitely support our outcome and also elucidate it further.

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Conflicts of interest

There are no conflicts of interest.

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