ORIGINAL RESEARCH

The DTR Technique—Drilling through the Roots of Posterior Teeth for Anatomically Guided Immediate Implant Placement: A Cohort Study

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Abstract

Aim: The present study clinically analyzes implant survival of immediate implant placement cases using the drilling through roots (DTR) technique for anatomically-guided implant site preparation, as an aid to placing immediate dental implants in multi-radicular teeth.

Materials and methods: This clinical analysis utilized patients' electronic dental records who underwent immediate implant surgery using the DTR technique. All immediately placed implants were followed up regularly every year, after restoration. Implant survival was assessed with the Albrektsson et al. criteria. Inferential statistics was performed using SPSS v 21(IBM Corp., Armonk, NY) software. The Kaplan–Meier survival analysis was done to assess the implant survival probability.

Results: A total of 250 records of dental implants placed in 227 subjects using the DTR technique were considered. Results showed that the mean survival duration of implants was found 63.29 months and the median survival duration to be 55 months. A 100% success rate was seen in implant fixed bridge cases, and about 97.6% success was seen in single crown cases. No significant difference was seen in the survival rates during the follow-up period when compared according to the quadrants/site of implant placement.

Conclusion: The findings concluded that tooth-guided rapid implant placement is a unique strategy for convenient and safe insertion, providing accurate three-dimensional positioning.

Clinical significance: The DTR method is a novel approach that facilitates accurate positioning and angulation of the implant bed preparation by stabilizing and guiding the osteotomy drills using the retained root. As a result, it enables optimal implant positioning at multirooted extraction sites.

Keywords: Anatomically guided surgery, Drilling through roots, Immediate implants, Implant bed preparation.

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Introduction

The surgical placement of dental implants for damaged or missing teeth is a well-established technique with a high percentage of success. In recent decades, there has been an increasing acceptance of immediate implant placement (IIP), following the first evidence of placing implants into newly extracted sockets provided by Schulte and Heimke.[1] Immediate implant placement is widely advocated and documented as a predictable procedure for replacing hopeless teeth, particularly for single-tooth replacement in the esthetic zone and molar regions.[2] Benefits include a reduction in the number of surgeries required, reduced treatment time, and increased patient satisfaction.[3] A recent systematic review reported a cumulative survival rate for immediately placed molar implants to be similar to implants placed in healed molar extraction sites.[4]

For initial stability, implants must be placed precisely in three dimensions, especially in multirooted teeth with periapical pathology and thin interradicular bone. Under these circumstances, the osteotomy drill could deviate away from the ridge or surface of the bone septa and unintentionally follow the remaining root space, presenting difficulty.[3] Placement in the molar regions of the upper and lower jaw poses many clinical difficulties due to specific anatomical characteristics of the area, including the existence of large extraction sockets and reduced bone heights underneath the socket.[4]

To have precise placement in these areas, prosthetically guided implant placement to optimize clinical outcomes is very common. However, guides are expensive and difficult for patients with limited mouth opening. A better alternative is required that can be useful for patients, is more economical and conservative, and requires less or no commercial materials. Drilling through roots surgical technique may be useful for dental implant placement in multirooted teeth. Using the teeth as a surgical guide, the DTR technique gradually drills the implant site using the structure and

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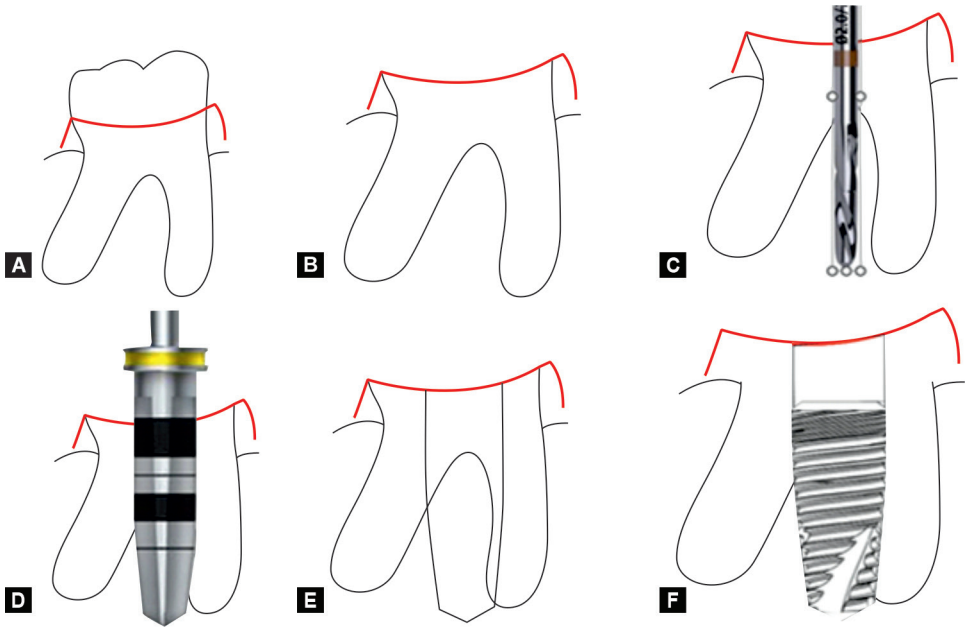


Figs 1A to F: Schematic representation of the steps of DTR: (A) Unrestorable tooth requiring extraction; (B) Coronal decortication done; (C) P drill through the roots; (D) Final drill in place; (E) Final osteotomy prepared and root fragments removed; (F) Implant placed subcrestally into the prepared bed

form of the multi-rooted teeth to guide and secure the implant between the roots. This approach ensures that the implants are securely placed in an ideal position, regardless of the size and shape of the extraction socket.[5]

Hereafter the authors report data from 250 implants placed using an anatomically-guided, drilling through roots technique, in multi-radicular molar teeth post-extraction sockets following up the restoration, evaluating implant survival through the follow-up periods by clinical and radiographic assessment.

Materials and Methods

This cohort study used patients' electronic dental records who underwent immediate implant surgery, using the DTR technique, at private clinics in New Delhi and Venezuela between 2015 and 2023. The sample size was estimated using G* power (v3.1.9.4) software. The sample size was estimated at alpha 0.05, power 80%, and effect size 0.25 (obtained from a similar study by considering the success rate after implant placement). The minimum sample size was calculated to be 206 and in the present study, a total of 250 implant sites were included, placed in 227 subjects.

The selected patients were above 18 years old and in good health, had complete demographic and medical history records, had available data related to implant therapy, and had written informed consent to publish their concerned data later.

All patients whose follow-up commences from the time of definitive restoration with minimum mid-term follow-up or more or equal to 12 months, with demonstrable clinical examination data and a minimum of a periapical view radiograph and a clinical photograph were included. Patients whose implants were not loaded with a restorative (temporary or permanent) for more than 12 months and non-compliant patients who failed to attend follow-up appointments were excluded.

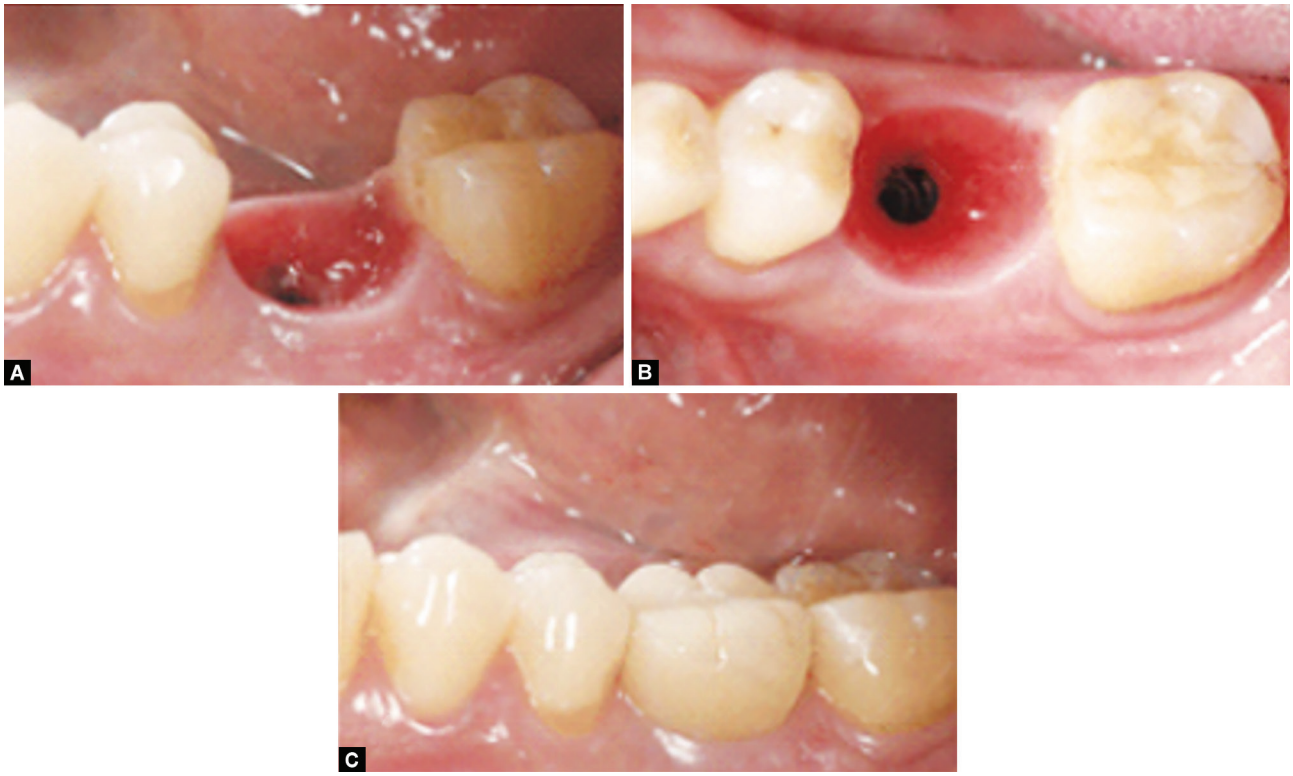
The following criteria were considered for IIP with the DTR technique: No history of systemic diseases or any contraindications to treatment, and was not on any prescription medications as per records; the teeth adjacent to the extraction socket were free of overhanging or insufficient restoration margins; the patient was not on nicotine; and bone coverage of at least 2/3 of the root was present with root integrity maintained. A tooth with any active pathology, the unfavorable position of the tooth or remaining roots, or fused or ankylosed roots were excluded from the survival analysis. Figure 1 depict the schematic representation of the steps of DTR and Figures 2 and 3 illustrate the completed case.

In all cases selected for the present study, only those were considered wherein DTR was performed and an adequate torque was achieved, allowing for non-submerged healing. The primary outcome of the measure was implant survival.

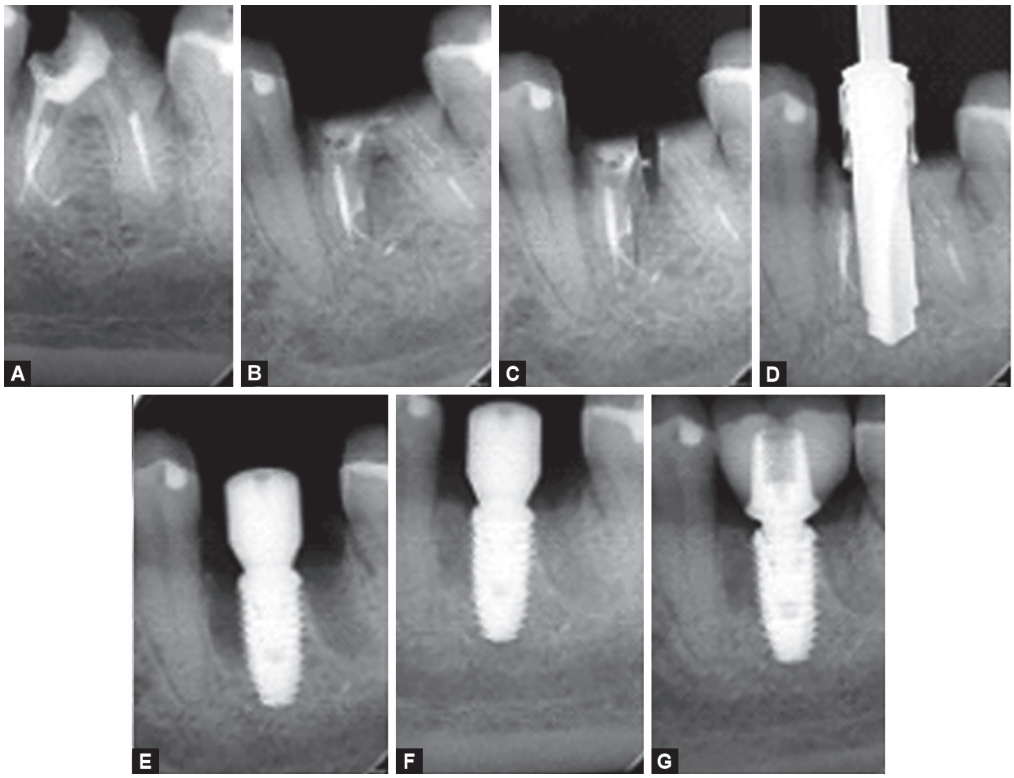
The criteria for determining the survival of implants were established using the guidelines proposed by Buser et al. in 1990 based on the clinical and radiographic findings. These criteria included the absence of persistent subjective complaints such as pain, foreign body sensation, or dysesthesia. Additionally, the absence of recurrent peri-implantitis with suppuration, mobility of the implant, continuous radiolucency around the implant, rapid progressive bone loss, and the possibility of restoration were also considered.[6]

Statistical Analysis

Data was analyzed using Statistical Package for Social Sciences (SPSS) version 21 (IBM Corp., Armonk, NY). Descriptive data was reported for each variable. Summarized data was presented using tables and Figures. The Kaplan–Meier survival analysis was done and implant survival probability was calculated as the number of subjects surviving divided by the number of patients.



Figs 2A to C: Step-by-step clinical case presentation of DTR with final crown



Figs 3A to G: Radiographic case presentation of DTR with a final: (A) Fractured tooth; (B) Decortication of crown; (C) Splitting root; (D) Osteotomy preparation; (E) Implant placed and residual root removed; (F) Healing after 3 months; (G) Final crown placed

Categorical variables were assessed using the Chi-square test. The level of significance was set at $p < 0.05$.

Results

A total of 262 dental records for implants were screened for eligibility in the study. Records of 12 dental implants were excluded from the analysis due to incomplete data, loss of follow-up, and duplicates. Finally, 250 records of dental implants placed at private clinics in New Delhi and Venezuela were available between 2015 and 2023 and were included in the present investigation. Table 1 shows that 14.9% belonged to 21–30 years, 32.5% belonged to 31–40 years, 18.9% belonged to 41–50 years, 24.6% belonged to 51–60 years, and 8.8% belonged to 61 years and above. The mean age was 49.97 ± 12.79 (Table 1). Out of the total of 227 subjects among which implants were placed, 47.6% were females and 52.4% were males (Fig. 6). Out of 250 implants that were placed, 41.2% belonged to the first quadrant, 52.4% belonged to the second quadrant, and 5.6% belonged to the third quadrant and fourth quadrant (Fig. 7). Though 100% success was seen with fixed brides, no significant difference was seen in the overall survival rates among subjects given single prostheses or fixed bridges ($p = 0.202$). A total of 4 failure cases were reported. The mean survival duration was estimated as 63.29 months and the median survival duration as 55 months (Table 2 and Fig. 8). The period of follow-up and the number of patients respectively are demonstrated in (Fig. 9). Out of total 4 failure cases, 2 cases were failed when implant was placed in the first quadrant and 2 cases failed when implants were placed in the fourth quadrant. No significant difference was seen in the survival rates when compared according to the quadrants/site of implant placement (Table 3 and Fig. 10).

Table 1: Age-group-wise distribution of the participants

Age-groups	*Frequency*	*Percent*
Age-groups		
21–30 years	34	14.9
31–40 years	74	32.5
41–50 years	43	18.9
51–60 years	56	24.6
61 years and above	20	8.8
Total	227	100.0
Mean age	49.97 ± 12.79 years	

Discussion

Immediate implants offer greater advantages over delayed placement of implants. One of the major advantages is the psychological and economic impact of a reduction in the number of surgeries and treatment time. Additionally, it aids the preservation of the gingival architecture and increases patient acceptance and comfort.[7]

However, the predictability of immediate implant implantation in multirooted tooth extraction sockets is questionable, despite its reported high rates of survival and success.[8,9] The challenges of immediate implants in the molar, include anatomical challenges like the relative size of the socket in comparison to the implant, the length of the root, the divergence of roots, the height of the root trunk and thin inter radicular bone, with the chances of drill slippage leading to inadequate preparation of implant bed.[10] All this can hamper the success of implant placement. Hence, achieving optimal implant placement is a crucial component of therapeutic significance.

Thus, it's essential to make modifications to the preexisting surgical procedure that can negotiate the challenges and make the treatment predictable. Several authors recommend drilling through

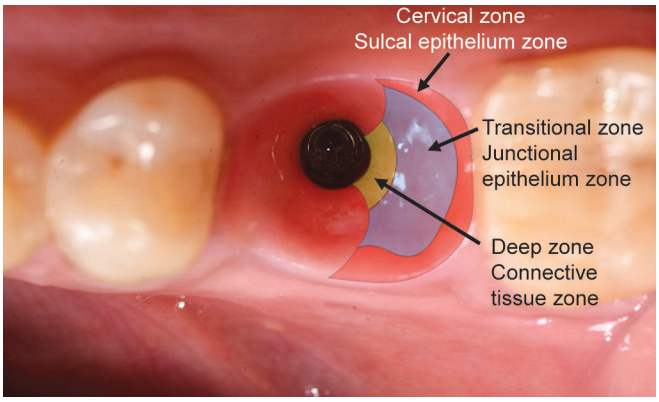


Fig. 4: Clinical image of implant supracrestal complex

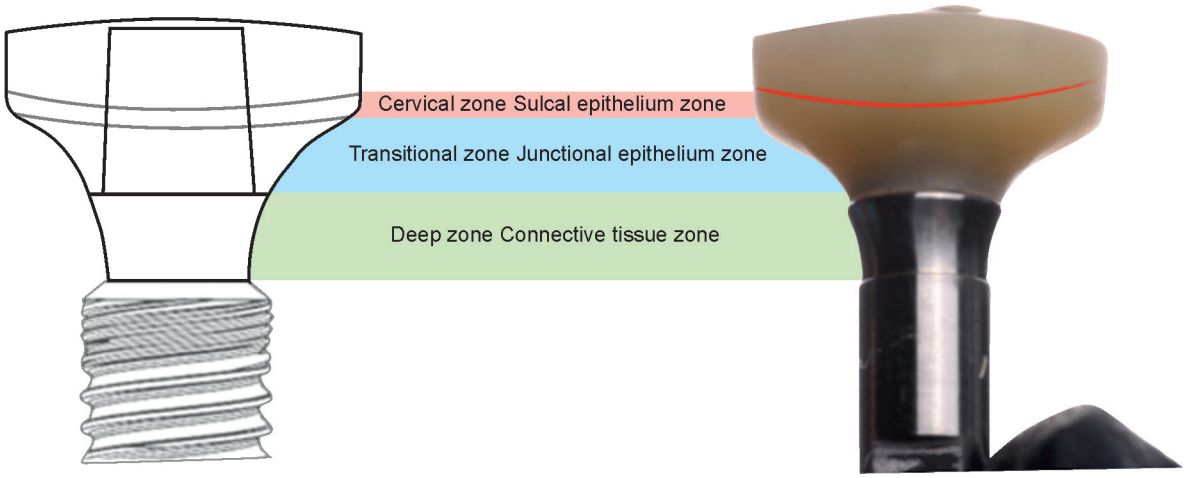


Fig. 5: Schematic representation of implant supracrestal complex

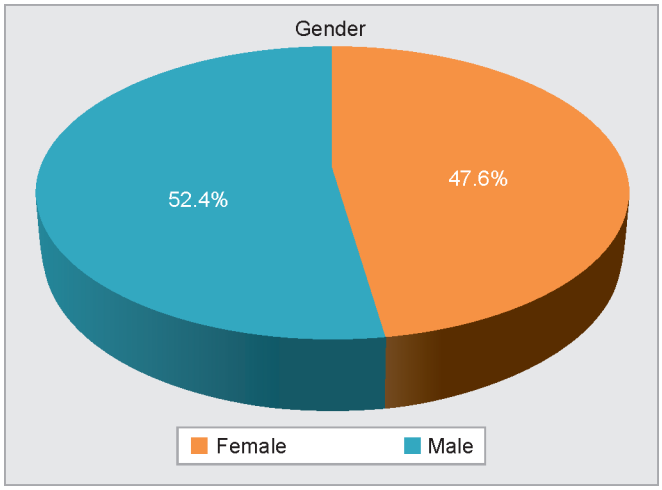


Fig. 6: Gender-wise distribution of the participants

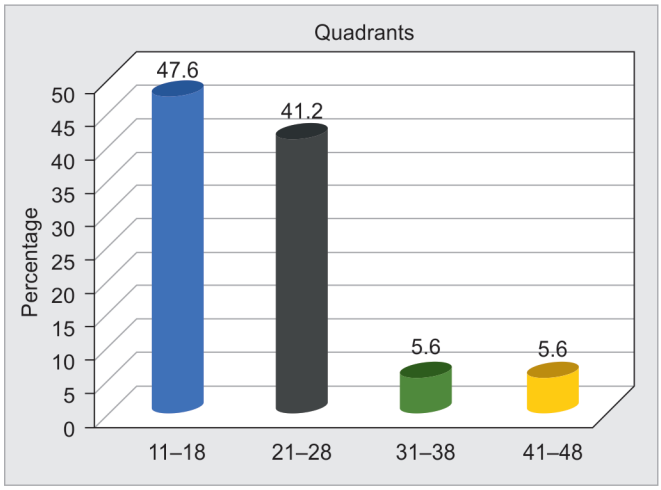


Fig. 7: Quadrant-wise distribution of the participants

Table 2: Overall survival analysis

Case processing summary							
				Censored			
Total no.		*No. of events*		*n*		*Percent*	
250		246		4		1.6	
Means and medians for survival time							
Mean[a]				*Median*			
		95% Confidence interval				*95% Confidence interval*	
Estimate	*Std. error*	*Lower bound*	*Upper bound*	*Estimate*	*Std. error*	*Lower bound*	*Upper bound*
63.292	1.031	30.272	34.312	55.000	1.647	21.772	28.228

[a]Estimation is limited to the largest survival time if it is censored

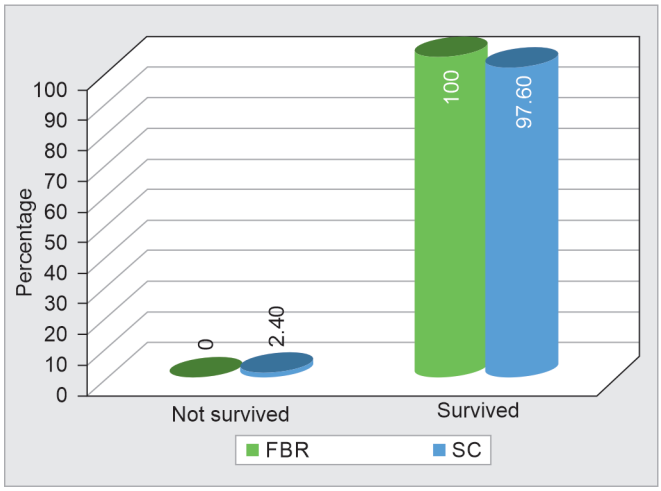


Fig. 8: Survival rates according to the prosthesis delivered

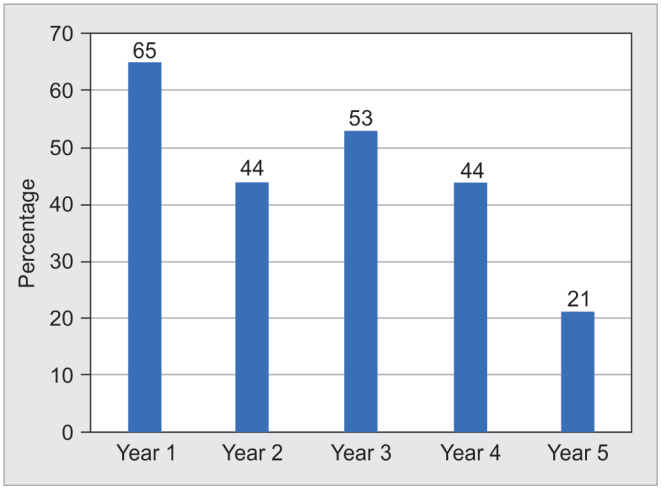


Fig. 9: Number of patients followed up per year of follow-up

the root for implant bed preparation, followed by extraction of the remaining root fragments. In a recent prospective pilot study, on 10 patients with badly destructed mandibular conducted by Abdelazim et al., wherein they used the anatomy of the root of the multi-radicular mandibular tooth for tooth-guided IIP, 1 out of the 10 implants failed and had to be removed. The remaining 9 implants reported an increase in implant stability quotient (ISQ) value after 3 months, also the cone-beam computed tomography (CBCT) showed an increase in bone density around implants compared to the immediate postoperative CBCT.[11]

In another pilot study, 22 patients were randomized to evaluate traditional tooth extraction, followed by inter-radicular bone

Table 3: Survival analysis according to site of implant placement

Case processing summary

			Censored	
Quadrant	*Total no.*	*No. of events*	*n*	*Percent*
11–18	116	116	0	0.0
21–28	108	106	2	1.9
31–38	13	13	0	0.0
41–48	13	11	2	15.4
Overall	250	246	4	1.6

Means and medians for survival time

	Mean[a]				*Median*			
			95% Confidence interval				*95% Confidence interval*	
VAR00002	*Estimate*	*Std. error*	*Lower bound*	*Upper bound*	*Estimate*	*Std. error*	*Lower bound*	*Upper bound*
11–18	50.313	1.437	27.496	33.130	55.000	0.999	23.042	26.958
21–28	54.169	1.599	31.035	37.303	56.000	4.352	27.470	44.530
31–38	54.385	5.327	23.943	44.826	50.000	5.392	19.431	40.569
41-48	51.692	5.283	21.337	42.047	54.000	9.706	4.976	43.024
Overall	52.268	1.036	30.237	34.299	55.000	1.637	21.792	28.208

	Chi-square	*df*	*p-value*
Log Rank (Mantel-Cox)	5.748	3	0.125

Test of equality of survival distributions for the different levels of VAR00002.

[a]Estimation is limited to the largest survival time if it is censored

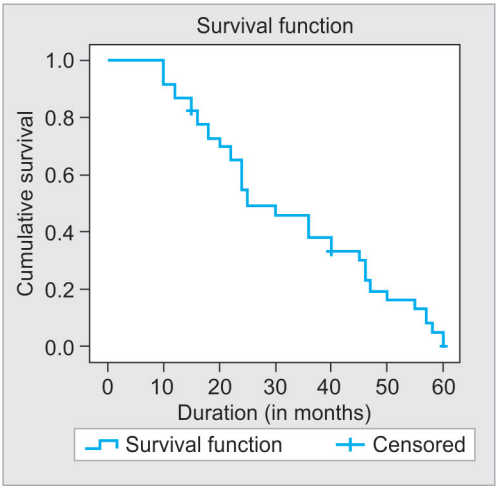


Fig. 10: Overall survival graph

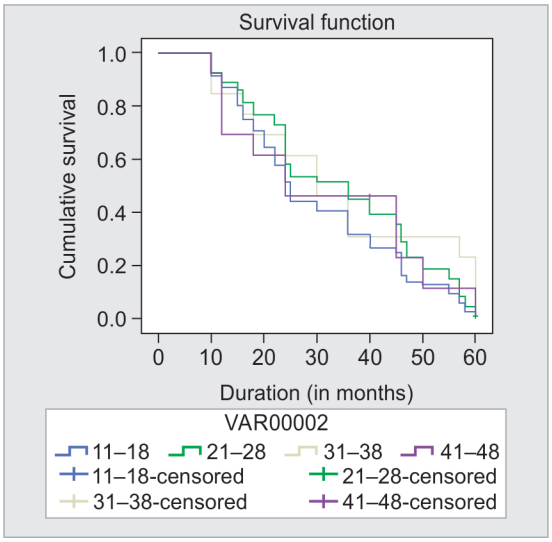


Fig. 11: Survival analysis according to site of implant placement

drilling, and IIP with DTR for implant bed preparation using an ultrasound device. The proposed approach yielded significantly superior outcomes for implant placement and primary stability.[12]

Based on these studies, the present study was done to assess the technique of DTR for implant bed preparation. The technique of implant insertion consisted of a progressive preparation of the implant site using the anatomy of the root of the multi-radicular molars. An overall high success rate of 100% for cases wherein after DTR a fixed bridge was given, and about 97.6% for a single crown, support the previous clinical and histological studies with high success rates and predictable results (Fig. 11). The DTR modality of treatment offers many advantages, not only surgical but also prosthetic. The main advantage is that the implant can be placed three-dimensionally in the correct position, with the osteotomy drills stabilized and guided by the retained root aspects.

From the mesiodistal and buccolingual points of view, the implant will be placed throughout the center of the space to be restored. From the smooth-apical point of view, the initially retained root complex serves as an ideal template for the emergence profile of the tooth to be replaced.[11–14] For example, using the crown of the molar and leaving it at the level of the gingival margin, serves as a vertical stop to place the implant 4 mm below the gingival margin, thus guaranteeing the space of the implant supracrestal complex and that the three biological zones can be created: The

deep zone, where the connective tissue will be found in contact with the cuff of the abutment (2 mm); the intermediate zone, where the cervical emergence profile and the formation of the junction to the epithelium will begin (1.5 mm); and finally, the superficial zone, or gingival sulcus, where the subcritical and critical zones will be modeled for a final esthetic result.

Moreover, it should be noted that when this technique is applied, other considerations such as esthetic and functional outcomes, preservation of the alveolar process, and stability of the gingival tissues at the time of restoration are other advantages of the DTR aspects that must be considered when the treatment plan is designed.

In the present study, for the DTR technique, sharp new drills were used to drill for the implant bed preparation, which was similar to Rebele et al., who recommended using a sharp new drill to drill through the dentin and cementum at the furcation region and claimed that drilling through the dentin and retained root aspects appeared to be similar to drilling through tissues, but it is slightly harder than dense cortical bone.[13] This also supports the results of Davarpanah and Szmukler-Moncler, who reported on implant placement in contact with ankylosed root fragments.[15]

Furthermore, it is important to highlight that while using this method, the retained roots serve as an ideal template for the emerging profile of the tooth that will be substituted. This statement aligns with the findings of Rohra et al.[16] If the operator favors direct bone-to-implant contact over implant-to-root contact, the residual root fragment, may be removed using ample irrigation and a curette. The implant crushes the roots into small fragments. The interface may have no symptoms or dentin may resorb and be replaced by bone.

One inherent constraint of this approach is the inability to use an infected or mobile root as a template. If an infection occurs, it is not practical to carry out the procedure since it might cause the infection to spread beyond the surrounding region. The authors do not recommend this technique for all immediate placements and would avoid those teeth with frank infections. Before inserting the implant, it is crucial to eradicate all potential sources of infection to avoid complications.[17]

It is important to be cautious while removing any previous endodontic filling material. While it is true that endodontic filling material might potentially lead to irritation in the adjacent region, it has been extensively proven that debris from the tooth structure or the tooth itself does not hinder the integration of dental implants. Instead, it is expected to contribute to local bone remodeling. Another disadvantage of this technique is the requirement of a longer time to place the implant.

In the present study, four implants failed; the failure could be attributed to the patient not complying with the post-surgery oral hygiene instructions. This coincides with Tolstunov's statement that inadequate oral hygiene is a primary factor contributing to premature implant failure.[18] No significant difference was seen in the survival rates of implants during the follow-up period irrespective of the site of placement, maxilla, or mandible.

In the present investigation, bone grafts were not used in extraction sockets following implant placement, allowing them to heal by secondary intention, and a large customized abutment was placed to cover the socket. This is in agreement with the consensus report by Schwartz-Arad and Chaushu on immediate implants.[19]

In this study, it is shown how the preparation of implant sites, using the DTR method, allows implant placement in an ideal prosthetic position. With this technique, all implants have higher stability than the traditional technique of bed preparation after the removal of the tooth. Using this method also lowers the risk of surgical problems caused by a small interocclusal distance in the posterior segment. This is especially true when surgical guides are used, which makes it impossible to insert drills through the guides. Furthermore, this methodology demonstrates cost-effectiveness in comparison to the computer-guided intervention for implant placement This finding is consistent with the research conducted by Mahesh et al. and Joshi et al.[17,20]

The DTR approach resulted in the final prosthesis being positioned optimally, ensuring uniform force distribution on the implant, achieving a perfect emergence profile, and effectively controlling plaque in the patients. This finding is consistent with Scarano's research.[12]

Thus, based on the results of the present study and the literature, this unique technique of implant bed preparation may be seen as a simple but beneficial modification of the traditional approach. It enables optimal alignment of the implant during immediate placement at extraction sites with multiple roots, however, a comparative controlled randomized clinical trial is needed to assess this technique's long-term advantages and drawbacks.

Conclusion

The study's findings concluded that tooth-guided rapid implant placement is a unique strategy for convenient and safe insertion, providing accurate three-dimensional positioning.

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