Influence of Thread Design on Implant Positioning in Immediate Implant Placement

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Background: It is generally believed that implants placed in extraction sockets have a tendency to shift in the facial direction during insertion. The purpose of this study is to investigate the effect of different thread designs on the final implant position in immediate implant placement.

Methods: In a split-mouth design involving 11 cadaver heads, each specimen received two implants, one with a square and one with a V-shaped thread design, in maxillary incisor extraction sockets. The facio-lingual locations of the drills and the implant were tracked, and the displacements were compared between the two groups.

Results: No statistically significant differences were observed between the square and V-shaped thread design groups. The mean displacements of the different groups showed a general tendency of the implants to be positioned facially compared with the initial drill trajectory. This tendency was greater for implants with square thread design.

Conclusion: There was no significant effect of implant thread design on the positioning of implants in extraction sockets. *J Periodontol 2012;83: 1420-1424.*

KEY WORDS

Cadaver; dental implantation, endosseous; dental implants; dental implants, single-tooth; dental prosthesis, implant-supported.

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The placement of implants in fresh extraction sockets has gained increasing popularity among dental practitioners.[1,2] This increasing popularity has been fueled by the introduction of implant designs aimed at achieving greater primary stability and faster osseointegration. Immediate implant placement, also known as type I placement,[3] enjoys survival rates similar to implants placed in a healed site.[1,2,4] A 95% survival rate is common for both immediate placement and conventional placement protocols.[2]

It is a well-known fact that the dimensions of the socket reduce in bucco-lingual width as well as height as healing progresses.[5,6] Placement of implants into these sockets does not stop this reduction of bone volume.[7-10] Botticelli et al.[7] found that there was a 56% reduction of the buccal tissue volume, whereas the lingual tissue reduced by only 27% after immediate implant placement. As a result, implants placed immediately are susceptible to buccal soft tissue recession and related esthetic problems.

Chen and Buser[2] in a systematic review showed that buccal recession in immediate placement was a common occurrence. Risk indicators for buccal recession were found to be a thin gingival biotype, facial malposition of the implant, and a thin or damaged buccal wall of the socket. A retrospective analysis revealed that implants with a buccally positioned shoulder exhibited three times more recession than

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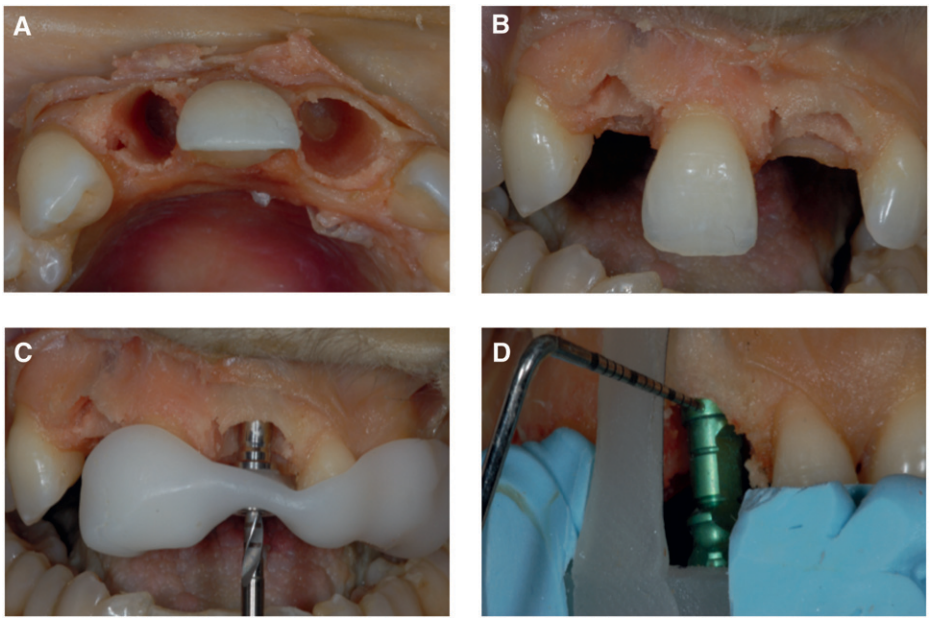

Figure 1.
*Representative images of experimental procedure. **A** and **B)** Incisal and facial views of specimen after tooth extractions. **C)** Pilot drill guided by surgical guide. **D)** Implant position being measured from a fixed reference.*

those with a lingual position.[11] Hence, it is suggested that placement of the implant toward the lingual aspect of the socket will help in preventing soft tissue recession. This makes ideal implant positioning critical to the esthetic success of immediately placed implants.[12]

One unique characteristic when considering implant design is the design of threads. Thread designs vary widely among implant systems. Historically, the primary consideration in choosing a particular thread design has been to achieve better stress transfer to the supporting bone.[13] Nonetheless, some designs are believed to provide better bone-to-implant contact, whereas others have faster insertion times.[14] Implants with square thread design (ST) possess certain beneficial qualities. In rabbit tibiae, ST implants were shown to achieve higher bone-to-implant contact.[13] Finite element studies show better stress-distribution characteristics for ST implants.[14-16] However, square threads are non-cutting threads and require a tapping drill to precut threads into the bone before implant placement. In a socket, when implants are typically placed into the palatal wall, this lack of cutting threads creates a tendency for the implant to be positioned more buccally.

The morphology of the socket makes it challenging to accurately position implants at the desired location. Drilling against the incline of the palatal wall of the socket creates a tendency for the drill to inadvertently move buccally.[17] The surgical technique for placement of implants into extraction sockets dictates that the surgeon, being mindful of these morphologic peculiarities, uses adequate pressure during drilling to avoid malposition of the implant. Nevertheless, there is no information in the literature regarding the influence of thread geometry on implant positioning. Therefore, the aim of this study is to investigate the effect of different thread designs on the final implant position in immediate implant placement.

MATERIALS AND METHODS

Thread Designs

This study compared two different thread designs. One group had implants with a V-shaped thread design (VT),† and the other group had ST implants.‡ In an attempt to standardize surgical placement, only one representative size of implants from each implant system was used for all study sites (4.0 × 12.0 mm for ST and 3.7 × 11.5 mm for VT). Because the implants used in the study are from two different commercially available systems, an exact match of the implant dimensions was not achievable. The closest possible match between the sizes of the two systems was used.

Description of Specimens

Specimens involved in this study were obtained from 23 human cadavers donated to the Division of Anatomic Sciences at the University of Michigan Medical School. After harvesting from the donors, the heads were frozen and stored at –20°C. They were thawed to room temperature before being used for the study. The following inclusion criteria were used to select the specimens: 1) all maxillary anterior teeth (incisors and canines) were present and intact, without signs of periodontal disease; 2) no evidence of clinical mobility, crowding, or diastema; and 3) no evidence of buccal or palatal dehiscence and fenestration around the study teeth (confirmed after flap elevation). A total of 11 specimens fulfilled the criteria, resulting in a sample size of 11. A prospective sample size calculation was not possible because of lack of any previous such studies. In addition, this is a cadaver study, so the amount of specimens available is limited. As such, this study was planned as a pilot investigation.

† Tapered Screw-Vent Implant System, Zimmer Dental, Carlsbad, CA.
‡ External Implant System, Biohorizons, Birmingham, AL.

Table 1.

Distribution of Implant Sites and Distances From Pilot Drill to Subsequent Drills and the Implant

Specimen No.	Implant System/ Thread Design	Site	Distance (mm)*		
			Pilot – 2nd Drill	Pilot – 3rd Drill	Pilot – Implant
1	VT	10	1.7	1.4	2.25
2	VT	8	–0.3	0.4	0.75
3	VT	7	0.2	–0.1	–0.75
4	VT	10	0.2	1.4	2.25
5	VT	9	0.2	–0.6	1.25
6	VT	9	0.7	0.4	0.25
7	VT	9	–0.3	0.4	–0.75
8	VT	7	–0.3	0.4	1.75
9	VT	7	–0.8	–1.1	–0.75
10	VT	7	–0.8	–0.6	–0.25
11	VT	8	0.2	–0.1	1.75
Mean ± SD			0.06 ± 0.71	0.17 ± 0.79	0.71 ± 1.21
1	ST	8	–0.65	–0.4	0.6
2	ST	10	0.35	1.1	0.6
3	ST	10	–0.15	0.6	1.1
4	ST	8	–0.15	0.1	1.1
5	ST	7	0.35	0.1	1.1
6	ST	7	–0.15	0.6	2.6
7	ST	7	0.35	0.6	0.6
8	ST	9	–0.15	–0.4	0.6
9	ST	9	–0.15	0.1	1.6
10	ST	10	1.35	1.1	2.6
11	ST	10	1.35	1.6	2.1
Mean ± SD			0.21 ± 0.64	0.46 ± 0.64	1.33 ± 0.79

* Negative values indicate distance in a palatal direction.

Extraction and Implant Placement

This study followed a randomized split-mouth design. One maxillary central and the contralateral lateral incisor from each specimen were selected as study teeth. A full-thickness mucoperiosteal flap was elevated, and study teeth were extracted in toto, taking care to maintain the integrity of the alveolar housing (Figs. 1A and 1B). Each site was randomly assigned to one of two groups, such that each specimen received one implant each from either system.

A surgical guide[§] was fabricated chairside by a prosthodontist (TK) (Fig. 1C). The general guideline of having the implant platform under the cingulum of the planned restoration was followed. A custom measurement stent was fabricated using a tray resin[‖] and stabilized to the maxillary arch using a bite registration material.[¶] Two surgeons (J-HF, H-LC) were involved in the placement of the implants. The specimens were randomly and evenly distributed between the two surgeons. The implants were placed according to the respective manufacturer recommended procedures.

Measurements

The location of each drill used and the location of the implant after placement were measured. An independent observer (TK) who was not involved in the placement of the implants made all measurements. The observer was calibrated before the start of the experiment to achieve intra-examiner reliability of >85%. A periodontal probe[#] was used for making all measurements (Fig. 1D). Measurements were made from a fixed reference point on the measurement stent to the labial-most extent of the drill or implant, down to the closest millimeter. Half the diameter of the drill or implant was added to the measured values to obtain the locations of the respective drill or implant. These actual locations of the drills and implants were used to calculate the distances from the pilot drill to the subsequent drill and the implant.

Data Analyses

Statistical analysis was performed using a statistical package.[**] The independent samples *t* test was used to compare the means of distances of implants between the two groups. Levene test was used to test the assumption of equality of variances. Within each group, the means of distances between subsequent drills were compared using a one-way repeated measures analysis of variance.

RESULTS

The randomized distribution of the sites and the distances between subsequent drills are shown in Table 1. Adequate primary stability was achieved with all implants, and an insertion torque of ≥40 Ncm was achieved.

The means of distances showed that all implants placed in extraction sockets tend to move facially during insertion. The statistical analyses showed no significant differences between any of the measurements of the two groups (Table 2). A greater displacement toward the facial was detected for the ST group (1.33 ± 0.79 versus 0.71 ± 1.21 mm in the

§ Thermoplastic drill template, Straumann, Andover, MA.
‖ Triad TruTray Custom Tray Material, DENTSPLY International, York, PA.
¶ Blu-Bite HP Rigid, Henry Schein, Melville, NY.
# UNC-15, Hu-Friedy, Chicago, IL.
** SPSS v.19.0.0, IBM, Armonk, NY.

VT group) (Figs. 2 and 3). Four implants from the VT group were in a position more palatal to the starting point (pilot drill). In contrast, all implants from the ST group were found to be in a facial location compared with the respective pilot drills.

DISCUSSION

A majority of the implants in this study ended up in a position that was facial to the planned position. This signifies the effect that socket morphology has on the implant osteotomy. The fact that the drills were being used on the inclined palatal wall of the socket possibly resulted in the observed tendency of a facial shift of the successive drills, eventually leading to a more facial position of the implant (Fig. 4).

Although to the best of our knowledge this tendency for a facial shift of the osteotomy has been documented for the first time in this study, the concept is not new. Surgical guidelines for immediate implant placement often advise the use of palatally directed force during site preparation and implant insertion. During immediate placement, the cutting nature of the implant threads is believed to aid in engaging more of the palatal wall and less of the buccal wall of the socket.[14] However, implants with non-cutting thread designs (e.g., square threads) would not be able to benefit from this rationale.

In this study, there is a slight difference in dimensions of implants between the two groups (0.3 mm in diameter and 0.5 mm in length). The authors believe that this minor difference in dimensions had little if any effect on the results of the study.

Because all the implants were placed in the cingulum axis of the extracted tooth, there exists variability in the socket morphology at the implant site. Some of the variables that may affect the placement include the following: 1) size of the socket; 2) thickness of the buccal and lingual walls of the socket; and 3) the relative location of the cingulum. However, these factors were controlled using randomization. The surgical guides used in this study use metallic sleeves, which aimed at standardizing position of the implant drills. However, implant placement was performed without the use of a surgical guide in an attempt to mimic the true clinical scenario to allow the authors to study the effect of thread design on implant positioning. Although this protocol followed commonly used clinical guidelines, the final position of the implant depends on the surgical technique used. Specifically, the amount of palatally directed force used during placement would influence the final position of the implant. This could be counteracted by the use of computed tomography–based treatment planning software and surgical templates for final implant placement in the future. This study does not show a significant effect of thread design on implant position in immediate placement. However,

Table 2.

Means of Distances Between the Pilot Drills and the Implants

Groups	Mean	SD	SEM	Significance
VT pilot – implant	0.71	1.21	0.37	0.171
ST pilot – implant	1.33	0.79	0.24	0.171

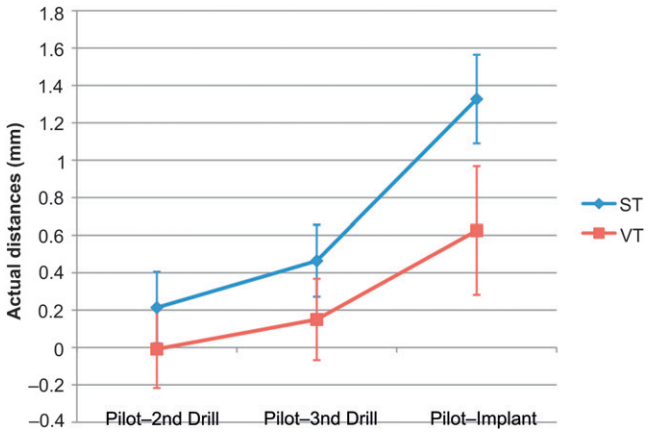

Figure 2.
Chart showing mean actual distances from the pilot drill (starting point) to the subsequent drills and implant. Error bars represent standard error.

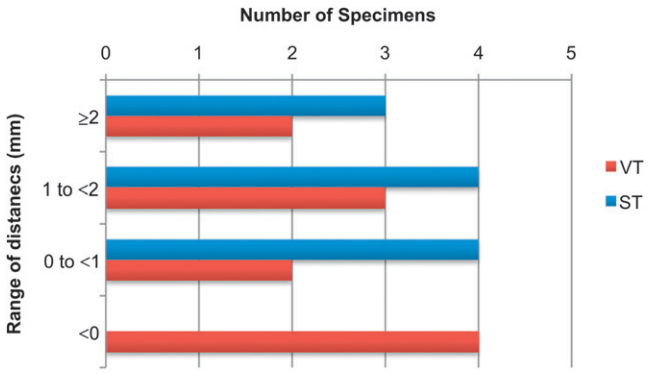

Figure 3.
Distribution of number of specimens based on the distances between pilot drill and implant positions.

a tendency was observed for ST implants to be placed more facially by an average distance of ≈0.6 mm compared with VT implants. The authors believe that one major reason for the inconclusive results is the fact that the study was underpowered. It is suggested that the data from this study be used to adequately power a similar study aimed at definitely answering the question. The clinical implications of the above considerations would be that implant macrodesign might have a role to play in ideal implant positioning for

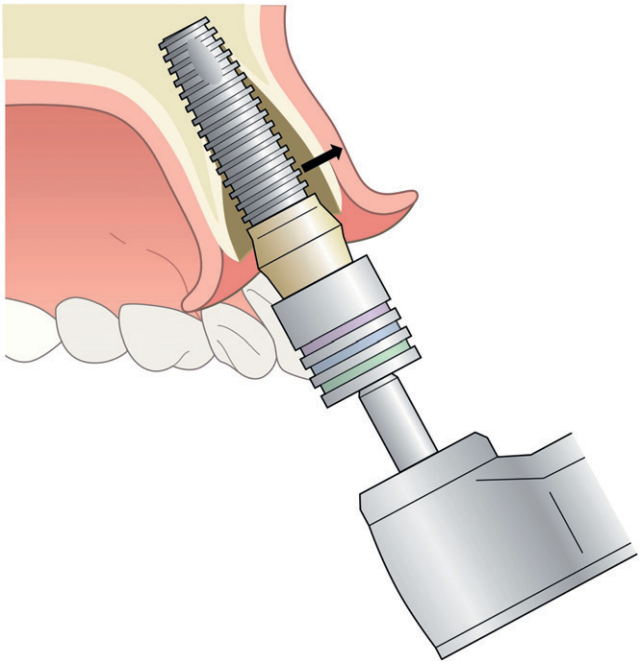

Figure 4.
Tendency of the implant to move facially during placement.

immediate placement. Features such as cutting threads may be more desirable compared with non-cutting threads in immediate implant placement.

CONCLUSION

Within the limitations of the present study, no significant effect of implant thread design was detected on implant positioning in extraction sockets.

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