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COMPARATIVE EVALUATION OF AMOUNT OF RESIDUAL CEMENT EXCESS USING SHORT AND LONG COLLAR HEIGHT ABUTMENTS WITH TWO DIFFERENT CEMENTATION TECHNIQUES: AN IN VIVO STUDY

Prosthodontics

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ABSTRACT

Cement-retained implant prostheses remain popular for their favourable esthetics and simplified laboratory procedures, but residual subgingival cement is a well-recognised etiological factor for peri-implant mucositis and peri-implantitis. This randomized controlled clinical trial evaluated the influence of prosthetic abutment collar height and cement removal technique on the amount of excess residual cement around implant-supported single crowns. Twenty equicrestally placed, platform-switched, internal-hex implants in the posterior maxilla and mandible were divided into short-collar (1 mm) and long-collar (3 mm) abutment groups, each further assessed using conventional cementation or a modified technique employing polytetrafluoroethylene (PTFE) tape making it total 40 samples. Residual cement was collected after crown retrieval and quantified using an analytical balance. Two-way ANOVA showed that both abutment collar height and cement removal technique significantly affected residual cement ($p<0.001$), with no significant interaction between the two ($p=0.791$). Long-collar abutments produced significantly greater residual cement than short-collar abutments, and the conventional technique produced significantly more residual cement than the PTFE tape technique. The combination of short-collar abutments with PTFE tape produced the least residual cement. Appropriate abutment selection combined with effective cement-control strategies is essential to minimise residual cement and reduce the risk of peri-implant biological complications.

KEYWORDS

Residual Cement; Abutment Collar Height; Ptfe Tape.

INTRODUCTION

Dental implants have become a widely accepted and predictable treatment modality for the replacement of missing teeth, offering high long-term success rates and improved patient satisfaction. Implant-supported restorations can broadly be classified into screw-retained and cement-retained prostheses, each with distinct advantages and limitations. Cement-retained restorations continue to be extensively utilised because of their favourable esthetics, passive fit, simplified laboratory procedures, and reduced chairside time.

Despite these advantages, cement-retained implant prostheses are associated with several biological and mechanical complications, the most notable being excess residual cement within the peri-implant sulcus, which is increasingly implicated as a primary etiological factor in peri-implant mucositis and peri-implantitis.[1] Unlike natural dentition, where connective tissue fibres insert perpendicularly into cementum, peri-implant tissues exhibit a circumferential fibre orientation parallel to the implant surface, which facilitates apical displacement of cement during crown seating. The absence of periodontal-ligament vascularity around implants may further reduce tissue resistance to bacterial insult and foreign-body reactions.

Cement remnants often go undetected because of the limited radiopacity of commonly used luting agents and restricted clinical access to deep subgingival margins,[2] making preventive strategies aimed at minimising cement extrusion more important than reliance on post-cementation clean-up alone.

Prosthetic abutment collar height directly influences margin depth and emergence profile. Longer collars often result in deeper margin placement, which may enhance esthetics but increases the difficulty of cement removal, whereas shorter collars facilitate visibility and accessibility for cement removal but may compromise peri-implant soft-tissue stability.[3] Various cement-control strategies, including vent holes, replica techniques and barrier methods such as polytetrafluoroethylene (PTFE) tape, have been proposed to limit cement adhesion and apical migration during crown seating.[4] However, limited literature examines the combined influence of abutment collar height and cement-removal technique on cement retention. The present study was therefore designed to evaluate the effect of prosthetic abutment collar height and cement-removal technique on the amount of excess residual cement, comparing short and long collar abutments in conjunction with conventional and PTFE tape cement-removal techniques.

MATERIALS AND METHODS

This randomized controlled clinical trial was conducted among subjects selected from the outpatient department of Oral and Maxillofacial Prosthodontics and Implantology after Ethical clearance was obtained from the Institutional Ethics Committee of Meghna Institute of Dental Sciences. Written informed consent was obtained from all participants prior to enrolment. Inclusion criteria comprised implants with a gingival sulcus depth of 1 mm requiring short-collar abutments and implants with a sulcus depth of 3 mm requiring long-collar abutments in the maxillary and mandibular posterior region, healthy gingiva of either thin or thick biotype, ASA-I non-smoking patients with no systemic disease affecting wound healing or bone metabolism, and willingness to comply with the study protocol. Patients who were pregnant, had uncontrolled diabetes, were immunocompromised, had gingival pathology, poor oral hygiene, active infection, psychiatric illness, substance abuse, or lacked implant primary stability were excluded.

Twenty equicrestally placed, platform-switched, internal-hex implants from the posterior maxillary and mandibular region was divided into two groups of 10 each: Group 1 with a prosthetic abutment collar height of 1 mm, and Group 2 with a collar height of 3 mm(fig -1). Each group was further evaluated using two techniques for removal of excess cement after cementation - conventional and PTFE (Teflon) tape technique - giving four subgroups: Group 1A (short collar, conventional), Group 1B (short collar, PTFE tape), Group 2A (long collar, conventional), and Group 2B (long collar, PTFE tape) with total of 40 samples.

Figure 1. 3mm collar height abutment

Surgical and prosthetic protocol: Following full-mouth oral prophylaxis and antibiotic prophylaxis, implants (length 8-11 mm, diameter 3.5-4.5 mm, internal hex connection) were placed equicrestally under local anaesthesia and torqued to 25-30 Ncm. After a healing period and second-stage surgery, final implant-level impressions were recorded with addition silicone material, and sulcus depth was verified on a silicone gingival mask fabricated around the implant analogue. Short-collar abutments were selected for shallow sulcus depths and long-collar abutments for deeper sulcus depths. Provisional crowns with an occlusal access opening were fabricated in self-cure acrylic resin, and the access was sealed with composite resin prior to cementation.

In the conventional technique, the screw access channel was blocked with a sterile cotton pellet and Type I glass-ionomer cement (GC) was applied as a thin uniform coat to the intaglio surface of the crown, which was then seated with firm finger pressure for approximately 10 seconds and held until setting. Gross excess cement was removed with a dental explorer and floss as shown in figure-2. The crown-abutment complex was then retrieved, and residual cement adhering to the crown and lodged in the sulcus was collected into pre-weighed sterile microtubes as shown in figure -3. In the modified technique, the same sequence was followed with the addition of a thin strip of PTFE (Teflon) tape adapted circumferentially around the abutment margin prior to cementation, acting as a mechanical barrier restricting cement flow to the supragingival region as shown in figure 4.

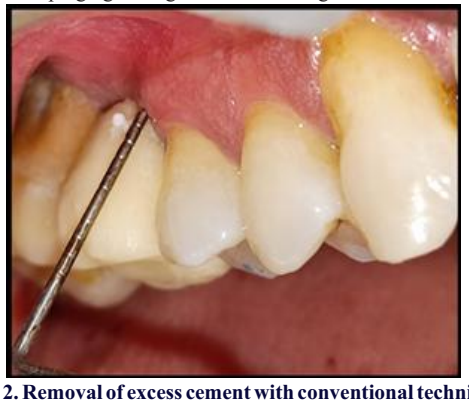

Figure 2. Removal of excess cement with conventional technique

Figure 3. abutment crown complex retrieved and excess cement removed

Figure 4. abutment placed and Teflon tape tucked below the margin

Figure 5. Each Sample Collected In Sample Container Weighed Analytical Balance

Residual cement collected from each sample was quantified using an analytical balance with a precision of ±0.0001 g, calibrated prior to each measurement session as shown in figure-5. Net residual cement weight was obtained by subtracting the pre-weighed empty microtube value from the final weight, recorded in milligrams. Data were analysed using the Shapiro-Wilk test for normality, followed by two-way analysis of variance (ANOVA) to assess the main effects of abutment collar height and cement-removal technique and their interaction, with Tukey's HSD test applied for pairwise post-hoc comparisons. The level of statistical significance was set at $p<0.05$.

RESULTS

All four groups showed Shapiro-Wilk p-values greater than 0.05, confirming a normal distribution and justifying the use of parametric tests for further analysis. Descriptive statistics for excess residual cement (mg) are summarised in Table 1.

Table 1: Descriptive statistics of excess residual cement (mg) by group.

Group	N	Mean (mg)	SD
1A (Short + Conventional)	10	11.70	2.63
1B (Short + PTFE tape)	10	2.40	1.78
2A (Long + Conventional)	10	16.90	4.48
2B (Long + PTFE tape)	10	8.10	2.23

Group 2A showed the highest mean residual cement and Group 1B the lowest. The PTFE tape technique resulted in lower cement remnants than the conventional technique in both short- and long-collar abutments.

Table 2: Two-way ANOVA for excess residual cement.

Source	Sum of Squares	df	Mean Square	F	p-value
Abutment collar height	297.025	1	297.025	33.81	<0.001
Cement removal technique	819.025	1	819.025	93.22	<0.001
Interaction	0.625	1	0.625	0.07	0.791
Error	316.300	36	8.79	—	—

Two-way ANOVA confirmed a statistically significant effect of both abutment collar height and cement-removal technique on residual cement ($p<0.001$ for each), with no significant interaction between the two variables ($p=0.791$), indicating that the two factors influence residual cement independently.

Table 3: Tukey post-hoc pairwise comparisons between subgroups.

Comparison	Mean Difference (mg)	p-value	Significance
1A vs 1B	9.30	<0.001	Significant
1A vs 2A	-5.20	0.002	Significant
1A vs 2B	3.60	0.048	Significant
1B vs 2A	-14.50	<0.001	Significant
1B vs 2B	-5.70	<0.001	Significant
2A vs 2B	8.80	<0.001	Significant

All pairwise subgroup comparisons were statistically significant. The

PTFE tape technique consistently produced lower cement remnants than the conventional technique, and long-collar abutments combined with the conventional technique showed the greatest cement retention. The interaction plot showed nearly parallel trends across collar heights for both techniques, supporting independent rather than synergistic effects of abutment height and cement-removal technique on residual cement.

DISCUSSION

Excess residual cement around implant-supported restorations is one of the most significant prosthetic risk factors contributing to peri-implant mucositis and peri-implantitis. The inability to consistently detect and remove subgingival cement remnants is largely attributable to the circumferential fibre orientation around implants and the poor radiopacity of many luting agents, which allows cement to remain undetected on radiographs.[1] Residual cement has been associated with inflammation, increased probing depth, bleeding on probing, suppuration and progressive crestal bone loss, and a strong positive relationship between excess cement and peri-implant disease has previously been demonstrated.[5]

The present study found significantly lower residual cement when the PTFE tape technique was used compared with conventional cementation, in agreement with prior experimental evidence reporting the highest cement remnants with conventional cementation and significantly lower values with PTFE tape, with replica techniques producing the lowest overall levels.[1] PTFE tape has been described as a non-fibrous, ultra-thin (<50 µm) barrier that does not increase sulcus width or entrap cement fibres, making it superior to gingival retraction cords that may widen the sulcus and facilitate deeper cement flow.[3] Venting and replica techniques have similarly been shown to significantly reduce residual cement volume compared with conventional cementation,[6] and cement application method has been shown to influence extrusion patterns, with putty replica techniques yielding significantly lower residual cement.[7] Although replica methods may produce the least cement remnants, PTFE tape offers a simple, economical and chairside-friendly approach that makes it an attractive option in routine clinical practice.

Long-collar abutments (3 mm) were associated with significantly greater residual cement than short-collar abutments (1 mm) in the present study, correlating with clinical findings of a progressive increase in residual cement volume as prosthetic collar height increases.[2] Deeper margins reduce visual access and limit the effectiveness of hand instrumentation during cement removal, while the confined subgingival environment encourages apical cement migration during seating. Deeper margin placement is often selected to improve emergence profile and esthetics; however, this benefit must be weighed against the increased biological risk posed by residual cement.

While long-collar abutments promote greater cement retention, insufficient abutment height has been shown to compromise peri-implant tissue stability, with short transmucosal abutments (<2 mm) associated with greater marginal bone loss and higher prevalence of peri-implantitis than longer abutments, attributed to inadequate space for supracrestal tissue attachment.[8] This creates a clinical paradox in which short abutments reduce cement retention but may compromise tissue stability, while long abutments improve tissue attachment but increase cement entrapment, underscoring the importance of cement-control techniques when longer abutments are required for biological or esthetic reasons. Abutment collar height also influences biomechanical stress distribution, with increased abutment height shown to elevate crown-to-implant ratio and stress concentration at the implant neck.[9]

In the present study, the interaction plot demonstrated that although long-collar abutments consistently retained more cement, the PTFE tape technique significantly reduced cement remnants across both collar heights, with nearly parallel trends indicating that cement-removal technique operates independently of abutment height. This reinforces the clinical value of PTFE tape as a predictable cement-control strategy irrespective of margin depth, suggesting that even when deeper margins are unavoidable, barrier techniques can substantially mitigate cement-induced risk.

LIMITATIONS

The study was limited by a small sample size, immediate evaluation without long-term follow-up, use of a single implant system and cement type, assessment of only two abutment collar heights, and the absence of microbiological or histological evaluation.

CONCLUSION

Within the limitations of this study, long-collar abutments (3 mm) demonstrated significantly greater excess residual cement than short-collar abutments (1 mm), and the conventional cementation technique resulted in higher cement remnants than the PTFE tape technique. The PTFE tape technique was effective in minimising subgingival cement extrusion for both abutment heights, and abutment collar height and cement-removal technique independently influenced residual cement, with no significant interaction between them. The combination of short-collar abutments with the PTFE tape technique produced the least residual cement, supporting the use of cement-control barrier techniques, particularly when deeper margins are clinically indicated.

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