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Original Research

Cylindrical Implant Versus Tapered Implant

[1]Dr. Simerpreet Kaur Bagga, [2]Dr. Amrita Gill

[1]DMD student, University of Pittsburgh, School of Dental Medicine, Pittsburgh, USA;
[2]Associate Dentist, Khurana Dental Clinic, Amritsar, Punjab, India

ABSTRACT:
Aim- The aim of the study was to compare the primary stability of tapered and cylindrical implants and evaluate their impact on implant success, particularly in relation to loading protocols in implant dentistry. **Materials and methods-** The study involved 20 partially edentulous patients requiring implant-based teeth replacement, selected based on stringent inclusion and exclusion criteria. Eligible participants were systemically and periodontally healthy adults aged 18 to 60 years with adequate bone structure and sufficient keratinized tissue, willing to provide informed consent. Patients were divided into two groups: Group 1 received 20 tapered implants, and Group 2 received 20 cylindrical implants. Radiographic evaluations, including intraoral periapical radiographs and orthopantomograms, assessed bone architecture, while ridge mapping helped select implant dimensions. Pain levels were recorded based on patient-reported VAS scores, categorized as no pain, moderate pain, or worst pain, ensuring comprehensive postoperative evaluation. Data analysis was done using SSPS software. **Results-** The mean implant stability was compared between Group 1 (tapered implants) and Group 2 (cylindrical implants) at different follow-up periods. Immediately after placement, Group 1 showed a higher mean stability (60.345 ± 1.325) compared to Group 2 (57.892 ± 0.242), with a statistically significant difference (P = 0.001). At one month, Group 2 exhibited greater stability (69.828 ± 1.252) than Group 1 (65.637 ± 1.324), maintaining statistical significance (P = 0.001). By six months, Group 1 showed slightly higher stability (75.412 ± 1.003) compared to Group 2 (73.246 ± 0.721), with the difference remaining significant (P = 0.001). **Conclusion-** Tapered implants offer greater primary stability than cylindrical implants, enhancing predictability and success, especially with the increasing use of loading protocols in implant dentistry.
Keywords- Implants, cylindrical, tapered

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Corresponding Author: Dr. Simerpreet Kaur Bagga, DMD student, University of Pittsburgh, School of Dental Medicine, Pittsburgh, USA

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INTRODUCTION

The history of dental implants is a fascinating journey through time, showcasing humanity's ingenuity in addressing tooth loss. Efforts to replace missing teeth date back to ancient civilizations, but a groundbreaking moment in modern dental implantology came in 1952, thanks to Dr. Per-Ingvar Brånemark.[1,2] His accidental discovery occurred during an experiment in which he implanted a piece of titanium into a rabbit's femur. To his surprise, the titanium fused seamlessly with the bone, making removal impossible. Recognizing the potential of this phenomenon, Dr. Brånemark conducted further research and eventually used titanium successfully to restore a missing tooth in a patient. This breakthrough revolutionized the dental implant field. Through extensive studies, Dr. Brånemark highlighted the benefits of titanium in implants, paving the way for the sophisticated and reliable dental implant systems we use today.[3]

Dental implants boast high survival rates of 89% to 97% over 4 to 10 years, but efforts to reduce treatment time by shortening the healing period for osseointegration have driven advancements in implant design.[4,5] Key factors influencing implant stability and success include implant surface, primary stability, thread configuration, surgical techniques, and bone quality. Research highlights the importance of primary stability for osseointegration and its dependence on implant design, particularly tapered shapes and surface modifications, which enhance stability in low-density bone. Cylindrical implants are a widely used design in modern dental implantology, characterized by their uniform, parallel-sided shape. This design offers predictable insertion and is particularly suitable for cases where uniform bone density is present. Cylindrical implants are engineered to achieve a firm initial fit while providing optimal conditions for osseointegration, the biological process where the implant fuses with the surrounding bone. Their straightforward geometry simplifies surgical placement and is compatible with various bone qualities. Over time, advancements in surface modifications and thread designs have enhanced the biomechanical stability and success rates of cylindrical implants, making them a reliable choice for restoring missing teeth in diverse clinical scenarios.[6]

The aim of the study was to compare the primary stability of tapered and cylindrical implants and evaluate their impact on implant success, particularly in relation to loading protocols in implant dentistry.

MATERIALS AND METHODS

The study involved 20 partially edentulous patients requiring implant-based teeth replacement, selected based on stringent inclusion and exclusion criteria. Eligible participants were systemically and periodontally healthy adults aged 18 to 60 years with adequate bone structure and sufficient keratinized tissue, willing to provide informed consent. Patients were divided into two groups: Group 1 received 20 tapered implants, and Group 2 received 20 cylindrical implants. Radiographic evaluations, including intraoral periapical radiographs and orthopantomograms, assessed bone architecture, while ridge mapping helped select implant dimensions.

The surgical procedure involved delayed-loading implants placed after crestal incisions and mucoperiosteal flap reflection under local anesthesia. Implant sites were prepared with pilot and sequential drills, ensuring good primary stability. Implants were used, followed by cover screw placement and soft tissue suturing. Postoperative care included antibiotics, anti-inflammatory medication, and routine follow-ups with suture removal on day seven. Three months later, a second stage surgery exposed the implants, and healing caps were placed before restoring them with metal-ceramic crowns.

Pain levels were recorded based on patient-reported VAS scores, categorized as no pain, moderate pain, or worst pain, ensuring comprehensive postoperative evaluation. Data analysis was done using SSPS software.

RESULTS

Table 1: Comparative Analysis of Mean Implant Stability across Groups During Follow-Up Periods

Follow up		N	Mean	SD	P value
Immediately	Group 1	20	60.345	1.325	0.001*
	Group 2	20	57.892	0.242	
One month	Group 1	20	65.637	1.324	0.001*
	Group 2	20	69.828	1.252	
6 months	Group 1	20	75.412	1.003	0.001*
	Group 2	20	73.246	0.721	

The mean implant stability was compared between Group 1 (tapered implants) and Group 2 (cylindrical implants) at different follow-up periods. Immediately after placement, Group 1 showed a higher mean stability (60.345 ± 1.325) compared to Group 2 (57.892 ± 0.242), with a statistically significant difference (P = 0.001). At one month, Group 2 exhibited greater stability (69.828 ± 1.252) than Group 1 (65.637 ± 1.324), maintaining statistical significance (P = 0.001). By six months, Group 1 showed slightly higher stability (75.412 ± 1.003) compared to Group 2 (73.246 ± 0.721), with the difference remaining significant (P = 0.001).

Table 2: Comparative Analysis of Mean VAS Scores Between Groups at All Follow-Up Stages

Follow up		N	Mean	SD	P value
2 hours	Group 1	20	1.324	0.021	0.001*
	Group 2	20	1.948	0.612	
6 hours	Group 1	20	1.969	0.354	0.001*
	Group 2	20	3.082	0.212	
12 hours	Group 1	20	1.893	0.213	0.001*
	Group 2	20	3.246	0.123	
24 hours	Group 1	20	1.312	1.133	0.001*
	Group 2	20	3.224	0.212	

The mean VAS (Visual Analog Scale) scores for postoperative pain were compared between Group 1 (tapered implants) and Group 2 (cylindrical implants) at various follow-up intervals. At 2 hours postoperatively, Group 1 reported a lower mean score (1.324 ± 0.021) compared to Group 2 (1.948 ± 0.612), with a statistically significant difference (P = 0.001). At 6 hours, the mean scores were 1.969 ± 0.354 for

Group 1 and 3.082 ± 0.212 for Group 2, again showing significant differences (P = 0.001). At 12 hours, Group 1 continued to report lower pain levels (1.893 ± 0.213) than Group 2 (3.246 ± 0.123), with P = 0.001. By 24 hours, Group 1 had a mean score of 1.312 ± 1.133, while Group 2 reported 3.224 ± 0.212, maintaining the statistically significant difference (P = 0.001).

Table 3: Comparison of mobility between groups at all levels of follow-up.

Follow up		Present (n)	%	P value
1 month	Group 1	2	5	0.021*
	Group 2	3	15	
3 months	Group 1	1	5	0.010*
	Group 2	2	5	
6 months	Group 1	1	5	-
	Group 2	0	0	

The comparison of implant mobility between Group 1 (tapered implants) and Group 2 (cylindrical implants) was assessed at various follow-up intervals. At 1 month, mobility was observed in 2 patients (5%) in Group 1 and 3 patients (15%) in Group 2, with a statistically significant difference (P = 0.021). At 3 months, mobility was recorded in 1 patient (5%) in Group 1 and 2 patients (5%) in Group 2, again showing statistical significance (P = 0.010). By the 6-month follow-up, mobility was present in 1 patient (5%) in Group 1, while no mobility was observed in Group 2, with no significant P-value reported for this interval.

DISCUSSION

Cylindrical and tapered implants represent two fundamental design approaches in dental implantology, each tailored to specific clinical needs. Cylindrical implants feature parallel-sided walls, ensuring a consistent and predictable fit, particularly in cases with uniform bone density. They are ideal for straightforward implant placements and allow for even distribution of mechanical forces during function.[7]

Tapered implants, on the other hand, mimic the natural shape of tooth roots with a narrowing profile towards the apex. This design is advantageous in areas of compromised bone quality or density, as it enhances primary stability, especially in low-density bone or immediately after extraction. The tapered shape also facilitates placement in anatomically challenging sites, such as near sinus cavities or narrow ridges.[8]

Both designs have been optimized through advancements in surface modifications and thread configurations, each offering unique benefits. While cylindrical implants excel in providing even load distribution, tapered implants are favored for their adaptability and superior initial stability in complex cases. The choice between the two depends on individual patient factors and the specific clinical scenario.[9]

In our study the mean implant stability was compared between Group 1 (tapered implants) and Group 2 (cylindrical implants) at different follow-up periods. Immediately after placement, Group 1 showed a higher mean stability (60.345 ± 1.325) compared to Group 2 (57.892 ± 0.242), with a statistically significant difference (P = 0.001). At one month, Group 2 exhibited greater stability (69.828 ± 1.252) than Group 1 (65.637 ± 1.324), maintaining statistical significance (P = 0.001). By six months, Group 1 showed slightly higher stability (75.412 ± 1.003) compared to Group 2 (73.246 ± 0.721), with the difference remaining significant (P = 0.001).

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In the study by Nandini N et al.,[10] the aim was to compare the efficacy of tapered and cylindrical implants by assessing implant stability using the Osstell Implant Stability Quotient (ISQ) instrument, postoperative pain through the Visual Analog Scale (VAS), and peri-implant health using the implant mobility scale. The study included 30 partially edentulous patients, each receiving 30 tapered implants on one side and 30 cylindrical implants on the other. Results showed that tapered implants demonstrated higher ISQ values, indicating greater implant stability, while also causing less postoperative pain and promoting better peri-implant health compared to cylindrical implants. Based on these findings, the study concluded that tapered implants offer superior primary stability, enhancing predictability and success in implant dentistry, particularly with loading protocols.

In another study by Waechter J et al.[11], the clinical outcomes of tapered and cylindrical implants were compared, focusing on their effects on bone site characteristics and peri-implant health during healing. Forty implants (20 tapered and 20 cylindrical) were placed in the posterior mandible, with implant site dimensions assessed using CBCT and bone type determined during drilling. Primary stability (PS) was evaluated using insertion torque (IT) and the implant stability quotient (ISQ), while secondary stability (SS) and peri-implant health were monitored for 3 months through various clinical indices. The results showed no significant differences between tapered and cylindrical implants in any outcome variable ($P > .05$). A decrease in ISQ was observed after 7 days, followed by a gradual increase up to the 90-day follow-up. Cortical height correlated with IT, while medullary bone dimensions were correlated with ISQ values. Insertion torque was significantly correlated with PS for cylindrical implants. The study concluded that both implant types exhibited similar biological behavior during healing, and bone site characteristics influenced insertion torque and implant stability.

While the study demonstrated that tapered and cylindrical implants exhibited similar biological behavior during the healing process, and bone site characteristics influenced primary stability, the results were based on a relatively small sample size, which may limit the generalizability of the findings. Future studies with larger sample sizes could provide more accurate data and further clarify any subtle differences between implant types in different clinical scenarios.

CONCLUSION

Tapered implants offer greater primary stability than cylindrical implants, enhancing predictability and success, especially with the increasing use of loading protocols in implant dentistry.

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