ISSN 2765-3633
Vol. 17 No. 1, November 2025
The Journal of Korean Academy of Osseointegration 2025, 17(1) 1-8

A retrospective clinical study on screw loosening in screw-connected versus locking-tapered abutments for single implants by snucone® in the second molar region

Kyungrock Min, Hyunhee Park, Minho Kim, A-mi Cho, Minsu Cho, Jisuk Han, Panjun Kim, Myungjin Jung, Soo Nam Yang

Department of Oral and Maxillofacial Surgery, Cheongju Hankook General Hospital, Cheongju, Korea

Objective: This retrospective clinical study aims to compare the outcomes of screw-connected and locking-tapered abutments in single implants placed in the mandibular second molar region. By analyzing cases in which patients returned due to implant-related complications, this study investigates the relationship between abutment connection type and the incidence of clinical issues requiring follow-up care.

Materials & Methods: A total of 148 cases from 139 patients who received single implants in the second molar region at Cheongju Hankook Hospital between January 1, 2017, and July 31, 2019, were reviewed. All patients were treated with either the screw-connected or locking-tapered fixture system by SNUCONE©. Only cases with a minimum follow-up period of 2 years (most exceeding 5 years) were included for analysis.

Results: A comparison of the two groups revealed the following findings: 1) Detachment of the cement between the crown and abutment occurred at a similar rate in both groups. 2) Multiple instances of screw loosening were observed in the screw-connected abutment group, while no such issues occurred in the locking-tapered group. 3) Complications between the implant fixture and surrounding alveolar bone were comparable across both types.

Discussion: Patients with locking-tapered abutments reported fewer clinical complications requiring hospital visits compared to those with screw-connected abutments. This may be attributed to the absence of abutment screws in the locking-tapered design, which eliminates the possibility of screw loosening. Moreover, the cold welding effect under masticatory forces in the locking-tapered system appears to enhance the stability of the implant over time.

Conclusions: Locking-tapered fixture systems demonstrate superior clinical stability and fewer postoperative complications compared to screw-connected systems in single implants placed in the second molar region. **(THE JOURNAL OF KOREAN ACADEMY OF OSSEOINTEGRATION 2025;17(1):1-8)**

Key words: Screw connection fixture, Locking tapered connection fixture, Screw loosening, cement wash, Abutment problem, Fixture-bone problem

INTRODUCTION

The loss of permanent teeth most commonly results from untreated or progressive dental caries and periodontal disease. Among these, molars—particularly second molars—play a crucial role in mastication[1]. Dental implants are now widely recognized as a reliable and predictable method for restoring missing teeth[2]. The loss of the second molar is relatively common, and potential treatment options include removable partial dentures, cantilever crowns, and implant-supported restorations. In the absence of contraindications, implant placement is generally regarded as the preferred treatment modality for second molar replacement[3].

Compared to fixed partial dentures, implant-supported restorations offer a more conservative approach, as they do not require the preparation of adjacent teeth. Additionally, they provide better masticatory efficiency, higher patient satisfaction, and eliminate the discomfort often associated with tissue-supported removable prostheses. As such, dental implants are no longer considered merely an alternative but are increasingly regarded as the

Received September 9, 2025, **Revised** October 29, 2025, **Accepted** October 31, 2025

Corresponding Author: Kyungrock Min, Department of Oral and Maxillofacial Surgery, Cheongju Hankook General Hospital, 106, Danjae-ro, Sang-dang-gu, Cheongju 28713, Korea, Tel: +82-43-222-7000, Fax: +82-43-255-7007, E-mail: minin123@naver.com

first-line treatment for edentulous spaces.

However, complications associated with implant therapy have become a growing concern for both clinicians and patients. Among these, the loosening or fracture of abutment screws has emerged as a particularly troublesome issue. Systematic reviews have reported that screw loosening affects approximately 12.7% of implant-supported prostheses over an average follow-up of five years. This complication can arise due to insufficient torque, fatigue, micromovement, or excessive bending forces. Thus, achieving adequate preload is essential for maintaining joint stability.

While screw loosening does not necessarily indicate prosthetic failure, it may lead to the formation of microgaps and micromovements, which can promote plaque accumulation. This, in turn, increases the risk of biological complications such as peri-implant mucositis and peri-implantitis. To address these issues, screwless implant systems—such as friction-fit conical connection systems—have been developed. These systems typically rely on a Morse taper design that enables cold welding between the fixture and the abutment, thereby eliminating screw-related complications.

In such systems, the abutment is secured solely through friction, with an internal taper angle typically less than 1.5°. This cold-welded connection provides a tight fixture–abutment interface that aids in plaque control and reduces the likelihood of biological complications. Compared to screw-based systems, locking-taper abutment connections demonstrate greater mechanical stability and better resistance to lateral and axial forces[4].

MATERIALS AND METHODS

1. Study population

This retrospective study included patients treated at Cheongju Hankook Hospital between January 1, 2017, and July 31, 2019, who received a single implant in the second molar region using either a screw-connected or a locking-tapered fixture system. Only cases with a minimum follow-up period of 2 years were included, with the majority of cases having been observed for over 5 years. A total of 148 implants placed in 139 patients were analyzed.

1) Patient age and gender distribution

The study population consisted of 69 male and 70 female patients, with a total of 148 implants placed. The patients ranged in age from 30 to 88 years, with the majority in their 50s and 60s (Tables 1 and 2).

2) Implant length and diameter

Among the implants placed with screw-connected abutment systems, the most commonly used length was 8 mm (n = 72), followed by 10 mm (n = 26) and 7 mm (n = 22). In terms of diameter, 5.3 mm implants were the most frequently used (n = 75), followed by 4.8 mm (n = 34), 5.8 mm (n = 11), and 4.3 mm (n = 1) (Table 3).

For implants placed with locking-tapered abutment systems, 8 mm implants were the most common (n = 15), followed by 7 mm and 6 mm implants (n = 7 each). The most frequently used diameter was 5.3 mm (n = 18), followed by 5.8 mm (n = 7) and 4.8 mm (n = 4) (Table 4).

Table 1. Patient distribution according to gender

Gender	Number of patient (% of patients)	Number of implant (% of implant placed)
Male	69 (49.64%)	74 (50.00%)
Female	70 (50.36%)	74 (50.00%)
Total	139	148

Table 2. Patient distribution according to age

Age	Number of patient (% of patients)	Number of implant (% of implant placed)
21~30	1 (0.72%)	1 (0.68%)
31~40	1 (0.72%)	1 (0.68%)
41~50	18 (12.95%)	18 (12.16%)
51~60	48 (34.53%)	52 (35.14%)
61~70	46 (33.09%)	50 (33.78%)
71~80	22 (15.83%)	23 (15.54%)
81~90	3 (2.16%)	3 (2.03%)
Total	139	148

Table 3. Numbers of implants placed according to implant length and diameter

Screw connection fixture	4.3 mm	4.8 mm	5.3 mm	5.8 mm	Total
7 mm	0	1	16	4	21
8 mm	0	22	47	3	72
10 mm	1	11	10	3	25
12 mm	0	0	0	1	1
Total	1	34	73	11	119

Table 4. Numbers of implants placed according to implant length and diameter

Locking tapered connection fixture	4.8 mm	5.3 mm	5.8 mm	Total
6 mm	0	2	5	7
7 mm	1	5	1	7
8 mm	3	11	1	15
Total	4	18	7	29

2. Methods

1) Surgical and prosthetic procedures

Implant surgeries were performed under local anesthesia using either a one-stage or two-stage approach. The timing of implant placement was defined as the point at which the fixture was inserted into the bone. The decision to perform a second-stage surgery was made by the clinician based on the initial stability of the implant.

All implants used in this study were either SNUCONE SF® (locking-tapered connection fixture) or SNUCONE AF® (screw-connected fixture), and were placed as single implants using the manufacturer's dedicated drilling protocol.

After an appropriate healing period, prosthetic procedures were initiated. All abutments used for the final restorations were also manufactured by SNUCONE®. The implant-specific cement used for the final prosthesis placement was the same product, premier®, in all cases. Patients were instructed to return for follow-up visits one year after the final prosthesis delivery for plaque control, clinical examination, and radiographic evaluation.

2) Evaluation of post-prosthetic follow-up visits

(1) Criteria for Evaluating Implant Complications According to Abutment Type

Cases in which patients returned to the clinic due to implant-related difficulties were classified as follows:

a. Cement washout

b. Abutment-related complications

c. Fixture–bone interface issues

3) Evaluation parameters

Clinical records and radiographs were reviewed to assess the following parameters:

(1) Distribution by patient age and gender

(2) Implant diameter and length

Implants were categorized into four diameter groups: 4.3 mm, 4.8 mm, 5.3 mm, and 5.8 mm. Survival rates were analyzed according to each diameter. Lengths were divided into five categories: 6 mm, 7 mm, 8 mm, 10 mm, and 12 mm, and the frequency of follow-up visits was assessed for each length group.

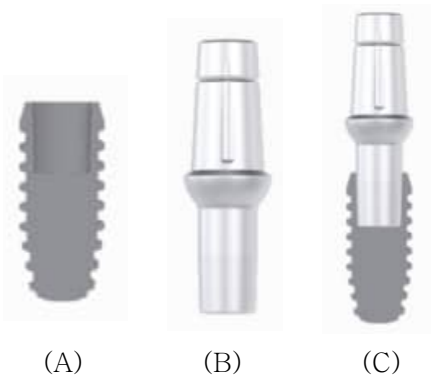

Figure 1. Schematic diagram of the SF implant. (A) Fixture cross sectional view. (B) Abutment. (C) Connection between the fixture and the abutment.

4) Types of implants used

(1) Locking-Tapered Connection Fixture (SF Fixture)

The SF implant introduced by SNUCONE®utilizes a 1.5° locking taper design, in which the connection between the fixture and abutment is achieved through the frictional engagement of a Morse taper (Figure. 1). The strong frictional force at the fixture–abutment interface disrupts the oxide layer on the surface, resulting in a cold-welded joint. This tight connection eliminates microgaps, thereby preventing bacterial infiltration at the junction and offering improved hygienic outcomes.

In essence, the fixture and abutment form an integrated unit, mimicking the characteristics of a one-piece implant. This close adaptation is expected to reduce the risk of peri-implantitis originating from the fixture–abutment interface[5].The locking-tapered connection method is widely used in South Korea and closely resembles the Bicon implant–abutment system.

(2) Screw connection fixture (AF fixture)

The SNUCONE®AF implant used in this study features a surface treated by sandblasting and large-grit acid etching (SLA), which promotes excellent osseointegration. The macrostructure of this implant is similar in appearance to those of most contemporary implant systems. It has a tapered design that narrows toward the apex, and the lower portion of the fixture includes a dual-cutting edge configuration, similar to those seen in other systems, allowing for self-tapping during placement (Figure. 2).

Figure 2. Schematic cross-section of the AF implant. (A) Fixture. (B) Abutment. (C) Abutment screw. (D) Abutment with screw. (E) Connection between the fixture and the abutment.

Table 5. Baseline

		Total	Screw connection fixture	Locking tapered connection tixture	*P*-value
Number of patient		139	113	26	
Age : mean (sd)		61.2 (10.0)	60.8 (9.5)	62.8 (11.7)	0.362
Age group	50 years old or younger	20 (14.39%)	18 (15.93%)	2 (7.69%)	0.403
	In their 50s	48 (34.53%)	38 (33.63%)	10 (38.46%)	
	In their 60s	46 (33.09%)	39 (34.51%)	7 (26.92%)	
	Over 70 years old	25 (17.99%)	18 (15.93%)	7 (26.92%)	
Sex : Male		69 (49.64%)	61 (53.98%)	8 (30.77%)	0.033
Number of implant		148	119	29	
Location	17	23 (15.54%)	19 (15.97%)	4 (13.79%)	0.082
	27	30 (20.27%)	25 (21.01%)	5 (17.24%)	
	37	42 (28.38%)	38 (31.93%)	4 (13.79%)	
	47	53 (35.81%)	37 (31.09%)	16 (55.17%)	
Diameter	4.3 mm	1 (0.68%)	1 (0.84%)	0 (0.00%)	0.089
	4.8 mm	38 (25.68%)	34 (28.57%)	4 (13.79%)	
	5.3 mm	91 (61.49%)	73 (61.34%)	18 (62.07%)	
	5.8 mm	18 (12.16%)	11 (9.24%)	7 (24.14%)	
Length	6 mm	7 (4.73%)	0 (0.00%)	7 (24.14%)	<0.001
	7 mm	28 (18.92%)	21 (17.65%)	7 (24.14%)	
	8 mm	87 (58.78%)	72 (60.50%)	15 (51.72%)	
	10 mm	25 (16.89%)	25 (21.01%)	0 (0.00%)	
	12 mm	1 (0.68%)	1 (0.84%)	0 (0.00%)	

The screw-connected system is also widely used in South Korea and is highly compatible with, and structurally similar to, the Astra implant-abutment connection system. It is an internal connection type, where the abutment is seated within the implant fixture (Figure. 2).

RESULTS

1. Baseline characteristics (Table 5)

A total of 139 patients were included in this study, with 113 patients treated using screw connection fixtures and 26 patients treated using locking-tapered connection fixtures. The mean age of the overall cohort was 61.2 years (SD ± 10.0). The mean age of patients in the screw connection group was 60.8 years, while that of the locking-tapered group was 62.8 years. Although the latter group showed a slightly higher mean age, the difference was not statistically significant.

Regarding sex distribution, male patients were more frequently treated with screw connection fixtures than with locking-tapered fixtures. Additionally, implants placed using screw con-

nection fixtures tended to be longer than those placed with locking-tapered fixtures.

A total of 148 implants were placed: 119 in the screw connection group and 29 in the locking-tapered group. There were no statistically significant differences between the two groups in terms of implant placement site or implant diameter.

2. Risk factor analysis (Table 6)

The "composite" outcome refers to the earliest occurrence among three types of complications: cement washout, abutment-related complications, and fixture–bone interface issues. In other words, it represents the first clinical event that prompted a patient to return to the clinic following implant placement.

An analysis of the hazard ratio for age in relation to cement washout revealed a value of 0.971, suggesting that with each additional year of age, the risk of experiencing a cement-related complication slightly decreased. However, this finding was not statistically significant. A hazard ratio of 1 indicates no difference in risk, values greater than 1 indicate increased risk, and values below 1 suggest reduced risk.

In the age group comparison, patients over 70 years old were used as the reference group. The hazard ratio for patients under 50 was 2.022, indicating a twofold higher likelihood of returning due to cement washout compared to the reference group. Despite this numerical difference, the result did not reach statistical significance.

For fixture–bone problems, the number of events was too low to permit meaningful statistical analysis in most subgroups. The final results showed that out of 148 implants in 139 patients, 3 implants failed, resulting in a survival rate of 97.97%.

Although none of the examined variables showed statistical significance across the different complication types, a potential trend was observed with age. Younger patients appeared to have a higher risk of complications, which may be attributed to their greater engagement in social or masticatory activities. Specifically, compared to patients over 70, those under 50 showed a hazard ratio of 3.255 for the composite outcome, while patients in their 50s and 60s also demonstrated approximately twice the risk.

Regarding implant type, the screw connection fixture group showed a hazard ratio of 1.123 for cement washout when compared to the locking-tapered connection fixture group (used as the reference). However, this difference was not statistically significant. Since the same implant-specific cement was used, there was no significant difference in the failure rate.

The most important result of this study, concerning the abutment problem, showed that no instances of abutment issues occurred with the locking tapered connection fixture, thus no value could be derived for the ratio. The only cases of abutment-related issues that required hospital visits were observed in the screw connection fixture, with a total of 42 occurrences.

As for sex, female patients demonstrated a hazard ratio of 0.897 for cement washout compared to male patients, suggesting a lower risk. This may reflect generally lower masticatory force in females and possibly greater attention to oral hygiene practices.

Overall, variables considered potential risk factors—including age, implant type, sex, implant location, diameter, and length—did not demonstrate statistically significant associations with any of the evaluated outcomes.

3. Main result (Table 7)

The concepts of survival rate and restricted mean survival time (RMST) were used to assess the longevity of implants without clinical complications. The 1-year survival rate refers to the probability that a patient will not experience any implant-related issues—such as cement washout, abutment complications, or fixture–bone problems—within the first year following implant placement. For cement washout, the 1-year survival rate was 97.3%, with a 95% confidence interval ranging from 94.7% to 99.9%.

The 1-year RMST indicates the average duration within the 1-year follow-up period during which no complications occurred. For cement washout, the 1-year RMST was 0.99 years, suggesting that patients remained complication-free for nearly the entire year. For the composite outcome (including any of the three complication types), the 1-year RMST was 0.92 years, indicating that patients were free from complications for an average of 0.92 years out of the 1-year follow-up period.

At the 3-year follow-up, the RMST for cement washout was 2.86 years, and for the composite outcome, it was 2.61 years. At 5 years, the RMST for abutment complications was 4.48 years, while the composite outcome showed an RMST of 4.15 years. These findings suggest that the majority of patients remained free from implant-related complications for most of the observation period.

Table 6. Risk factor analyses

		Cement wash out		Abutment related complications		Fixture – bone interface issues		Composite	
		Crude HR (95%CI)	*P*–value	Crude HR (95%CI)	*P*–value	Crude HR (95%CI)	*P*–value	Crude HR (95%CI)	*P*–value
Age		0.971 (0.937 to 1.007)	0.111	0.989 (0.945 to 1.034)	0.614	0.979 (0.888 to 1.079)	0.665	0.971 (0.943 to 1.000)	0.051
Age group	50 years old or younger	2.022 (0.570 to 7.170)	0.275	1.975 (0.330 to 11.818)	0.456	NC		3.255 (1.001 to 10.577)	0.050
	in their 50s	1.363 (0.434 to 4.283)	0.596	1.773 (0.368 to 8.535)	0.475	NC		2.129 (0.711 to 6.375)	0.177
	in their 60s	1.245 (0.395 to 3.925)	0.709	2.146 (0.456 to 10.105)	0.334	NC		2.317 (0.782 to 6.862)	0.129
	over 70 years old	ref	0.704	ref	0.812	ref		ref	0.271
Type : screw connection fixture		1.123 (0.461 to 2.736)	0.799	NC		NC		1.929 (0.817 to 4.557)	0.134
Sex : Female		0.897 (0.448 to 1.796)	0.758	0.650 (0.266 to 1.589)	0.345	NC		0.680 (0.379 to 1.221)	0.196
Location	17	1.017 (0.353 to 2.934)	0.975	1.680 (0.533 to 5.293)	0.376	NC		1.390 (0.613 to 3.150)	0.082
	27	0.543 (0.172 to 1.717)	0.298	0.487 (0.101 to 2.346)	0.370	NC		0.569 (0.221 to 1.462)	
	37	1.398 (0.615 to 3.174)	0.424	1.065 (0.358 to 3.169)	0.910	NC		1.264 (0.630 to 2.539)	
	47	ref	0.433	ref	0.515	ref		ref	0.319
Diameter	4.3 mm + 4.8 mm	1.799 (0.574 to 5.641)	0.314	0.414 (0.104 to 1.656)	0.213	NC		0.898 (0.356 to 2.267)	0.821
	5.3 mm	0.969 (0.322 to 2.913)	0.955	0.567 (0.183 to 1.759)	0.326	NC		0.842 (0.365 to 1.942)	0.686
	5.8 mm	ref	0.249	ref	0.443	ref		ref	0.918
Length	6 mm + 7 mm	0.835 (0.280 to 2.489)	0.747	0.565 (0.152 to 2.103)	0.394	NC		0.690 (0.287 to 1.663)	0.409
	8 mm	1.002 (0.400 to 2.511)	0.996	0.620 (0.216 to 1.786)	0.376	NC		0.805 (0.389 to 1.665)	0.559
	10 mm + 12 mm	ref	0.914	ref	0.615	ref		ref	0.707

HR : Hazard ratio.

Table 7. Survival rate and restricted mean survival time (RMST)

	Cement wash out	Abutment related complications	Fixture – bone interface issues	Composite
1 year survival rate	97.3% (94.7% to 99.9%)	91.2% (86.7% to 95.8%)	100%	88.5% (83.4% to 93.6%)
3 year survival rate	91.2% (86.6% to 95.8%)	88.5% (83.3% to 93.6%)	99.3% (98.0% to 1.00)	81.1% (74.7% to 87.4%)
5 year survival rate	81.2% (74.7% to 87.6%)	86.4% (80.9% to 91.9%)	98.6% (96.7% to 1.00)	71.7% (64.3% to 79.1%)
1 year RMST	0.99 (0.97 to 1.00)	0.94 (0.90 to 0.97)	1.00	0.92 (0.88 to 0.96)
3 year RMST	2.86 (2.78 to 2.94)	2.74 (2.61 to 2.87)	3.00 (2.99 to 3.00)	2.61 (2.37 to 2.76)
5 year RMST	4.58 (4.41 to 4.75)	4.48 (4.26 to 4.71)	4.98 (4.94 to 5.01)	4.15 (3.88 to 4.41)

DISCUSSION

In implant systems, the connection between the prosthesis and the fixture is primarily categorized into screw-retained and tapered (friction-fit) types, each with its own advantages and disadvantages.

The screw-retained system secures the abutment to the fixture via a screw, allowing for retrievability through an access hole. Its key advantages include ease of disassembly and repair, convenient prosthetic replacement, and precise positional adjustments, especially in cases requiring anti-rotational features. This design also allows for uniform stress distribution through controlled torque application. However, it carries the risk of screw loosening over time due to factors such as occlusal loading and vibration. Aesthetic concerns may also arise, particularly in the anterior region where the access hole can compromise the visual outcome. Additionally, this system requires technical expertise due to the need for accurate torque control, reflecting a degree of operator dependency.

In contrast, the tapered connection system employs a conical friction-fit mechanism, achieving a secure abutment–fixture interface without the use of screws. This method offers excellent initial stability through strong frictional retention and superior esthetic outcomes, as it eliminates the need for access holes. It also minimizes mechanical complications such as screw loosening or fracture, due to the absence of stress concentrations from screw tightening. Nonetheless, drawbacks include limited retrievability once seated, since detachment requires more than simply loosening a screw. The system also demands high manufacturing precision and tight tolerances, which may result in increased production costs.

Screw-retained systems typically exhibit microgaps of approximately 40~100 μm at the abutment–fixture interface[6], which may allow for bacterial infiltration and increase the risk of peri-implantitis[7,8]. In contrast, tapered systems reduce microgaps to as little as 1~3 μm, significantly lowering this risk[9].

In this study, a comparison between screw connection and locking-tapered connection fixtures placed as single implants in the second molar region revealed that patients in the locking-tapered group experienced fewer clinical complications that led to additional visits. This is likely due to the absence of abutment screws, eliminating the risk of loosening. Additionally, cold welding through occlusal forces from opposing dentition may enhance the long-term stability of the tapered connection during function.

Tapered implant systems have demonstrated favorable clinical outcomes in the posterior region, particularly where interocclusal space is limited. These systems are associated with high survival rates, low incidence of biological or mechanical complications, minimal crestal bone loss, and high patient satisfaction[10].

However, this study has several limitations. First, due to its retrospective design, there was a significant discrepancy in the sample sizes between the two groups (screw-connected, n = 119 vs. locking-tapered, n = 29). This imbalance suggests the possibility of selection bias, potentially stemming from operator preference or specific clinical indications during the study period.

In particular, the relatively small sample size of the locking-tapered group (n = 29) is a major factor that reduces the statistical power of this study. This limits the ability to make a statistically significant comparison of complication rates (e.g., screw loosening) between the two systems.

Therefore, the "zero cases" of screw loosening reported in the locking-tapered group must be interpreted with great caution. Given the small sample size, the possibility that a rare complication, which could occur in reality, was not observed in this sample cannot be excluded. Consequently, this result of "zero cases" is insufficient to serve as strong evidence supporting the conclusion that the locking-tapered system is inherently superior regarding screw loosening.

To overcome these limitations and draw more definitive conclusions, a future prospective randomized controlled trial (RCT)

with a larger and more balanced sample size will be necessary.

CONCLUSION

This study evaluated a total of 148 implants placed in 139 patients at Cheongju Hankook Hospital between January 1, 2017, and July 31, 2019, using SNUCONE SF® (locking-tapered connection fixture) and SNUCONE AF® (screw connection fixture) implant systems as single-tooth implants. The following conclusions were drawn:

1) There was no significant difference between the screw connection and locking-tapered connection fixtures in terms of complications related to cement washout or fixture–bone interface problems.

2) Abutment-related complications occurred exclusively in the screw connection group, with 42 instances recorded.

3) The use of locking-tapered connection fixtures, which do not require abutment screws, may significantly reduce the likelihood of postoperative clinic visits related to abutment issues.

4) No statistically significant differences were observed based on sex, age, implant diameter, or length.

5) Among the 148 implants placed in 139 patients, three failures were recorded, resulting in an overall survival rate of 97.97%.

While further long-term and large-scale studies are warranted, the results of this study suggest that both the SNUCONE SF® and AF® systems offer high cumulative survival rates and minimal marginal bone loss. These findings indicate that both systems are predictable and clinically effective options across a wide range of implant cases. Furthermore, in posterior implant placements, the use of locking-tapered connection implants may help reduce unnecessary patient visits and enhance long-term prosthetic stability compared to screw connection systems.

REFERENCES

1. Hatami A, Dreyer C. The extraction of first, second or third permanent molar teeth and its effect on the dento-facial complex. Aust Dent J 2019;64:302–311.
2. Bassir SH, El Kholy K, Chen CY, Lee KH, Intini G. Outcome of early dental implant placement versus other dental implant placement protocols: a systematic review and meta-analysis. J Periodontol 2019;90:493–506.
3. Wang Z, Hua C, Zhang Y, Wang L, Shao L, You J. The clinical effect of the digital guide in the early implant restoration of second molars. Technol Health Care 2023;31(Suppl 1):S25–S34.
4. Gao WM, Geng W, Luo CC. Prosthetic complications of fixed dental prostheses supported by locking-taper implants: a retrospective study with a mean follow-up of 5 years. BMC Oral Health 2021;21:476.
5. Mangano C, Mangano F, Shibli JA, Tettamanti L, Figliuzzi M, et al. Prospective evaluation of 2,549 Morse taper connection implants: 1- to 6-year data. J Periodontol 2011;82:52–61.
6. Weng D, Nagata MJ, Bell M, Bosco AF, de Melo LG, Richter EJ. Influence of microgap location and configuration on the peri-implant bone morphology in submerged implants: an experimental study in dogs. Clin Oral Implants Res 2008;19:1141–1147.
7. Todescan FF, Pustiglioni FE, Imbronito AV, Albrektsson T, Gioso M. Influence of the microgap in the peri-implant hard and soft tissues: a histomorphometric study in dogs. Int J Oral Maxillofac Implants 2002;17:467–472.
8. Tallarico M, Canullo L, Caneva M, Ozcan M. Microbial colonization at the implant-abutment interface and its possible influence on peri-implantitis: a systematic review and meta-analysis. J Prosthodont Res 2017;61:233–241.
9. Dibart S, Warbington M, Su MF, Skobe Z. In vitro evaluation of the implant-abutment bacterial seal: the locking taper system. Int J Oral Maxillofac Implants 2005;20:732–737.
10. Sun G, Cao L, Zhang H. The application of locking-taper implants in posterior area implant restoration with insufficient occlusal-gingival distances. Am J Transl Res 2021;13:7221–7227.