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Effect of repeated use of an implant handpiece on an output torque: An *in-vitro* study

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PURPOSE. This study aimed to evaluate the effect of repeated use of an implant handpiece under an implant placement torque (35 Ncm) and overloading torque condition (50 Ncm) on an output torque. **MATERIALS AND METHODS.** Two types of implant handpiece systems (Surgicpro/X-DSG20L [NSK, Kanuma, Japan] and SIP20/CRB46LN [SAESHIN, Daegu, South Korea]) were used. The output torque was measured using a digital torque gauge. The height and angle (x, y, and z axes) of the digital torque gauge and implant handpiece were adjusted through a jig for passive connection. The experiment was conducted under the setting torque value of 35 Ncm (implant placement torque) and 50 Ncm (overloading torque condition) and 30 times per set; a total of 5 sets were performed (N = 150). For statistical analysis, the difference between the groups was analyzed using the Mann–Whitney U test and the Friedman test was used to confirm the change in output torque (α=.05). **RESULTS.** NSK and SAESHIN implant handpieces showed significant differences in output torque results at the setting torques of 35 Ncm and 50 Ncm (P<.001). The type of implant handpiece and repeated use influenced the output torque (P<.001). **CONCLUSION.** There may be a difference between the setting torque and actual output torque due to repeated use, and the implant handpiece should be managed and repaired during long-term use. In addition, for successful implant results in dental clinics, the output torque of the implant handpiece system should be checked before implant placement. [J Adv Prosthodont 2021;13:136-43]

KEYWORDS
Dental implants; Repeated use; Output torque; Implant handpiece

INTRODUCTION

Until recently, in its gradual development, the dental implant handpiece system has been actively used not only for complete or partial edentulous pa-

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tients but also for the placement of single implants.[1-5] Its initial stability has been demonstrated as the most important feature for dental implant placement; a torque of 35 Ncm is recommended.[1-10] In particular, bone quality, placement torque, and implant type, which are closely related to initial stability, have been reported.

Most dental implant handpiece systems are used in accordance with the manufacturer's recommendations to meet the stability requirements for implant surgery.[11-13] In a study on the time of use of the handpiece during implant placement, it was found that the more complicated the dental implant surgery, the longer the implant handpiece's use.[3] In addition, the frictional heat should not exceed 47°C for stability during implant placement[4] because excessive drilling during implant placement can lead to bone necrosis due to frictional heat.[5] Bone necrosis is closely related to the initial stability of implant surgery, especially the implant handpiece. Heat may be generated in the bone tissue when an implant handpiece is used repeatedly, requiring the stability of the output torque.

Excessive repeated use of the dental implant handpiece may cause aging of the handpiece through heat generation of the implant motor and affect its lifespan.[6] An overloading torque condition of 50 Ncm of the implant handpiece affects the output torque.[10] In addition, the implant handpiece is used not only for implant placement but also for screwing the implant prosthesis.[7] Screw loosening of the implant prosthesis often occurs, and it can be caused by various factors such as occlusal force and fit of the prosthesis.[7,8] To maintain a constant and accurate torque value, the implant system should be maintained to minimize the failure of the screw or loosening of the screw.[9] In addition, the actual output torque value decreases when the implant handpiece is repeatedly used.[10] The reliability of the surgical motor is measured by the accuracy of the output torque.[14] However, studies on the effect of the output torque in the repeated use of the implant handpiece and overloading torque condition are still insufficient.

Therefore, this study aimed to compare the output torque of two types of implant handpieces under clinically used implant placement torque (35 Ncm) and overloading torque condition (50 Ncm) and to evaluate the effect of repeated use of the implant handpiece on the output torque. The null hypotheses of this study are that there is no difference in output torque during repeated use of implant handpieces and the repeated use and types of implant handpieces do not affect the output torque and absolute deviation of the handpiece.

MATERIALS AND METHODS

In this study, two types of implant handpiece systems were used. The NSK implant surgical handpiece system (Surgicpro/X-DSG20L, NSK, Kanuma, Japan) and the SAESHIN implant surgical handpiece system (SIP20/CRB46LN, SAESHIN, Daegu, South Korea) were prepared as unused products. Prior to the experiment, each implant handpiece system was calibrated according to the manufacturer's recommendations (Fig. 1). The sample size was determined using a power software program (G * Power v3.1.9.2, Heinrich-Heine-Universität, Dusseldorf, Germany) based on the results of five pilot experiments (N = 30 per set; effect size (d) = 1.04; power = 99; actual power = 99.06).

The output torque of the implant handpiece was measured using a digital torque gauge (MARK-10, MGT-12, Mark-10 Corp., Copiague, NY, USA) (Fig. 2). The digital torque gauge was calibrated according to the manufacturer's recommendations and was installed on a specially manufactured jig. The specially manufactured jig can install the implant hand-

Fig. 1. Calibration for the implant handpiece system.

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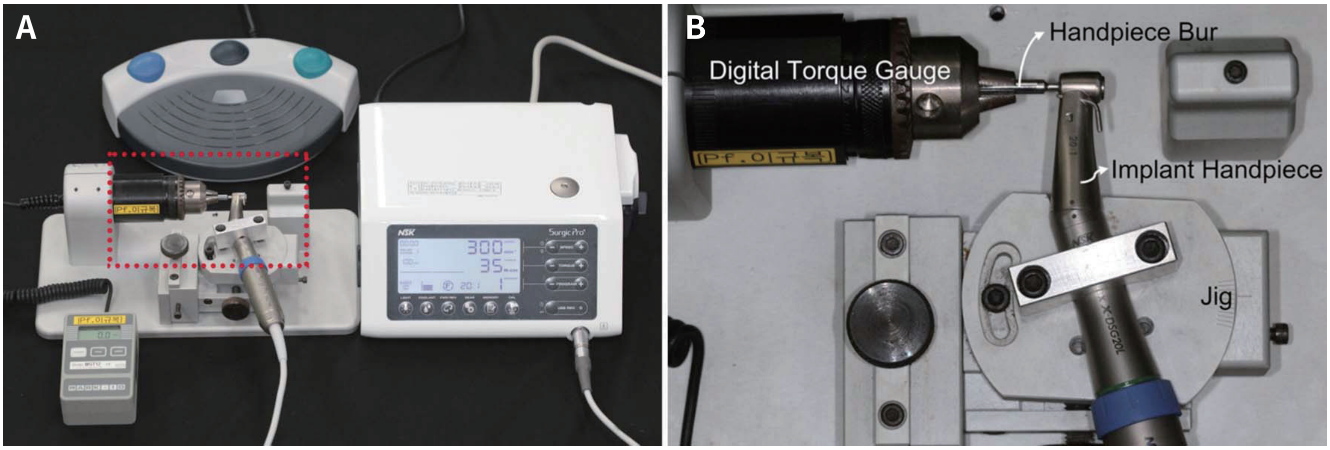

Fig. 2. Output torque measurement with a custom-made jig. (A) Preparation for output torque measurement, (B) Implant handpiece and a torque gauge fixed to the jig.

piece as well as the digital torque gauge without any movement, and the handpiece can be accurately positioned on the torque meter (Fig. 2). For a passive connection between the digital torque gauge and the implant handpiece, the height and angle (x, y, and z axes) were adjusted using the jig (Fig. 2B). The digital torque gauge and the implant handpiece were connected using a bur for calibration (SAESHIN, Daegu, South Korea).

The use of the implant handpiece system was conducted by an experienced investigator (K.S.). The implant handpiece fixed to the jig was tested under the setting torque value of 35 Ncm (insertion torque) and 50 Ncm (overloading torque condition), and the revolutions of handpiece per minute were set to 800.[1,6,10] Each torque (35 and 50 Ncm) was performed 30 times per set, and a total of 5 sets were performed (N = 150). To prevent excessive use, the implant handpiece was rested for 10 minutes after the previous set. In addition, when the setting torque value was changed, the experiment was continued after 24 hours, and the degree of deviation of the output torque compared to the setting torque was evaluated as an absolute deviation.

All data were analyzed using a statistical software (SPSS ver 25.0, IBM, Chicago, IL, USA) ($\alpha = .05$). First, the normal distribution of the data was investigated through the Shapiro–Wilk test, and the difference between the groups was verified using the Mann-Whitney U test because the normal distribution was not achieved. The Friedman test was used to confirm the change in output torque in 5 sets (150 times). Factorial analysis of variance (ANOVA) on ranks was performed to confirm the interaction effect of the implant handpiece and repeated use. The chi-square test was used to compare manufacturers and torque levels and analyze the relevance.

RESULTS

The NSK and SAESHIN implant handpieces showed significant differences in output torque results at 35 Ncm and 50 Ncm ($P < .001$) (Table 1, Fig. 3). For the setting torque of 35 Ncm, NSK (38.2 ± 2.0 Ncm) showed significantly higher output torque than SAESHIN (30.9 ± 1.5 Ncm) ($P < .001$), but the absolute deviation was significantly higher in SAESHIN ($P < .001$). For the setting torque of 50 Ncm, SAESHIN (53.3 ± 6.3 Ncm) showed a significantly higher output torque than NSK (47.8 ± 0.3 Ncm) ($P < .001$) (Fig. 3), whereas the absolute deviation was significantly higher in SAESHIN ($P < .001$).

For the setting torque of 35 Ncm, the repeated measurement results are shown in Table 2. NSK exceeded the setting torque value, and SAESHIN showed an output torque value that was less than the setting torque value (Fig. 4A). NSK showed a measured value that exceeded the setting torque value in the 1st to the 4th sets, but less than the setting torque value in the 5th set, which had the smallest absolute deviation. On the other hand, SAESHIN recorded an out-

Table 1. Comparison of the output torque at the setting torque of 35 Ncm and 50 Ncm

Setting torque		Mean ± SD (Ncm)		*P**
		NSK	SAESHIN	
35 Ncm	Output torque	38.2 ± 2.0	30.9 ± 1.5	< .001
	Absolute deviation	3.4 ± 1.7	4.1 ± 1.4	.001
50 Ncm	Output torque	47.8 ± 0.3	53.3 ± 6.3	< .001
	Absolute deviation	2.1 ± 0.2	6.7 ± 2.3	< .001

*Significance determined using the Mann–Whitney U-test, $P < .05$.

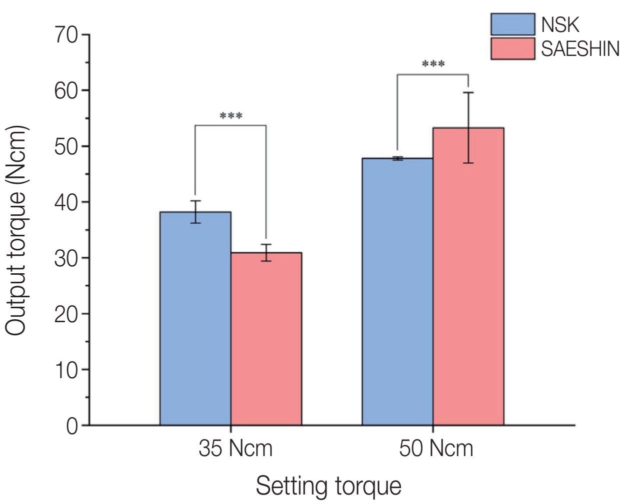

Fig. 3. Comparison of the output torque at a setting torque of 35 Ncm and 50 Ncm.

put torque value that was less than the setting torque value, but the result was that the setting torque value became closer as the set was repeated. In the 2nd and 3rd sets, there was no significant difference in the absolute deviation between NSK and SAESHIN ($P > .05$), but in the other sets, there was a significant difference in the absolute deviation ($P < .001$).

For the setting torque of 50 Ncm, the repeated measurement results are shown in Table 3. NSK's value was less than the setting torque value, and in the case of SAESHIN, higher measured value was recorded (Fig. 4B). NSK showed less than the setting torque in all sets but recorded constant output torque values in all sets. In the case of SAESHIN, the result value exceeding the setting torque value was measured in the 1st and 2nd sets, but the output torque value approached the setting torque value as the repetition was repeat-

Table 2. Comparison of the output torque with repeated use at the setting torque of 35 Ncm

Set		Mean ± SD (Ncm)		*P**
		NSK	SAESHIN	
1 (n = 30)	Output torque	38.0 ± 1.5	29.5 ± 0.4	< .001
	Absolute deviation	3.0 ± 1.5	5.4 ± 0.4	< .001
2 (n = 30)	Output torque	40.1 ± 0.4	29.9 ± 0.2	< .001
	Absolute deviation	5.1 ± 0.4	5.0 ± 0.2	.308
3 (n = 30)	Output torque	38.7 ± 1.1	30.7 ± 2.2	< .001
	Absolute deviation	3.7 ± 1.1	4.6 ± 1.4	.151
4 (n = 30)	Output torque	39.3 ± 0.3	31.9 ± 0.4	< .001
	Absolute deviation	4.3 ± 0.3	3.0 ± 0.4	< .001
5 (n = 30)	Output torque	34.9 ± 1.0	32.6 ± 0.3	< .001
	Absolute deviation	0.9 ± 0.5	2.3 ± 0.3	< .001
*P***	Output torque	< .001	< .001	
	Absolute deviation	< .001	< .001	

*Significance determined using the Mann–Whitney U-test, $P < .05$. **Significance determined using the Friedman test, $P < .05$.

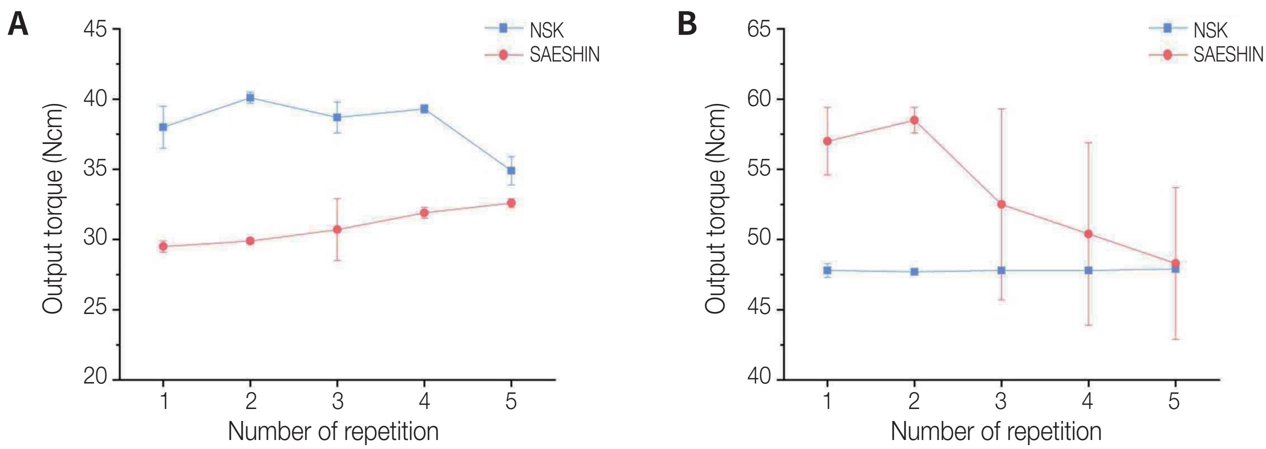

Fig. 4. Comparison of the output torque with repeated use. (A) 35 Ncm, (B) 50 Ncm.

Table 3. Comparison of the output torque with repeated use at the setting torque of 50 Ncm

Set		Mean ± SD (Ncm) NSK	SAESHIN	P*
1 (n = 30)	Output torque	47.8 ± 0.5	57.0 ± 2.4	< .001
	Absolute deviation	2.2 ± 0.3	7.0 ± 2.4	< .001
2 (n = 30)	Output torque	47.7 ± 0.2	58.5 ± 0.9	< .001
	Absolute deviation	2.2 ± 0.2	8.5 ± 0.9	< .001
3 (n = 30)	Output torque	47.8 ± 0.1	52.5 ± 6.8	< .001
	Absolute deviation	2.1 ± 0.1	6.9 ± 2.2	< .001
4 (n = 30)	Output torque	47.8 ± 0.1	50.4 ± 6.5	.056
	Absolute deviation	2.1 ± 0.1	6.0 ± 2.2	< .001
5 (n = 30)	Output torque	47.9 ± 0.1	48.3 ± 5.4	.184
	Absolute deviation	2.0 ± 0.1	5.2 ± 2.2	< .001
P**	Output torque	.105	< .001	
	Absolute deviation	< .001	< .001	

*Significance determined using the Mann–Whitney U-test, $P < .05$. **Significance determined using the Friedman test, $P < .05$.

ed. NSK and SAESHIN showed the smallest absolute deviation in the 5th set, and SAESHIN showed a significantly higher absolute deviation ($P < .001$).

For the NSK implant handpiece, there was a significant decrease in the output torque with repeated use at 35 Ncm, and no significant decrease was observed at 50 Ncm (Table 2 and Table 3). In the case of SAESHIN, a significant decrease in the output torque due to repeated use was measured at 50 Ncm, but at 35 Ncm, a decrease in torque due to repeated use was not measured (Table 2 and Table 3). The type of implant handpiece and repeated use affected the out-

Table 4. Result of ANOVA of the implant handpiece and repetition

Source	P*
Implant handpiece	< .001
Repetition	< .001
Implant handpiece × Repetition	< .001

ANOVA, analysis of variance.
*Significance determined by factorial ANOVA on ranks, $P < .05$.

put torque (P < .001) (Table 4). In addition, the repetition and implant handpiece showed an interaction effect (P < .001). As a result of the chi-square test, the output torque was statistically related according to the manufacturer (P < .001).

DISCUSSION

This study aims to compare the output torque and absolute deviation of the NSK and SAESHIN implant handpieces in clinically used placement torque (35 Ncm) and overloading torque condition (50 Ncm) and to investigate the effect of repeated use of implant handpiece. For this, the null hypothesis is that the repeated use and types of implant handpieces do not affect the output torque and absolute deviation of the handpiece. However, after repeated use at the setting torque of 50 Ncm, all null hypotheses were rejected (P < .001) (Table 1, Table 2, Table 3), except for the results of NSK (P = .105) (Table 3). NSK and SAESHIN had significant differences in both output torques (P < .001), but the absolute deviation at the setting torque of 35 Ncm was not significantly different in the 2nd and 3rd sets (P > .05).

Low torque during implant placement provides insufficient torque to obtain initial fixation of the implant, and excessive torque may generate heat in the surrounding bone tissue, leading to bone necrosis.[15-17] Neugebauer *et al*.[1] reported the possibility that the implant may fail if the output torque is more than 35 Ncm during implant placement and that the placement torque and implant stability are related. Strietzel *et al*.[18] reported that a high output torque could lead to a high bone resorption rate. Eriksson and Albrektsson[19] reported that bone damage occurred due to an increase in temperature due to high output torque and that 30% of bone resorption occurred four weeks after implant placement. Therefore, proper output torque is one of the important factors to consider for long-term prognosis. In this study, the output torque was higher in NSK (38.2 ± 2.0 Ncm) than SAESHIN (30.9 ± 1.5 Ncm) at the setting torque of 35 Ncm (Table 1). Through these results, the output torque may vary depending on the implant handpiece system. However, all output torque values of SAESHIN below 35 Ncm may cause a decrease in implant stability, according to a previous study.[20] A previous study compared the high torque group and low torque group and reported that the implant insertion of high torque group increases the primary stability of the implant.[20] Therefore, it is necessary to check the output torque before implant placement for a successful implant prognosis in dental clinics.

Generally, high torque is not applied continuously during dental implant surgery.[10] However, a high implant insertion torque increases the primary stability of the implant.[20] Another previous study has also shown that the use of a high insertion torque does not interfere with osseointegration between the bone and implant surface.[21] However, the insertion of a high torque will interfere with drilling due to friction, which will cause the handpiece to move continuously without stopping to avoid stopping and may cause placement failure.[10] In this study, the repeated use of implant handpieces showed different trends according to the type of handpiece system. In NSK, at the setting torque of 35 Ncm, the output torque decreased significantly with repeated use (P < .001), but at 50 Ncm, the output torque did not change due to repeated use (P = .105). SAESHIN showed a significant increase in the output torque when repeatedly used at a setting torque of 35 Ncm (P < .001), but a significant decrease in the output torque when used repeatedly at a setting torque of 50 Ncm (P < .001) was observed. In these results, the actual output torque decreased when continuously used at 35 Ncm for NSK and 50 Ncm for SAESHIN. Therefore, when the dental fixture gets stuck in the bone due to the reduction of the output torque during surgery, the clinician should use the implant torque wrench to obtain a high insertion torque.[10]

In the previous study, the output torques among manufacturers were compared in the implant surgery motor, and the difference in the output torque among manufacturers was reported.[10] Due to the difference in output torque among manufacturers in implant placement, different methods of use have been suggested depending on the manufacturer.[10] In addition, an increase in output torque relative to the set torque may cause excessive heat generation during implant placement.[4] Likewise, in the present study, the results of the chi-square test had an effect on the output torque depending on the manufacturer (P < .001). However, the difference in output torque between manufacturers requires additional studies on actual heat generation and stability.

In actual clinical trials, a saline solution is injected to reduce the heat generation of bone tissue.[20] In addition, the initial stability of the implant can be maintained through stepwise torque placement rather than by applying continuous force.[20,21] However, in this study, the output torque was measured in a laboratory environment, which is different from the clinical placement environment. To measure more torque values, additional experiments with various torque values of implants from other companies are required. In addition, further studies are warranted to investigate the impact of the difference in output torque according to the implant handpiece system on the actual implant placement. Additionally, in the present study, the bur is fixed to the digital torque gauge without movement, but the implant placement process has some resistance during the bone removal process. These differences from clinical environments require additional clinical studies.

CONCLUSION

The NSK and SAESHIN implant handpieces showed different output torque trends according to the setting torque, and repeated use affected the output torque. The SAESHIN implant handpiece did not show signs of aging due to repeated use at 35 Ncm, unlike the NSK implant handpiece. In the overloading torque condition (50 Ncm), the SAESHIN implant handpiece showed aging due to repeated use. During implantation, repeated use of these handpieces may cause a difference between the setting torque and the actual output torque. Hence, implant handpiece should be managed and repaired if used in the long term. In addition, for successful implant results in dental clinics, the output torque of the implant handpiece system should be checked before implant placement.

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