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An in vitro study on the impact of the torque after repeated use of the implant handpiece: An original research

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***Abstract*---**Introduction: Extreme repeated use of the dental implant handpiece may cause aging of the handpiece through heat generation of the implant motor and affect its lifespan. We aim to conduct an in-vitro study on the impact of the torque after repeated use of the implant handpiece. Materials and methods: Two types of implant handpiece systems NSK, and SAESHIN were applied. The output torque was calibrated using a digital torque gauge. The experiment was done 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). Results: NSK and SAESHIN implant handpieces depicted significant differences in output torque output 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: Notable changes were noted due to repeated use, and the implant handpiece should be achieved and repaired during long-term use. Moreover, for successful implant results in dental clinics, the output torque of the implant handpiece system should be checked before implant placement.

***Keywords*---**Handpiece, Torque, Dental implants, Excess Use.

Introduction

A handpieces' initial stability has been established as the most important feature for dental implant placement; a torque of 35 Ncm is recommended.1-5 Most dental implant handpiece systems are applied in accordance with the manufacturer's suggestions to meet the stability requirements for implant surgery.6-10 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 placement4 because excessive drilling during implant placement can lead to bone necrosis due to frictional heat.11,12 Bone necrosis is closely connected to the initial stability of implant surgery, particularly the implant handpiece. 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.13 An overloading torque condition of 50 Ncm of the implant handpiece affects the output torque.10 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 The reliability of the surgical motor is measured by the accuracy of the output torque.9-14 However, studies on the effect of the output torque in the frequent use of the implant handpiece and overloading torque condition are still insufficient. Hence in this study we aim to conduct an in-vitro study on the impact of the torque after repeated use of the implant handpiece.

Materials and Methods

We considered two different types of handpieces. The NSK implant surgical handpiece system and the SAESHIN implant surgical handpiece system were arranged as unused products. The specially manufactured jig can install the implant hand piece as well as the digital torque gauge without any movement, and the handpiece can be precisely positioned on the torque meter. 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. The digital torque gauge and the implant handpiece were connected using a bur for calibration. The use of the implant handpiece system was conducted by an experienced investigator. 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). The data was recorded and the $p<0.05$ was considered significant after the application of appropriate statistical tools.

Results

The NSK and SAESHIN implant handpieces showed significant differences in output torque results at 35 Ncm and 50 Ncm (P < .001) (Table 1). 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), 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. 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 and SAESHIN showed the smallest absolute deviation in the 5th set, and SAESHIN showed a significantly higher absolute deviation (P < .001). The type of implant handpiece and repeated use affected the out 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)

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.

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, $P < .05$.

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

Set		Mean ± SD (Ncm)		P*
		NSK	SAESHIN	
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, $P < .05$.

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, $P < .05$.

Discussion

We observed in our study that 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 produce 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 location torque and implant stability are related. Strietzel et al. 16 reported that a high output torque could lead to a high bone resorption rate. From our results, the output torque may vary depending on the implant handpiece system. Nonetheless, all output torque values of SAESHIN below 35 Ncm may cause a decrease in implant stability, according to a previous study. Few studies compared the high torque group and low torque group and described that the implant insertion of high torque group increases the primary stability of the implant.19 So, it is necessary to check the output torque before implant placement for a successful implant prognosis in dental clinics. In this study, the repeated use of implant handpieces showed different trends according to the type of handpiece system. Consequently, when the dental fixture gets stuck in the bone due to the lessening of the output torque during surgery, the clinician should use the implant torque wrench to obtain a high insertion torque.10 Furthermore, an increase in output torque relative to the set torque may cause excessive heat generation during implant placement.4 Similarly, in the present study, the results of the chi-square test had an effect on the output torque depending on the manufacturer ($P < .001$). Though, the variance 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.19 In addition, the initial stability of the implant can be maintained through stepwise torque placement rather than by applying continuous force.18,19 Though, in this study, the output torque was measured in a laboratory environment, which is different from the clinical placement environment. To calculate more torque values, additional experiments with various torque values of implants from other companies are required.

Conclusion

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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