The Influence of Torque Tightening on the Position Stability of the Abutment in Conical Implant-Abutment Connections

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The influence of repeated system-specific torque tightening on the position stability of the abutment after de- and reassembly of the implant components was evaluated in six dental implant systems with a conical implant-abutment connection. An established experimental setup was used in this study. Rotation, vertical displacement, and canting moments of the abutment were observed; they depended on the implant system ($P = .001$, $P < .001$, $P = .006$, respectively). Repeated torque tightening of the abutment screw does not eliminate changes in position of the abutment. *Int J Prosthodont 2015;28:538–541. doi: 10.11607/ijp.3853*

Position stability of the implant-abutment connection influences prosthetic superstructure fit.[1] Repeated manual tightening and repositioning of the abutment performed during the restoration process has been shown to result in abutment position deviations.[2-4] According to the manufacturer's instructions, torque tightening is not to be performed prior to the definite seating of the superstructure. Repeated torque tightening of the abutment screw in all laboratory and clinical procedures has been recently recommended to enhance position stability of the abutment in conical implant-abutment connections.[5]

The aim of the present study was to investigate the influence of repeated system-specific torque tightening of the abutment screw on abutment position stability in implant systems with a conical connection and different positional index designs.

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Materials and Methods

An established experimental set-up was used.[3,4] Six implants of six implant systems were fixated in a stainless steel cast and standardized test bodies were attached to the corresponding abutments (Table 1).

Two persons each alternately de- and reassembled the implant-abutment-test body complexes of each system 20 times. After each reassembly, the abutment screws were tightened using the system-specific torque wrench and torque value (Table 1), and the position of the test body was registered using a coordinate-reading machine (Video Check IP 600 × 650, Werth Messtechnik) under standardized test conditions in relation to a three-dimensional coordinate system. Vertical, rotational, and canting changes of position of the abutment were quantified (Fig 1).

The data were statistically evaluated using the nonparametric analysis of variance of repeated measurements with SPSS 17.0 (SPSS) and SAS 9.1 (SAS). A P value $< .05$ was considered significant.

Results

Rotation of the abutment ranged up to 6.02 degrees. The range of values concerning the vertical displacement varied from 19 to 144 µm. Canting moments of the abutment showed a range of up to 4.31 degrees. The range of values, the median, and the statistical analysis for each system are shown in Fig 2. Position stability of the abutment was influenced by the implant system ($P = .001$, $P < .001$, $P = .006$).

Table 1 Specifications of the Implant Components Used and System-Specific Torque Value

System	Implant	Art. no.	Abutment	Art. no.	Abutment screw art. no.	Cone angle	Positional index design	System-specific tightening torque
S1 (Conelog: Camlog Biotechnologies)	Screw-Line ConeLog Implantat Promote plus 4.3 × 11 mm	C1062.4311	CE-marked Prototype: Universal Abutment ConeLog GH 1.5-2.5 mm	E-C2211. 4300-15	C4005.1601-10	7.5°	Cam-groove	20 Ncm
S2 (Nobel Active: Nobel Biocare)	Nobel Active Implantat Internal RP 4.3 × 11.5 mm	34132	Esthetic Abutment Nobel Active Int RP 3 mm	34199	–	12°	Hexagon	35 Ncm
S3 (Ankylos C/X: Friadent)	C/X Implantat B14 4.5 × 11 mm	31010430	Regular /X Abutment GH 3.0/A0	31024130	–	5.7°	Cam-groove	15 Ncm
S4 (Astra Tech: Astra Tech Dental)	Osseo Speed Implantat 4.5 × 11 mm	24632	TiDesign 4.5/5.0 – ∅ 5.5, 1.5 mm	24235	–	11°	Dodecagram	25 Ncm
S5 (Straumann Bone Level: Institut Straumann)	Bone Level Implantat ∅ 4.1 mm RC SLA 12 mm	021.4412	RC Anatomic Abutment 0°, GH 3.5 mm	022.4104	–	15°	Cam-groove	35 Ncm
S6 (Straumann Tissue Level: Institut Straumann)	Standard Implantat ∅ 4.1 mm RN SLA 12 mm	033.053S	RN synOcta Cementable Abutment H 5.5 mm	048.605	–	8°	Octagon	35 Ncm

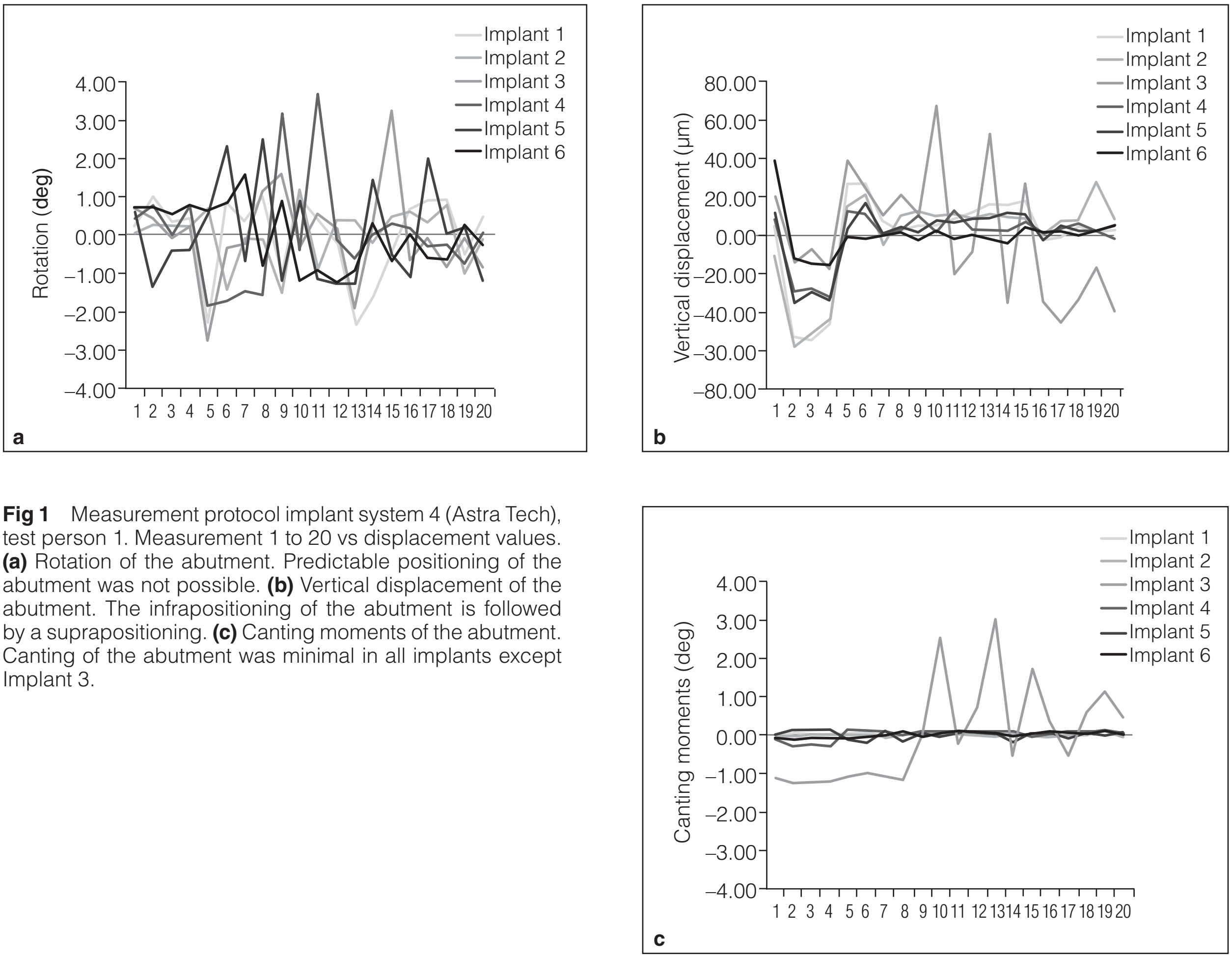
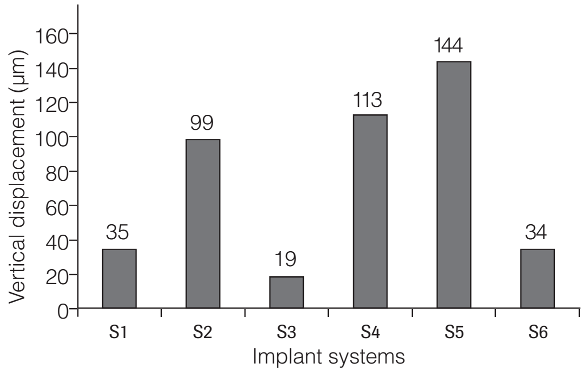


Fig 1 Measurement protocol implant system 4 (Astra Tech), test person 1. Measurement 1 to 20 vs displacement values. **(a)** Rotation of the abutment. Predictable positioning of the abutment was not possible. **(b)** Vertical displacement of the abutment. The infrapositioning of the abutment is followed by a suprapositioning. **(c)** Canting moments of the abutment. Canting of the abutment was minimal in all implants except Implant 3.



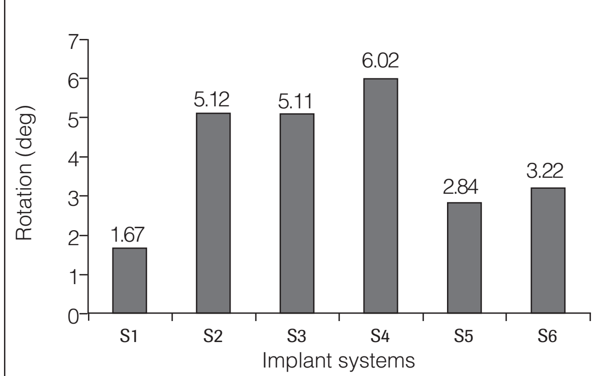
Median (25th, 75th percentile) (µm)

S1	S2	S3	S4	S5	S6
3 (3, 4)	6 (5, 7)	2 (2, 3)	14 (9, 18)	20 (14, 30)	4 (3, 5)

Statistical analysis ($P < .05$)

S1 vs S2	S2 vs S1	S3 vs S1	S4 vs S1	S5 vs S1	S6 vs S2
S1 vs S3	S2 vs S3	S3 vs S2	S4 vs S3	S5 vs S2	S6 vs S3
S1 vs S4	S2 vs S5	S3 vs S4	S4 vs S6	S5 vs S3	S6 vs S4
S1 vs S5	S2 vs S6	S3 vs S5		S5 vs S6	S6 vs S5
		S3 vs S6			

a



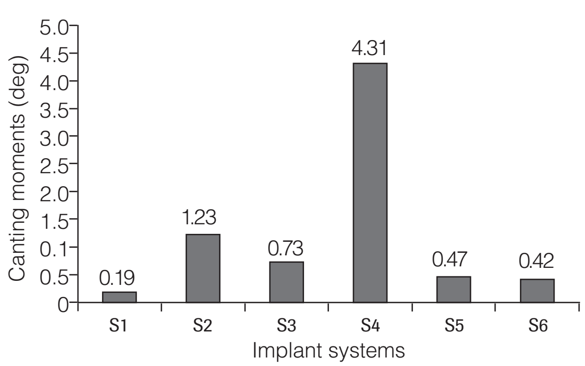
Median (25th, 75th percentile) (deg)

S1	S2	S3	S4	S5	S6
0.40 (0.30, 0.54)	0.72 (0.39, 0.98)	0.74 (0.46, 0.93)	0.84 (0.61, 1.10)	0.47 (0.38, 0.70)	0.12 (0.08, 0.44)

Statistical analysis ($P < .05$)

S1 vs S2	S2 vs S1	S3 vs S1	S4 vs S1	S5 vs S4	S6 vs S2
S1 vs S3	S2 vs S4	S3 vs S6	S4 vs S2		S6 vs S3
S1 vs S4	S2 vs S6		S4 vs S5		S6 vs S4
			S4 vs S6		

b



Median (25th, 75th percentile) (deg)

S1	S2	S3	S4	S5	S6
0.02 (0.02, 0.03)	0.10 (0.07, 0.17)	0.05 (0.02, 0.09)	0.07 (0.04, 0.12)	0.09 (0.05, 0.12)	0.04 (0.03, 0.08)

Statistical analysis ($P < .05$)

S1 vs S2	S2 vs S1	S3 vs S2	S4 vs S1	S5 vs S1	S6 vs S1
S1 vs S4	S2 vs S3				S6 vs S2
S1 vs S5	S2 vs S6				
S1 vs S6					

c

Fig 2 Results: **(a)** vertical displacement, **(b)** rotation, and **(c)** canting moments of the abutment. S1 = Conelog, S2 = Nobel Active, S3 = Ankylos C/X, S4 = Astra Tech, S5 = Straumann Bone Level, S6 = Straumann Tissue Level. Range of values (in µm [vertical displacement] and degrees [rotation, canting moments]), median (25th, 75th percentile) (in µm [vertical displacement] and degrees [rotation, canting moments]), and statistical analysis.

Discussion

In the present study, an increased vertical displacement was observed for implant systems having cone angles > 10 degrees. The range of values was higher than for hand-tightened implant-abutment complexes.[3,4] Ankylos C/X (cone angle: 5.7 degrees) showed the least vertical displacement; it was similar to that of butt-joint connections.[3] The hand-tightening and torque-tightening values for Ankylos C/X are similar[3,4] as its system-specific torque value is close to typical hand-tightening values. In all systems except Ankylos C/X, a vertical infrapositioning of the abutment, as expected by the mechanical nature of the joint, was followed by a suprapositioning. The reason might be a loss of elasticity of the screw and/or wear debris on the surface of the conus. The extent of vertical mispositioning would be even greater when the implant components were assembled without screw tightening prior to the experiment; manual screw-tightening of the implant-abutment complex was necessary for the fabrication of the experimental model and determination of abutment initial position.

In evaluating abutment rotation, two cam-groove connections showed a lower degree of rotation than the systems with a polygonal index. This corresponds to analytical findings showing that polygonal indexes demonstrate a higher rotational freedom than cam-groove connections due to their geometric design when a similar positional index size and comparable manufacturing tolerances are assumed. Although S2, S3, S5, and S6 showed lower rotational freedom after repeated torque tightening than after repeated hand-tightening,[2,3] inconsistent values for the rotational position stability of the abutment in each implant system occurred in the present study: Repeated torque tightening of the abutment screw does not eliminate rotation of the abutment.

Canting moments were minimal and similar to the hand-tightening values[2,3] in all systems except Astra Tech. Implant 3 of S4 showed increased deviations in all dimensions; this might be referable to manufacturing tolerances. Presumably, torque tightening does not minimize canting moments of the abutment.

Conclusions

Repeated torque tightening of the abutment screw does not diminish changes of position of the abutment in implant systems with a conical implant-abutment connection; such position changes preclude a passive fit of prosthetic superstructures.

Acknowledgments

The authors thank Dipl-Ing E. Trostmann and Dipl-Math G. Siebert. The study was funded by the Camlog Foundation. The authors reported no conflicts of interest related to this study.

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