Abutment Screw Loosening in Single-Implant Restorations: A Systematic Review

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Purpose: *The purpose of this study was to systematically review clinical studies on the incidence of abutment screw loosening in single-implant restorations with different implant-abutment connection geometries.* ***Materials and Methods:*** *The literature search was conducted using several electronic databases. Specific terms were used for the database search, which spanned the years 1990 to 2006. The search was augmented by using the option of "related articles" as well as hand searching of references and relevant journals. Relevant studies were selected according to predetermined inclusion and exclusion criteria. Agreement between reviewers was determined by using Cohen's kappa coefficients. Three-year complication-free rates (survival proportions) were calculated with the aid of a survival function, assuming constant failure rates. Summary estimates per group for complication-free rate after 3 years (M-estimator) were calculated using Tukey's biweight estimator.* ***Results:*** *The initial database search yielded 1,526 relevant titles. After the subsequent filtering process, 27 studies were finally selected. Interexaminer agreement ranged from good to perfect. The external-connection group comprised 12 studies following 586 single-implant restorations for a mean follow-up time that ranged from 3 to 5 years. The estimated percent of complication-free single-implant restorations after 3 years was 97.3% (95% CI: 95.6–98.3). The internal connection group comprised 15 studies following 1,113 single-implant restorations for a mean follow-up time that ranged from 3 to 10 years. The estimated percentage of complication-free single-implant restorations after 3 years was 97.6% (95% CI: 96.5–98.3).* ***Conclusion:*** *The results show that abutment screw loosening is a rare event in single-implant restorations regardless of the geometry of implant-abutment connection, provided that proper antirotational features and torque are employed.* Int J Oral Maxillofac Implants 2008;23:681–690

Key words: *implant complications, implant geometry, meta-analysis, screw loosening, single implants*

The stability of the connection between different implant parts is important for the overall success of the reconstruction. This is especially true for single-tooth restorations, where a strong interlock between the abutment and implant is necessary. Various mechanisms have been proposed to connect the dental implant abutment to the implant body. Different systems vary in connection geometry, materials, and overall screw mechanics. The implant-abutment connection stability is also influenced by factors such as component fit, machining accuracy, saliva contamination, and screw preload.[1–8] Most in vitro studies,[9–12] with the exception of one,[13] have demonstrated that internal connections are more mechanically stable than external flat (hex-type) connections. Loosening of abutment screws, particularly with the "classic" external-hex implant systems, has been a well-known technical problem, occurring mainly during the first 2 years after delivery of the crown.[14–17] The stability of the external implant-abutment connection was subsequently improved by altering the screw alloys and their surfaces and applying proper torque values to establish higher initial preloads.[3,18–21]

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Industry surveys[22,23] have shown that external-hex implants still dominate the European and US markets, although there is a continuous rise in internal-connection implants. The literature is lacking studies that compare the incidence of abutment screw loosening in implant systems of different connection geometries following the improvements in screw materials and preload.

The purpose of this study was to systematically review clinical studies with respect to the incidence of abutment screw loosening in single-implant restorations and to compare external- and internal-connection systems.

MATERIALS AND METHODS

Search Strategy

The literature search was conducted by 2 reviewers (AT, HP), using different electronic databases (Medline-PubMed, The Cochrane Register of RCTs, the database of abstracts of Reviews of Effects-DARE) for clinical studies reporting on the incidence of abutment screw loosening of various implant systems with different implant-abutment connection geometries. The search terms that were used, alone or in conjunction, were "screw complications," "screw loosening," "implant abutment complications," "implant-abutment interface," "implant-abutment connection," "preload," "torque,""screw mechanics," and "screw type." The years searched were 1990 to September 2006. The option of "related articles" was also used. Review articles, as well as references from different studies, were also used to identify relevant articles. Hand searching for the time span 1995–September 2006 was conducted for the following journals: *Journal of Prosthetic Dentistry, International Journal of Prosthodontics, International Journal of Oral & Maxillofacial Implants, Implant Dentistry,* and *Clinical Oral Implants & Related Research*.

Selection of Studies

The review process consisted of 2 phases. During the first phase, the review was conducted by the 2 reviewers together. Any disagreement was resolved by discussion and, in case of doubt, the full text of the article was obtained. Initially titles were screened for relevance, and the full text of the relevant abstracts was obtained. Hand searching of the selected journals, as well as searching of the references of the selected studies, was also implemented at this point. The articles obtained were screened during the first step of the review process using the following exclusion and inclusion criteria:

Exclusion criteria

1. Laboratory studies
2. Case reports
3. Technical articles
4. Studies in a language other than English or without an English abstract

Inclusion criteria

1. Studies reporting on single-implant restorations (SIR)
2. Clinical studies with follow-up
3. Mechanical complications reported

The selected full texts were further screened independently by 2 reviewers in the second phase of the review using the following inclusion criteria: *(1)* Mean follow-up period of at least 3 years, *(2)* Single-tooth abutments with antirotational features and proper torque used in external-hex connections, *(3)* number of patients stated, *(4)* number of SIR stated, *(5)* implant system stated, and *(6)* study outcome stated as mechanical complications involving abutment screw loosening. Inter-reviewer agreement was determined using Cohen's kappa coefficients.

The final included studies that passed the second phase in the review process were classified according to the strength of evidence into 4 categories according to Jokstad et al[24]: *(1)* A1, controlled clinical trial with patient randomization (RCT); *(2)* A2, controlled clinical trial with split-mouth randomization (split-mouth RCT); *(3)* B, prospective controlled trial without randomization (CCT); and *(4)* C, clinical studies with different designs than categories A and B (retrospective, case series, etc).

Data of the final studies was tabulated according to implant-abutment connection geometry, and the incidence of abutment screw loosening was calculated. In cases where the study included both single restorations and fixed partial dentures without specifying which restorations presented with abutment screw loosening, the worst case scenario was recorded (all failures attributed to single crowns). In studies where only the minimum follow-up time was mentioned, that interval was used to measure the total exposure time of the restorations. In cases of multiple publications following the same cohort of patients, the study with the longest follow-up was taken into account.

Three-year complication-free rates (survival proportions) were calculated with the aid of survival function S, $S(t) = \exp(-t^*\text{failure rate})$, where $t = 3$ years, assuming constant failure rates. Number of failures per study was considered to follow a Poisson distribution for the calculated sum of implant years. Summary estimates per group of rates for complication-free implants after 3 years (M-estimator) were

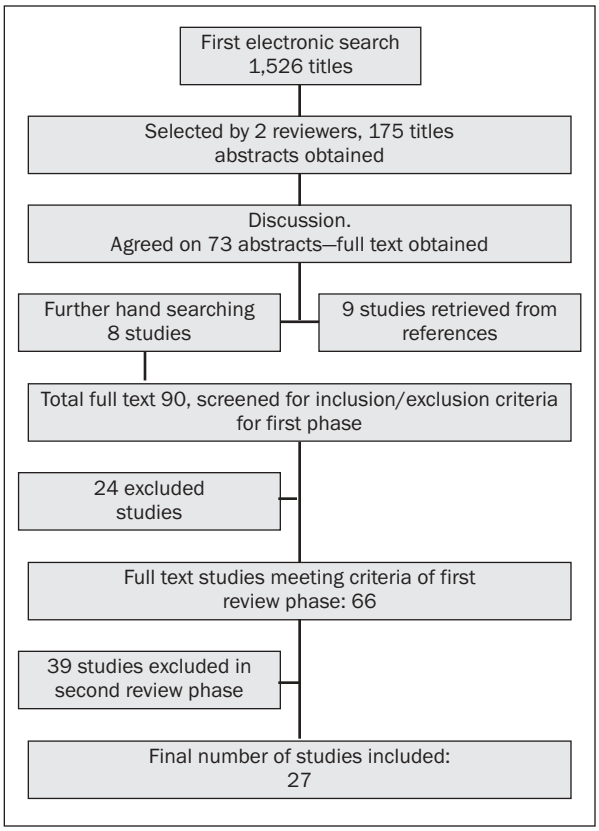

Fig 1 Search strategy and results.

calculated using Tukey's biweight estimator. The 95% CI for the complication-free rate per group was calculated from 95% confidence limits of the event rates. All analyses were performed using STATA, version 10 (Statacorp LP, College Station, TX) and CMA, version 3 (Biostat, Englewood, NJ).

The event rate of abutment screw loosening was compared between groups with different connection geometries. The possible effect of the type of study (prospective versus retrospective) on the outcome measured was also calculated.

RESULTS

The database search initially yielded 1,526 titles. Sixty-six studies passed the first review phase, and 27 studies[25–51] were finally selected for analysis (Fig 1). The inter-reviewer agreement for the 6 inclusion criteria during the second review phase ranged from "good" to "very good" (kappa: 0.72–1.00; Table 1). The studies[52–89] that were rejected during the second review phase are shown in Table 2.

Table 1 Inter-reviewer Agreement

Criterion	Kappa	Standard error	95% CI	
Follow-up period	0.750	0.058	0.635	0.865
Proper method of fixation	0.969	0.022	0.926	1.000
No. of patients stated	0.937	0.031	0.877	0.998
No. of SIR stated	1.000	–	–	–
Implant system stated	0.937	0.031	0.877	0.998
Study outcome stated	0.719	0.061	0.598	0.839

Table 2 Excluded Studies During the Second Review Phase and Reason for Exclusion

Exclusion criteria/ studies	Year
Mean follow-up period < 3 y	
Levine et al[52]	1997
McMillan et al[53]	1998
Drago[19]	2003
Dhanrajani and Al Rafee[54]	2005
Ericsson et al[55]	2000
Lindquist et al[56]	1996
Priest[57]	1999
Levine et al[58]	2002
Schropp et al[59]	2005
Andersson et al[60]	2003
Vermylen et al[61]	2003
Karlsson et al[62]	1997
Engquist et al[16]	1995
Jemt et al[63]	1998
Wie[64]	1995
No proper fixation	
Lekholm et al[65]	1994
Lekholm et al[66]	1999
Jemt et al[67]	2000
Screw loosening not reported	
Simon[68]	2003
Kourtis et al[69]	2004
Haas et al[70]	1995
Polizzi et al[71]	1999
De Boever et al[72]	2006
Scurria et al[73]	1998
Bher et al[74]	1998
Wee and McGlumphy[75]	2003
Balshi and Wolfinger[76]	1997
Henry et al[17]	1996
Fartash and Arvidson[77]	1997
Moberg et al[78]	1999
No. of patients not stated	
Weigl[79]	2004
Döring et al[80]	2004
Implant system not stated	
Cooper et al[81]	2001
Mean follow-up period < 3 y, screw loosening not reported	
Norton[82]	2004
Implant system not stated	
Wennström et al[83]	2004
Schwartz-Arad et al[84]	1999
No proper fixation, no. of SIR not stated	
Wyatt and Zarb[85]	1998
Mean follow-up period < 3 y, no proper fixation	
Ekfeldt et al[15]	1994
Carlson and Carlsson[86]	1994

Table 3 Demographics of Included Studies with External Connection

Study	Year	Category of evidence*	Planned no. of patients	Planned no. of patients with SIR	Actual no. of patients with SIR	Drop out %	Age range (y)	Mean age (y)	Setting
Andersson et al[28]	1998	B2(P)	57	57	49	14	14–56	32	University
Andersson et al[34]	2001	A1(P RCT)	15	15	15	0	17–49	32	University
Balshi et al[33]	1996	C(P)	47	22	21	4.5	NR	NR	Private
Bambini et al[26]	2001	C(R)	59	32	32	0	38–65	57	NR
Cho et al[27]	2004	C(P)	106	NR	NR	0	20–74	NR	University
Gibbard and Zarb[32]	2002	C(P)	42	42	24	42.8	23–74	42.7	University
Glauser et al[36]	2004	C(P)	27	27	18	11.4	26–75	44	University
Parein et al[29]	1997	C(R)	152	NR	NR	NR	14–90	55.7	University
Scheller et al[31]	1998	C(P)	82	82	57	30.5	14–73	35	Private
Scholander et al[30]	1999	C(R)	183	183	NR	NR	16–71	29.8	University
Vigolo et al[35]	2004	A1(P RCT)	12	12	12	0	NR	NR	Private
Wannfors and Smedberg[25]	1999	B2(P)	69	NR	NR	NR	17–72	26	University

*Study design shown in parentheses. NR = not reported, R = retrospective, P = prospective.

Table 4 Demographics of Included Studies with Internal Connection

Study	Year	Category of evidence*	Planned no. of patients	Planned no. of patients with SIR	Actual no. of patients with SIR	Drop out % of patients with SIR	Age range (y)	Mean age (y)	Setting
Behneke et al[39]	2000	C(P)	55	NR	NR	0	17–81	44.2	University
Brägger et al[44]	2004	C(P)	89	48	48	0	28–88	58.9	University
Duncan et al[43]	2003	C(P)	51	19	19	0	21–76	43.2	University
Mericske-Stern et al[45]	2001	C(P)	75	75	71	5.3	19–82	50.1	University
Nedir et al[51]	2006	C(R)	236	NR	NR	NR	18–89	57.5	Private
Levine et al[37]	1999	C(R)	129	129	110	15	13–84	52	Private
Wennström et al[50]	2005	C(P)	40	40	36	10	20–71	40.9	University
Gotfredsen[49]	2004	B2(P)	20	20	20	0	18–59	33	University
Norton[48]	2006	C(R)	54	54	54	0	40–79	57	Private
Norton[40]	2001	C(P)	23	23	13	43	23–77	48.7	Private
Palmer et al[38]	2000	C(P)	15	15	14	6.7	16–48	33	University
Romanos and Nentwig[47]	2000	C(R)	51	51	NR	NR	NR	45.1	University
Krennmair et al[42]	2002	C(R)	112	112	112	0	NR	F 29.2, M 43.1	NR
Mangano and Bartolucci[41]	2001	C(R)	69	69	69	0	16–61	42	Private
Muftu and Chapman[46]	1998	C(P)	168	NR	NR	NR	NR	NR	Hospital

*Study design shown in parentheses. NR = not reported, R = retrospective, P = prospective.

All selected studies[25–51] were published in the last 12 years. The publication date of the external-connection implant systems ranged from 1996 to 2004 with half of the studies published after 2000. The publication date of the internal-connection implant systems ranged from 1998 to 2006, with the majority of the studies published after 2000. No study directly compared the incidence of screw loosening between internal- and external-connection implant systems. Most of the studies were classified as category C according to the strength of the evidence, and most were implemented in a university setting.

The studies included a total of 2,038 patients with an age range of 13 to 90 years. The demographics of the included studies are depicted in Tables 3 and 4. The studies reported on various commercially available implant systems. Most of the external-connection implant systems included in the final studies were either 3i (Biomet 3i, Palm Beach Gardens, FL) or Nobel Biocare (Nobel Biocare, Göteborg, Sweden), which essentially have similar geometry for their respective regular platforms. The exception was 1 study that utilized Threadlock/Spline (Sulzer Calcitek, Carlsbad, CA) implants. The internal-connection systems were Straumann (Straumann, Basel, Switzerland), Astra (Astra Tech, Mölndal, Sweden), Frialit (Friatec, Mannheim, Germany), Mac System (Cabon, Milan, Italy), Bicon (Bicon, Boston, MA), and Ankylos (Degussa Hulls, Hanau, Germany). Due to the possible effect of the variability of internal-connection geometry on the stability of the implant-abutment interface, the internal connection group of studies was

Table 5 Information on SIRs in Included Studies with External Connection

Study	Year	Implant system	Planned total no. of implants	Planned no. of SIR*	Actual no. of SIR	Drop out %	Follow-up range (y)	Mean follow-up (y)
Andersson et al[28]	1998	Nobel Biocare	65	65	55	15	N/A	5
Andersson et al[34]	2001	Nobel Biocare	20	20	20	0	N/A	3
Balshi et al[33]	1996	Nobel Biocare	72	8	8	0	N/A	3
Bambini et al[26]	2001	Threadlock/Spline	96	32	32	0	N/A	3
Cho et al[27]	2004	3i	213	39	39	0	3–5	4
Gibbard and Zarb[32]	2002	Nobel Biocare	49	49	30	38.8	5–13	5
Glauser et al[36]	2004	Nobel Biocare	53	53	36	32	4–4.5	4.1
Parein et al[29]	1997	Nobel Biocare	392	35	35	0	NR	4.2
Scheller et al[31]	1998	Nobel Biocare	99	99	65	34.3	N/A	5
Scholander et al[30]	1999	Nobel Biocare	259	208	208	0	2.5–9	4.4
Vigolo et al[35]	2004	3i	24	24	24	0	N/A	4
Wannfors and Smedberg[25]	1999	Nobel Biocare	80	34	34	0	N/A	3

*Refers to SIR with antirotational features.
N/A = not applicable; NR = not reported.

Table 6 Information on SIRs in Included Studies with Internal Connection

Study	Year	Implant system	Planned total no. of implants	Planned no. of SIR	Actual no. of SIR	Drop out % of SIR	Follow-up range (y)	Mean follow-up (y)
Behneke et al[39]	2000	ITI	114	19	19	0	5–8.3	5.4
Brägger et al[44]	2005	ITI	179	69	65	6	8–12	10
Duncan et al[43]	2003	ITI	186	34	34	0	N/A	3
Mericske-Stern et al[45]	2001	ITI	109	109	106	2.8	1–9	4.2
Nedir et al[51]	2006	ITI	528	171	155	9.3	3–8	3
Levine et al[37]	1999	ITI	174	174	157	10	2+	3.3
Wennström et al[50]	2005	Astra	45	45	40	10.1	N/A	5
Gotfredsen et al[49]	2004	Astra	20	20	20	0	N/A	5
Norton[48]	2006	Astra	181	181	180	0.6	1.8–7.6	3
Norton[40]	2001	Astra	27	27	14	48	4–7	5.25
Palmer et al[38]	2000	Astra	15	15	14	6.7	N/A	5
Romanos and Nentwig[47]	2000	Ankylos	58	58	7	88	> 5 y	5
Krennmair et al[42]	2002	Frialit	146	146	144	1.4	0.25–7	3
Mangano and Bartolucci[41]	2001	Mac System	80	80	78	2.5	NR	3.5
Muftu and Chapman[46]	1998	Bicon	432	82	80	2.4	N/A	4

N/A = not applicable, NR = not reported.

further categorized into 3 categories: "Straumann," "Astra," and "Other." The information on implants and SIR is depicted in Tables 5 and 6.

The external-connection group comprised 12 studies following 586 SIR for a mean follow-up time that ranged from 3 to 5 years (Table 7). The estimated percentage of complication-free SIR after 3 years was 97.3% (95% CI: 95.6–98.3).

The internal-connection group comprised 15 studies following 1,113 SIR for a mean follow-up time that ranged from 3 to 10 years (Table 8). The estimated percentage of complication-free SIR after 3 years was 97.6% (95% CI: 96.5–98.3). The complication-free percentage of SIR for the 3 groups was as follows: Straumann 98.2% (95% CI: 96.8–99.0), Astra 97.0% (95% CI: 94.4–98.4), and Other 97.1% (95% CI: 94.7–98.5).

The design of the study (prospective versus retrospective) did not have any effect on the outcome. The estimated percentage of complication-free SIR after 3 years was as follows: external connection/prospective 97.2% (95% CI: 94.9–98.5), external connection/retrospective 97.1% (95% CI: 93.6–98.7), internal connection/prospective 97.6% (95% CI: 95.9–98.6), and internal connection/retrospective 97.6% (95% CI: 95.8–98.6).

DISCUSSION

Systematic reviews differ from other types of reviews in that they adhere to a strict scientific design to make them more comprehensive to minimize the

Table 7 Abutment Screw Loosening Rates of External-Connection Implants

Study	Year	Total no. of implants	Mean follow-up time (y)	No. of failure (loosen)	Estimated minimum time exposure (y)	Estimated failure rate (per 100 implant years)	Estimated complication-free: % after 3 y
Andersson et al[28]	1998	55	5	0	275	0.00	100
Andersson et al[34]	2001	20	3	0	60	0.00	100
Balshi et al[33]	1996	8	3	0	24	0.00	100
Bambini[26]	2001	32	3	3	96	3.13	91.1
Cho[27]	2004	39	4	0	156	0.00	100
Gibbard and Zarb[32]	2002	30	5	0	150	0.00	100
Glauser et al[36]	2004	36	4.1	2	148	1.36	96.0
Parein et al[29]	1997	35	4.2	1	147	0.68	98.0
Scheller et al[31]	1998	65	5	4	325	1.23	96.4
Scholander et al[30]	1999	208	4.4	2	915	0.22	99.3
Vigolo et al[35]	2004	24	4	0	96	0.00	100
Wannfors and Smedberg[25]	1999	34	3	1	102	0.98	97.1
Total		586		13	2,494		
Summary estimate						0.92 (0.57–1.50)	97.3 (95.6–98.3)

Table 8 Abutment Screw Loosening Rates of Internal-Connection Implants (per Implant Type and Total)

Study	Year	Type of implant	Total no. of implants	Mean follow-up time (y)	No. of failure (loosen)	Estimated minimum time exposure (y)	Estimated failure rate (per 100 implant years)	Estimated complication-free: % after 3 y
Behneke et al[39]	2000	Straumann	19	5.4	1	103	0.97	97.1
Brägger et al[44]	2005	Straumann	65	10	2	650	0.31	99.1
Duncan et al[43]	2003	Straumann	34	3	0	102	0.00	100
Mericske-Stern et al[45]	2001	Straumann	106	4.2	0	445	0.00	100
Nedir et al[51]	2006	Straumann	155	3	2	465	0.43	98.7
Levine et al[37]	1999	Straumann	157	3.3	5	518	0.97	97.1
Total			536		10	2,283		
Summary estimate (95% CI)							0.59 (0.33–1.07)	98.2 (96.8–99.0)
Wennström et al[50]	2005	Astra	40	5	2	200	1.00	97.0
Gotfredsen[49]	2004	Astra	20	5	2	100	2.00	94.2
Norton[48]	2006	Astra	180	3	4	540	0.74	97.8
Norton[40]	2001	Astra	14	5.25	1	74	1.36	96.0
Palmer et al[38]	2000	Astra	14	5	0	70	0.00	100
Total			268		9	984		
Summary estimate (95% CI)							1.03 (0.54–1.93)	97.0 (94.4–98.4)
Romanos and Nentwig[47]	2000	Other	7	5	0	35	0.00	100
Krennmair et al[42]	2002	Other	144	3.0	5	432	1.16	96.6
Mangano and Bartolucci[41]	2001	Other	78	3.5	1	273	0.37	98.9
Muftu and Chapman[46]	1998	Other	80	4	3	320	0.94	97.2
Total			309		9	1,060		
Summary estimate (95% CI)							0.97 (0.51–1.82)	97.1 (94.7–98.5)
Total			1,113		28	4,327		
Summary estimate (95% CI)							0.83 (0.58–1.18)	97.6 (96.5–98.3)

chance of bias and to ensure their reliability. Rather than reflecting the views of the authors or being based on only a (possibly biased) selection of the published literature, they contain a comprehensive summary of the available evidence with strict inclusion and exclusion criteria. Methodologies for undertaking systematic reviews have been described.[87,88] The gold standard for systematic reviews is to study randomized clinical trials (RCT), which are the studies with the most robust design. Most of the studies included in this review were retrospective. They were classified in category C according to the strength of evidence and clearly indicate a lower quality of data compared with prospective studies.[24] This clearly points out the need for clinical studies with better designs. No RCTs existed which directly compared the incidence of abutment screw loosening between external and internal connection implant systems. The effect of study design (prospective versus retrospective) was not significant; therefore, the results could be pooled together.

Two reviewers were used to ensure that tasks such as selection of studies for inclusion and data extraction could be performed independently, increasing the chance that errors were detected. The interexaminer agreement ranged from good to perfect agreement. Database search was also augmented by hand searching to minimize selection bias.[89]

The exclusion of papers in languages other than English may have led to the omission of some papers. This is problematic for 2 reasons: *(1)* the precision of summary estimates could be reduced if a substantial number of additional studies published in other languages existed; *(2)* bias may have been introduced if the results of studies published in English differed systematically from those published in other languages. However, a recent empirical study found little effect of the inclusion/exclusion of trials published in language other than English on combined effect estimates in meta-analyses of RCTs.[90] Moreover, it is difficult to have access to non-English journals all over the world, and it is hard to establish the features of the peer-review processes of these journals. When these non-English papers are selected, based on their abstracts, the contents must be translated. This includes the risk of interpretation problems.[91]

The majority of the studies included in this review were conducted in a university setting. The results may therefore not be applicable to all practice settings. The papers originating from private practice settings showed a tendency for a slightly higher incidence of abutment screw loosening, especially regarding internal-connection implant systems.

The follow-up time chosen was set at a minimum of 3 years which could be considered small. It was the authors' intention to try to include as many clinical studies as possible in order to reach a stronger conclusion. Had the cutoff point for mean follow-up time been set at 5 years, 17 more studies would have been excluded. Furthermore, it has been shown that most of mechanical problems take place in the first years after abutment connection.[14–17] The mean follow-up time for the included studies ranged between from 3 to 10 years. However the results do not provide safe conclusions regarding the long-term stability of various implant-abutment connections.

The results of this review showed that abutment screw loosening is a rare event in SIR regardless of the implant-abutment connection geometry, provided that proper antirotational features and torque are employed. More than 97% of SIR studied maintained a stable implant-abutment connection after 3 years of service. This is in agreement with results from in vitro studies,[18–21] which have demonstrated stable abutment screw joints for internal-connection implants as well as for external-connection implants with improved screw materials and preload. This study did not look into other types of mechanical complications, such as screw fracture, where implant-abutment connection geometry might play a role. The results of this systematic review are in agreement with the results of a previous systematic review[92] that examined the incidence of biological and technical complications in implant therapy reported in prospective longitudinal studies of at least 5 years. That study found a very low incidence of complications affecting implant-connection components after 5 years of clinical service. Another systematic review[91] of single implants stated that maintenance treatments were quite common with approximately 1 out of 5 single-tooth implants in need of maintenance, varying from abutment screw retightening to crown remake. The study did not look specifically at the incidence of abutment screw loosening.

No attempt was made to distinguish between anterior and posterior SIR, even though one could assume that the vector of force is different. The reasons were that most of the studies did not specify the number of posterior versus anterior SIR and that the incidence of abutment screw loosening reported was extremely low. The same holds true for the possible effect of restorative implant platform diameter and method of crown retention. In the majority of included studies, implants with a regular-diameter restorative platform and cement-retained restorations were used. The method of reporting did not permit the statistical analysis of the possible effect of the aforementioned clinical factors on the incidence of abutment screw loosening.

CONCLUSION

The results show that abutment screw loosening is a rare event in SIR regardless of the geometry of implant-abutment connection, provided that proper antirotational features and torque are employed.

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