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Dental implants in patients with rheumatoid arthritis: clinical outcome and peri-implant findings

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Abstract

Purpose: Implant prosthodontic treatment outcomes for patients suffering from autoimmune rheumatoid arthritis (RA) with or without concomitant connective tissue diseases (CTD) were evaluated.

Material and Methods: Thirty-four female patients' (25 isolated RA; nine RA+CTD) implant survival/success rate, peri-implant conditions (marginal bone loss, pocket depth, plaque index, gingiva index and bleeding index) and incidence of prosthodontic maintenance were retrospectively evaluated.

Results: Implants evaluated presented a high implant survival (100%) and a 3.5-year success (93.8%) rate during the follow-up programme (mean 47.6 month) without difference between isolated RA (94.6%) and RA and concomitant CTD (92.3%), respectively. In isolated RA, acceptable marginal bone resorption (mean: 2.1 mm; SD: 0.5 mm), pocket depth (mean: 2.8 mm; SD:3.2 mm) and healthy soft-tissue conditions (plaque/bleeding/gingiva index Grade 0 in 80%) were noticed. However, patients with RA+CTD presented increased bone resorption (mean: 3.1 mm; SD: 0.7 mm) and more vulnerable soft-tissue conditions (higher bleeding index) differing significantly to patients with isolated RA ($p < 0.01$). Peri-implant parameters were significantly influenced by the patients' underlying disease (RA, RA+CTD; Kruskal–Wallis test, Jonckheere–Terpstra test).

Conclusions: In contrast to isolated RA, in RA patients with concomitant CTD, differences in the peri-implant parameters such as pronounced marginal bone resorption and bleeding may be anticipated and appear to be significantly influenced by the patients' underlying disease.

Key words: connective tissue disease; dental implants; rheumatoid arthritis

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Successful osseointegration and long-term maintenance of endosseous dental implants are influenced by implant–bone interface requiring continual bone remodelling. Initial dental implant osseointegration and post-insertion course are influenced by specific systemic or local oral conditions (Marco et al. 2005, Joos et al. 2006). According to various statements, patients suffering from local and/or systemic disorders are often considered to be at an increased risk for implant placement and asymptomatic osseointegration and successful post-insertion course (van Steen-berghe et al. 2002, Alsaadi et al. 2008). Oral hard as well soft tissue may be affected by systemic disease interfering with healing and being associated with an increased implant failure. Implant placement is often considered as being contraindicated in such patients and consequently they may also be excluded from dental implant therapy (Oczakir et al. 2005, Mombelli & Cionca 2006, Alsaadi et al. 2008) It is a well-known fact that failure of osseointegration is multi-factorial, dependent on anatomic conditions, systemic health, genetic disposition, immune function and behavioural factors (Vehemente et al. 2002, van Steenberghe et al. 2003).

Conflict of interest and source of funding statement

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Patients requiring special care because of rare systemic disease are those suffering from autoimmune diseases affecting the bone as well as soft-tissue structures (Oczakir et al. 2005, Mombelli & Cionca 2006). Thus, patients with rheumatoid arthritis (RA) and concomitant connective tissue disease (CTD) represent a population with autoimmune diseases affecting soft- and hard-tissue structures. These structures are of major interest for oral medicine and especially for dental implantology (Haugeberg et al. 2003, Pincus 2005, Costner & Grau 2006, Alsaadi et al. 2008, Haugeberg 2008).

RA represents a chronic inflammatory disease leading to arthritis, bursitis and tendovaginitis as a result of synovitis, which shows a progressive, but intermittent course eventually leading to joint destruction (Eder & Watzek 1999, Brosch et al. 2003, Haugeberg et al. 2003, Haugeberg 2008). RA is frequently accompanied by osteoporosis as a result of increased systemic bone turnover and anti-inflammatory and/or combined anti-immune treatment regimens. Clinically, haematology shows a marked increase of non-specific inflammatory parameters and en elevation of positive rheumatoid factors in 75% of the cases (Sontheimer & Kovalchick 1998, Brosch et al. 2003, Hueber et al. 2003).

Apart from isolated RA involving only bone and joint structures, autoimmune disease with RA characteristics can be present in conjunction with several kinds of CTD (e.g. Sjögren's syndrome). As a result of similarities in clinical symptoms, diagnosis and pathomechanisms, such as positive rheumatoid factors/inflammatory markers and autoimmune genesis, similar treatment modalities have been traditionally used for RA with and without concomitant CTD (Ostezan & Callen 1996, Sontheimer and Kovalchick 1998, Wu et al. 2007, Gilliam 2008, Krathen et al. 2008, Pan et al. 2008).

The current literature only includes few comprehensive studies or case reports for special care patients including RA patients and reporting on the beneficial effect of implant prosthodontics in oral rehabilitation (Payne et al. 1997, Isidor et al. 1999, Binon 2005, Mombelli & Cionca 2006, Alsaadi et al. 2008). In few articles, evident clinical improvement of oral mucosal complaints after implant placement and prosthodontic rehabilitation have been described in patients suffering from RA with CTD such as Sjögren's syndrome (Isidor et al. 1999, Oczakir et al. 2005). In general, there is a lack of detailed reports on patients with RA (with/without concomitant CTD) and their outcome of implant treatment procedures for prosthodontic rehabilitation.

The purpose of this study was to evaluate the impact of systemic autoimmune bone and soft-tissue disease such as RA on the survival and success rate of osseointegrated implants. The analysis was focused on demonstrating that autoimmune diseases such as RA should not generally be considered as absolute contraindication for dental implant placement and that differentiation between autoimmune RA diseases with and those without concomitant soft-tissue affection (differentiation of the underlying disease) may be essential for evaluating clinical implant-prosthodontic success.

Material and Methods

Patient and implant selection

In this retrospective clinical follow-up study, a series of patients with specific medical conditions was recruited. They all received submerged implants in the time between March 2001 and May 2008 for implant-based prosthodontic rehabilitation and the study population comprised 34 patients suffering from autoimmune disease such as RA. The study population included ($n = 34$) was part (4.7%) of a population of 714 patients receiving implant-prosthodontic rehabilitation treatment in this time period. According to patient charts, the study population included represented the complete number of patients with the target condition (RA). The study population could be further subdivided into patients suffering from isolated RA ($n = 25$) and into patients suffering from RA with concomitant CTD ($n = 9$).

Diagnosis of RA was based on the criteria of American Rheumatism Association (ARA), which were fulfilled by 34 patients (Pincus 2005, Costner & Grau 2006). CTDs were diagnosed as a concomitant disease together with RA ($n = 9$). Rheumatoid factors (positive in 31/34 patients), anti-nuclear antibodies (positive in CTD), C-reactive protein (reference standard: < 0.5 mg/dl) and other inflammatory markers provided specific diagnostic markers for both autoimmune disorders and have been listed in Table 1a and b (Ostezan & Callen 1996, Wu et al. 2007, Krathen et al. 2008; Pan et al. 2008).

Clinical presentation of CTD varied between Sjögren's syndrome, scleroderma and dermatomyositis and was also diagnosed by clearly defined general medical criteria (Pincus 2005, Costner & Grau 2006, Pan et al. 2008). Patients included received either no therapy at all (no therapy) or basic medical treatment such as non-steroidal anti-inflammatory drug(s) (NSAIDs) or treatment with glucocorticoids (GC) or a combination of both (NSAIDs+GC) (Table 1a and b). Distribution of medical treatments regimens for the underlying disease was similar in the RA (no therapy: 12%, NSAIDs: 16% and GC/GC+NSAIDs: 72%) and RA+CTD group (no therapy: 11%, NSAIDs: 11% and GC/GC+NSAIDs: 78%).

All patients (34 females; age: mean: 58.1 years; SD: 12.6 years) underwent implant surgery and prosthodontic treatment and were treated with screw-designed dental implants [Camlog®, Winsheim, Germany; root-line, promote surface (including 1.5 mm smooth collar)] placed, restored or removed by dentists (G. K.). An overall 126 implants of different lengths and diameters were placed with indications varying for different stages of edentulism ranging from single tooth gaps to complete edentulism. Seven of 34 (20.6%) patients [5/25 in isolated RA (20%); 2/9 in RA+CTD (22.2%, NS)] presented as smokers (10–15 cigarettes per day). At implant placement, no patients had signs of acute periodontitis and presented healthy periodontal conditions (Mombelli et al. 1987). All subjects were invited to participate in a follow-up examination carried out by clinicians in the dentist office. All participants had provided their written informed consent for follow-up examinations.

Prosthetic treatment

Two to 4 weeks after implant exposure, implant prosthetic treatment was performed using implants ($n = 126$) for single teeth ($8\times$), overdenture treatment ($4\times$), fixed partial dentures ($25\times$) and full-arch fixed denture ($5\times$) restorations (Table 1a and b). Single tooth crowns and fixed partial prostheses were made in metal-ceramic (gold alloy, titanium) or in full ceramic prostheses. Full-arch dentures were fabricated either of acrylic resin with a metal framework or of metal-ceramic design. Overdentures were supported by

bar retention on two implants in the mandible and supported by milled bars stabilized on six implants in the maxilla. Both overdentures were fabricated with metal-reinforced frameworks.

Implant and prosthodontic follow-up examination

All patients included were part of a regular recall programme and were placed on a strict follow-up programme and initially evaluated at intervals of 6 months, and thereafter at annual intervals. The recall programme included assessments of peri-implant marginal bone loss (mm) of implants initially placed in crestal level, pocket depth (mm), modified plaque index, gingiva index (GI) and bleeding index (BI) in addition to implant survival time (months).

Modified plaque index (score: 0–3; 0 = no visible plaque; 1 = local plaque accumulation; 2 = general plaque accumulation >25%; and 3 = abundance of plaque) was assessed according to Mombelli et al. (1987) and Salvi & Lang (2004). BI and GI were assessed using criteria defined by Mombelli et al. (1987) and Aspe et al. (1991) (BI: score 0–3; 0 = no bleeding; 1 = isolated bleeding spots; 2 = blood forms a confluent red line on mucosal margin; 3 = heavy bleeding; GI: 0–3: 0 = normal mucosa; 1 = minimal inflammation with colour change and minor oedema; 2 = moderate inflammation with redness, oedema and glazing; 3 = severe inflammation with redness, oedema, ulceration and spontaneous bleeding).

Marginal bone resorption for the implants was assessed radiographically using a digital imaging system (Orthophos XG^{Plus}, Sidexis, Siemens, Sirona Dental System, Bensheim, Germany). The radiographic evaluation included an orthopantomogram and single periapical radiographs based on the paralleling technique, where the reduction of the bone height level was determined in relation to the implant shoulder. For this purpose, the initial post-operative radiograph (baseline) was compared with the most recent one to calculate implant crestal bone level and the effective marginal bone loss as a result of the difference (Batenburg et al. 1998).

Peri-implant pocket depth was measured using the periodontal probe (Hu-Friedy, Chicago, IL, USA) on mesial, distal, lingual and buccal sides.

During the follow-up period, prosthodontic complications and repairs for the implant-supported restorations were registered (modified from Payne & Solomons 2000) according to the following events:

Table 1a Characteristics of patients ($n = 25$) with implant prosthodontic rehabilitation suffering from isolated rheumatoid arthritis (RA)

Patient #: age (years)	RA (years)	Rh-factor	C-reactive protein (mg/dl)	Implants	Prosthesis design	Follow-up month	Med.: NSAIDs	Med.: GC
#1: 62	31.0	+	1.2	Two Ma	OD	92	+	–
#2: 56	25.5	+	3.2	Four Ma	FD	66	+	+
#3: 53	19.5	+	2.2	Five Mx	FPD	43	+	+
				Two Ma	S (2 ×)	46	–	–
#4: 38	5.5	+	0.7	Two Ma	FPD	92	+	+
#5: 61	16.3	+	1.2	Four Ma	OD	33	+	+
#6: 32	0.5	+	4.7	One Ma	S	19	–	–
#7: 36	1.3	–	3.1	Three Mx	FPD	34	+	+
#8: 41	2.5	+	2.8	Three Mx	FPD	32	+	+
#9: 51	4.2	+	1.6	Four Mx	FPD (2 ×)	39	+	+
#10: 48	8.5	+	1.1	Four Mx	FPD	48	+	+
#11: 59	10.3	+	4.8	Three Mx	FPD	54	–	–
				Five Ma	FPD (2 ×)	62	+	–
#12: 62	37.5	+	2.8	Four Mx	FD	59	–	–
#13: 70	28.5	–	6.1	Four Ma	FD	60	+	+
#14: 29	4.0	+	3.8	Two Ma	FPD	28	+	+
#15: 34	3.5	+	2.2	Four Mx	FPD	30	–	+
#16: 38	0.5	+	0.6	Two Ma	S (2 ×)	64	–	+
#17: 41	2.0	+	0.9	Two Ma	FPD	90	+	+
#18: 68	17.0	+	5.1	Four Ma	OD	30	+	+
#19: 60	16.5	+	7.3	Four Mx	FPD	35	+	+
#20: 44	13.3	+	2.0	Three Mx	FPD	54	+	–
#21: 54	20.5	+	3.3	Four Mx	FPD (2 ×)	26	+	+
#22: 37	5.0	+	3.9	Four Mx	FPD	25	+	+
# 23: 28	2.8	+	4.8	One Ma	S	22	–	–
# 24: 36	6.0	–	4.0	Three Mx	FPD	32	+	+
#25: 30	1.0	+	2.1	Two Ma	S (2 ×)	42	–	+

Rh-factor, rheumatoid factor positivity; CRP, C-reactive protein (reference standard: 0–0.5 mg/dl); Ma, mandible; Mx, maxilla; FD, complete (full-arch) denture; FPD, fixed partial dentures; OD, overdenture; S, single implant tooth; Med., medication; NSAIDs, non-steroidal anti-inflammatory drug(s); GC: glucocorticoids.

Table 1b Characteristics of patients ($n = 9$) suffering from rheumatoid arthritis (RA) and concomitant connective tissue diseases (CTD)

Patient #: age (years)	RA (years)	CTD	Rh-factor	C-reactive protein (mg/dl)	ANA	Implants	Prosthesis design	Follow-up month	Med.: NSAIDs	Med.: GC
#1: 68	16.3	SJ	+	3.2	+	Six Mx	OD	96	+	+
#2: 62	20.4	DM	+	1.5	+	Two Mx	FPD	25	–	–
#3: 48	22.0	SJ	+	0.7	+	Three Mx	FPD	48	+	+
#4: 42	8.3	SJ	+	2.1	+	Four Mx	FPD	50	+	+
#5: 72	35.5	SJ	+	4.2	+	Eight Ma	FD	44	+	–
#6: 41	7.0	SJ	+	1.2	+	Three Mx	FPD	49	+	+
#7: 52	15.5	SJ	+	5.2	+	Four Mx	FPD	52	+	+
#8: 55	26.5	SJ/SK	+	3.8	+	Four Ma	FD	34	+	+
#9: 41	3.5	SJ	+	1.8	+	Seven Mx	FPD (2)	42	+	+

SJ, Sjögren's syndrome; SK, scleroderma; DM, dermatomyositis; ANA, anti-nuclear antibodies; CRP, C-reactive protein (reference standard: 0–0.5 mg/dl); Ma, mandible; Mx, maxilla; FD, complete (full-arch) denture; FPD, fixed partial dentures; OD, overdenture; S, single implant tooth; Med., medication; NSAIDs, non-steroidal anti-inflammatory drug(s); GC, glucocorticoids.

(1) implant component maintenance: implant loss/fracture, abutment screw loosening and screw/abutment/bar fracture;
(2) prosthesis (dentures) component maintenance: crown/fixed partial denture loosening [cement failure (temporary cementation with Temp-Bond, Kerr, Romulus, MI, USA)], ceramic fracture; matrix activation/renewed, overdenture teeth fracture/renewed, overdenture fracture, denture margin adaptation (reduction or relining), overdenture rebased and opposing prosthesis maintenance (fracture/rebased/remade).

Additionally, soft-tissue alterations such as the incidence of recession, fistulae and mucosal enlargement were assessed.

Concerning the implant outcome, cumulative survival and success rates were calculated for individual implants by means of life table analysis. Implants being in function (survivor) underwent evaluation using additional success criteria (Buser et al. 1990; Karoussis et al. 2004). Success criteria included: (1) absence of persistent complaints such as pain and/or dysesthesia, (2) absence of peri-implant infection with suppuration, (3) absence of mobility and (4) absence of pronounced peri-implant radiolucency around the implant determining extent of marginal peri-implant bone loss (Buser et al. 1990; Karoussis et al. 2004).

Patients' satisfaction and denture handling

All patients included were evaluated for their subjectively rated implant prosthodontic satisfaction and their possibility/capability of denture handling (insertion/removal of removable dentures and denture cleaning). A subjective score (1 = very easy, 2 = easy, 3 = moderate, 4 = difficult and 5 = very difficult) for cleaning/handling was obtained. Patients' subjective denture satisfaction was also scored using also a grading system [1–5; ranging from very satisfied (1) to not satisfied at all (5)]. The patients' stage of RA (Stages 1–4 according to ARA classification) was determined by the patients manual dexterity. The stage of RA corresponding to manual dexterity was compared and correlated with patient handling/cleaning possibility/capability (Grassi et al. 1998; Holsbeeck van et al. 1988).

Statistics

The parameters were tabulated and primarily evaluated in descriptive statistical manner. The groups (i.e. RA *versus* RA+CTD) were compared regarding the main parameters (marginal bone loss, pocket depth, plaque index, GI and BI) using the non-parametric Wilcoxon-rank sum test. Main parameters showing significant differences of both groups were tested in a Kruskal–Wallis test regarding therapeutic groups (''no therapy'' – ''NSAIDs'' – ''GC/GC+NSAIDs'') to test for equal distribution and in the Jonckheere–Terpstra test for increasing medians. In case of the latter, alternative hypotheses were formulated as (1) disease: RA < RA+CDT; (2) therapy: ''no therapy'' < ''NSAIDs'' < ''GC/GC+NSAIDs''. Cumulative success rates of both groups were compared using the log rank test. To compensate for multiple testing, *p*-values were Bonferroni corrected. A significance level of 0.05 was defined for all hypotheses.

Results

Implant survival/success rate

As a result of the strict recall procedure, 34 patients including 126 implants were available for follow-up examination after a mean of 47.6 months (SD: 18.9 months; range: RA: 19–92 months; RA+CTD: 25–96 months). No permanent dropouts for the recall were encountered, although temporary dropouts for the annual check-up were seen for various reasons (cerebral stroke, accident and sickness).

Patient characteristics such as the kind of autoimmune disease and type of implant prosthodontic restoration are presented in Table 1a and b. Patients' age (RA: 46.7 ± 13.0 years; RA+CTD: 53.4 ± 11.7 years) and duration of their underlying disease (RA: 11.3 ± 10.6 years; RA+CTD: 17.2 ± 10.2 years) and the follow-up examination period (RA: 46.6 ± 21.1 months; RA+CTD: 48.9 ± 19.7 months) did not differ between the group with isolated RA and the group with RA ± CTD (Table 1a and b). Significantly ($p < 0.01$) more implant prosthodontic rehabiliations were performed using fixed prostheses (single tooth: $n = 8\times$, FPD: $n = 25$, full-arch denture: $n = 8$) than with removable prostheses (overdentures: $n = 4$). In total, 85/126 (67.5%) implants were placed in RA patients with isolated RA and 41/123 (32.5%; Table 1a) were placed in patients with RA and concomitant autoimmune CTD (Table 1b). The concomitant CTD predominantly consisted of Sjögren's syndrome (7 ×) and only one case of dermatomyositis and Sjögren's syndrome+scleroderma. Previous or current medical therapy (NSAIDs/GC) has been summarized (Table 1a and b). Detailed implant characteristics with lengths and diameters used for the prosthodontic rehabilitation are presented in Table 2. Figure 1 shows a detailed distribution of 126 loaded implants (49 mandibular implants; 77 maxillary implants).

At the time of data collection for this retrospective study, all implants placed had been in situ (at least 1 year and up to 7 years) representing a cumulative implant survival rate of 100% (no loss). However, with regard to the success criteria defined, seven implants (three RA; four RA+CTD) did not fulfill success criteria (multiple reasons) presenting an overall success rate of 93.8%. Figure 2 presents the cumulative implant success rate using a Kaplan–Meier estimation. There were slight but insignificant differences in 3.5-year success rates between implants placed in RA (94.6%) and implants placed in RA and concomitant CTD (92.3%).

Peri-implant parameters and prosthodontic maintenance

Figure 3 provides peri-implant parameters [marginal bone resorption (mm), pocket depth (mm)] at the most recent examination for RA and RA with concomitant CTD. Table 3 presents

Table 2 Implant characteristics of patients with rheumatoid arthritis (± connective tissue diseases)

Diameter Length (mm)	3.8 mm *n* (%)	4.3 mm *n* (%)	5.0 mm *n* (%)	Total
11	–	1 (0.8)	2 (1.6)	3
13	12 (9.5)	21 (16.6)	10 (7.9)	43
16	46 (36.5)	18 (14.3)	16 (12.7)	80
Total	58 (46.0)	40 (31.7)	28 (22.2)	126

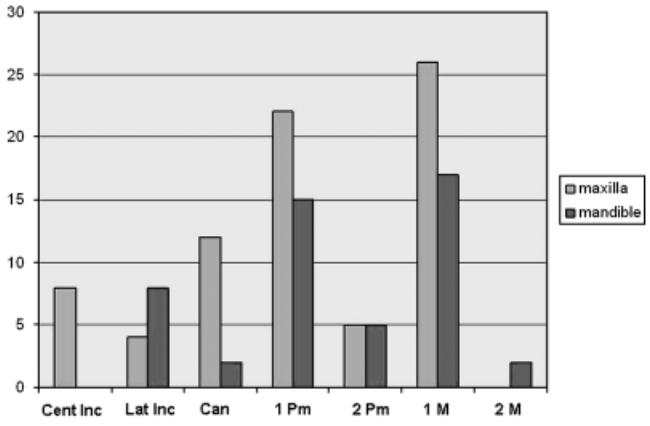

Fig. 1. Distribution of 126 loaded implants (47 mandibular implants; 79 maxillary implants) in patients ($n = 34$) suffering from autoimmune disease (RA+/−CTD).

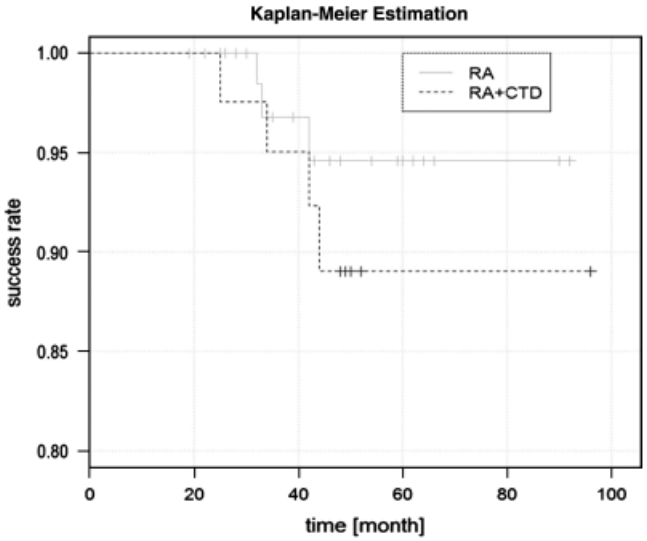

Fig. 2. Kaplan–Meier life table analysis for implants placed in RA and in RA+CTD.

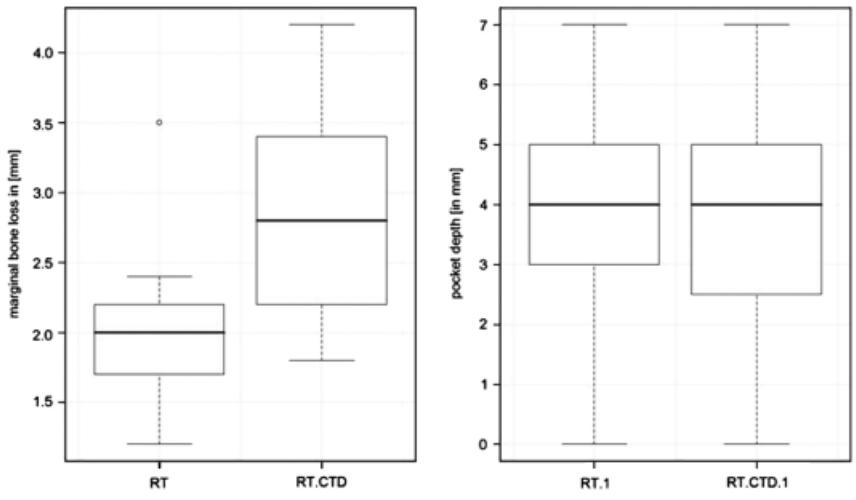

Fig. 3. Comparison of marginal bone resorption (Fig. 3a) and pocket depth (Fig. 3b) between RA and RA+CTD using box-plots.

soft-tissue peri-implant parameters of patients with RA and RA+CTD. PI, GI and pocket depth did not differ between the groups investigated (Wilcoxon-rank sum test; $p > 0.05$). Significant differences between isolated RA and RA+CTD were noticed for BI ($p = 0.0025$, adjusted $p = 0.0015$; Wilcoxon-rank sum test) and marginal bone loss ($p = 0.001$, adjusted $p = 0.001$,Wilcoxon-rank sum test). Figure 4 presents peri-implant marginal bone resorption of RA and RA+CTD in relation to the treatment modalities used for the underlying disease (''no therapy'' – ''NSAIDs'' – ''GC/GC+NSAIDs''). Detailed distribution of BI (Grades 0–3) for RA and RA+CTD in relation to therapy (''no therapy'' – ''NSAIDs'' – ''GC/GC+NSAIDs'') used is shown in Fig. 5. Additional tests (Kruskal–Wallis test, Jonckheere–Terpstra test) regarding the therapeutic effects on marginal bone resorption and on BI showed only a slightly significant influence ($p < 0.02$) of the therapeutic regimens on peri-implant marginal bone resorption.

The follow-up revealed that all prostheses could be maintained without major revision (remakes or significant changes). During the follow-up period, a total of 17 post-insertion interventions for the implant and prosthodontic components were noticed. Implant component maintenance included only abutment screw loosening [3 × (ST 2 × , FPD 1 ×)] but no implant, abutment or bar fracture. The most common post-insertion prosthesis component maintenance for the fixed or removable restorations was repair of fractured prosthesis teeth without any predominance of denture type [8 × teeth fracture (acrylic 6 × , porcelain 2 ×)]. The detailed distribution of evaluated post-insertion aftercare is shown in Table 4.

Patient satisfaction and denture handling/cleaning

All patients followed showed a high subjective satisfaction score with their implant prosthodontics (mean: 1.2; SD: 0.4; range 1–2). Manual dexterity (stage of RA) varied individually providing a wide range of RA staging (Stage 1: 42%, Stage 2: 46%, Stage 3: 12%, Stage 4: 0%; mean stage: 1.8; SD: 0.8). Scoring of denture handling and denture cleaning ability (mean: 2.1; SD: 0.7; range: 1–4) also presented a wide range. Stage of manual dexterity and denture handling/cleaning did not show a significant correlation for patients with RA (± CTD). But patients with removable denture ($n = 4$) showed significantly reduced data for handling/cleaning ability (score: mean: 3.2; SD: 0.6) *versus*

Table 3 Soft–tissue characteristics of implants ($n = 126$) in patients ($n = 34$) with RA or RA+CTD

	Plaque index				Bleeding index				Gingiva index			
	RA		RA+CTD		RA		RA+CTD		RA		RA+CTD	
	n	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%
Grade 0	69	81.2	32	78.0	71	83.5	24	58.5	70	82.3	32	78.1
Grade 1	13	15.3	7	17.1	13	15.3	6	14.6	15	17.7	9	21.9
Grade 2	3	3.5	2	4.9	1	1.2	11	26.8	0	0	0	0
Grade 3	0	0	0	0	0	0	0	0	0	0	0	0

RA, rheumatoid arthritis; CTD, connective tissue diseases.

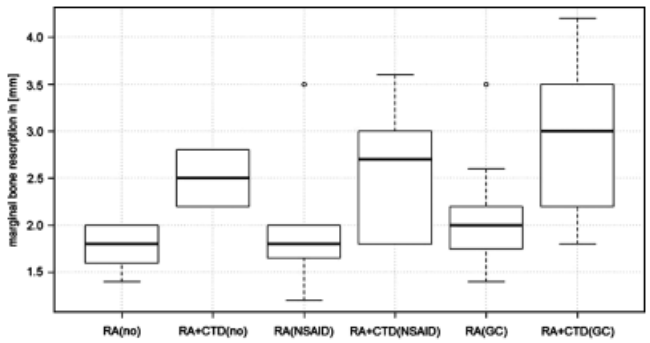

Fig. 4. Marginal peri-implant bone resoprtion in relation to rheumatic basis therapy. no, no therapy; NSAID, non-steroidal anti-inflammatory drug(s); GC, glucocorticosteroids.

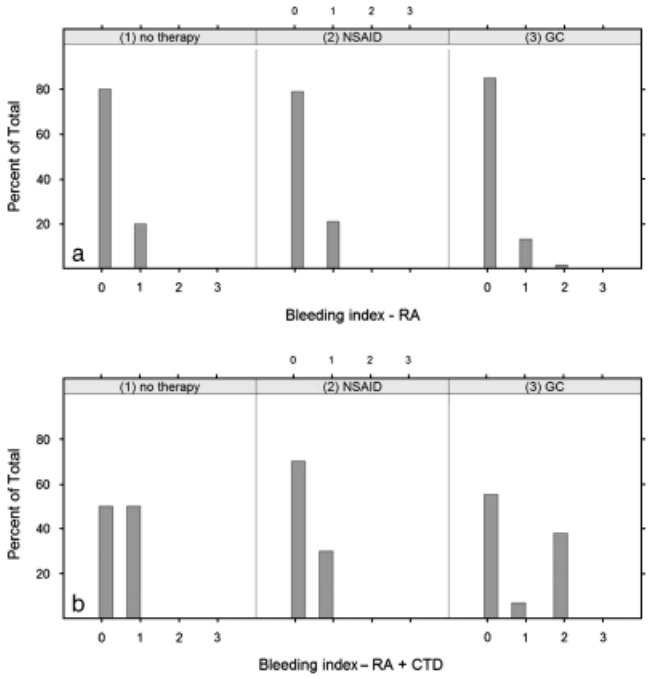

Fig. 5. Detailed distribution of bleeding index (grade 0–39 in relation to basis disease therapy). no, no therapy; NSAID, nonsteroidal anti-inflammatory drug(s); GC, glucocorticosteroids. For RA (Fig. 5a) and RA+CTD (Fig. 5b).

those with fixed restoration ($n = 30$; score: 1.8; SD: 0.3).

Discussion

Patients with RA with or without concomitant corticosteroid treatment will develop localized osteopenia and generalized osteoporosis in 30–50% of all cases (Raisz 1988, van Staa et al. 2006, Nakayama 2007, Haugeberg 2008). RA-associated bone loss and osteoporosis may develop very early and correlate directly with disease activity and also be associated with a negative impact on patient mobility at later stages (Callahan et al. 1997, Haugeberg et al. 2003, Chao et al. 2004, van den Berg et al. 2007).

Extensive use of corticosteroids and/or additional development of other endocrinopathies may induce or promote osteoporosis, which may be associated with a higher risk of bone fracture and prolonged healing periods following bone surgery (Callahan et al. 1997, Giannoudis et al. 2007). Pathogenetic co-factors such as corticosteroids reduce the intestinal calcium absorption and increase the renal calcium excretion resulting in a compensatory increase of release of parathyroid hormone (PTH) and an increased sensitivity of bone to PTH. Bone of RA patients is likely to show a higher bone turnover and an increased prevalence of osteoporosis by twofold is to be expected (Weng & Lane 2007, Briot & Roux 2008).

Although the relationship between skeletal and mandibular/maxillary bone mass is limited and only few correlations can be found (von Wowern et al. 1988), dental implant outcome has frequently been a topic of clinical interest for studies in patients with different types of induced osteoporosis (Dao et al. 1993, Mombelli & Cionca 2006, Scully et al. 2007, Alsaadi et al. 2008, Holahan et al. 2008). In separate studies, Friberg (1994) and van Steenberghe et al. (2002) reported acceptably high implant success rates for patients with osteoporosis induced by post-menopausal hormone deficiency or by corticosteroid use. Moreover, previous studies by Dao et al. (1993) and more recently by Holahan et al. (2008) provide only minor evidence for an association of osteoporosis of different causes and dental implant failure. The results of the present clinical study confirm that RA – which may be associated with osteoporosis – does not constitute a contraindication for implant therapy and was not associated with a higher implant loss rate than that seen for a healthy population without RA (Krennmair et al. 2010). As a limiting factor for the results obtained in the present study, it must be pointed out that the degree of osteoporosis in the RA patient population studied was not determined in detail using measurements with dual energy X-ray absorptiometry technique (von Wowern et al. 1988). However, the additional information obtained on the current or previous use of corticosteroids and/or immunosuppressant medica-

Table 4 Type of implant prosthodontic maintenance and complications in patients with rheumatoid arthritis (± connective tissue disease)

Implant component maintenance	
Implant fracture	0
Abutment screw loosening	3
Abutment fracture	0
Implant bar fracture	0
Prosthodontic component maintenance	
Crown/FPD loosening	2
Prosthesis teeth fracture	8
Acrylic/porcelain teeth fracture	6/2
Denture matrix activation/renewed	0
Denture margin adaption (reduction/relined)	4
Opposing prosthesis rebased/remade	0

tion may be helpful in establishing a clinical diagnosis of reduced bone quality (Mombelli & Cionca 2006). Therefore, the authors agree with the statement of Mombelli & Cionca (2006) that visual assessment of bone quality at a site considered for implantation may be more informative than bone mineral density measurements obtained in peripheral bone.

The use of a traditional healing period (3–6 months) – even for dental implants with surfaces (acid etched) showing accelerated osseointegration (Khang et al. 2001, Cochran et al. 2007) as recommended by Friberg (1994) for soft bone quality – resulted in high absolute success and survival rates for implants placed in RA patients (van Steenberghe et al. 2003, Oczakir et al. 2005, Alsaadi et al. 2008). In addition, detailed information of patients at risk regarding their underlying disease will provide them with high motivation in complying with a regular recall and maintenance programme. In this respect, aftercare was highly successful and helpful in establishing and ensuring optimal implant outcome including acceptable data for peri-implant parameters and implant prosthodontic results (Tolle 2008). The exclusive presence of female patients also confirms the general prevalence of RA and RA+CTD and provides for a patient population being well informed about their disease (Isidor et al. 1999, Oczakir et al. 2005).

Although the results of the present study showed that implant prosthodontic outcome was also excellent for the RA population with and without concomitant connective tissues diseases, a distinction between isolated RA and RA with concomitant CTD should be made. It is a well-known fact that clinical benefits and advantages of implant placement in conjunction with fixed prostheses were especially noted in patients suffering from CTD such as Sjögren's syndrome. Sjögren's syndrome predominantly affects the oral mucosa and consequentially the mucosal denture support (Payne et al. 1997, Isidor et al. 1999, Binon 2005, Samet et al. 2007). The problem of soreness of the oral mucosa in conjunction with removable mucosa-supported prostheses and dry-mouth sensation is well known and may constitute a particular problem for (elderly) patients that could be avoided or reduced by exclusive implant support of dentures (Payne et al. 1997). In separate studies, Binon (2005) and Isidor et al. (1999) described that the clinical benefit of purely implant-supported dentures was evident for patients with Sjögren's syndrome. In the present study, all patients with RA+CTD had all prostheses manufactured for a pure implant support [FPD/FD/OD with milled bars (see Table 1a and b)] so that none of the dentures was found to interfere with the vulnerable mucosa.

Although the implant success rate did not differ between RA and RA+CTD, some differences were noted for the peri-implant parameters. There was evidence that pericrestal bone resorption was more pronounced for implants placed in RA patients with Sjögren's syndrome. Sophisticated tests evaluating the therapeutic treatment regimens and the underlying disease entity demonstrated that the kind of underlying rheumatic disease will influence the peri-implant parameters (marginal bone resorption, BI) significantly. Differentiation of underlying disease (isolated RA *versus* RA+CTD) showed a highly significant impact on peri-implant parameters, while medical therapy showed only a minor impact on marginal bone loss only. According to these findings, the peri-implant marginal bone resorption as well as the pronounced BI may be explained by the pathogenesis of the underlying disease with a decrease of mucosal vascularization and a consequent reduction of bone nutrition also reflecting a tissue reduction (Kovács et al. 2000, Gunawardena et al. 2007, Kahaleh 2008, Mosca et al. 2009). Although hygiene parameters were acceptable as a result of the strict recall cleaning programme, patients with RA+CTD also showed a higher BI than patients suffering from isolated RA without concomitant CTD. Vulnerability of the soft tissue as a result of vascular involvement of the immune pathogenesis of connective tissue may also play a critical role for this pathomechanism (Kahaleh 2008, Mosca et al. 2009).

In general, no atypical pattern of prosthodontic complications and maintenance efforts was observed for implants and implant prosthodontics in RA with/without concomitant CTD. Only abutment screw loosening or denture margin adaptation for removable overdentures was predominantly observed (Payne et al. 1997). Most of the implant prosthodontic rehabilitation was performed with fixed prostheses to avoid soft-tissue trauma and keep prosthodontic maintenance to a minimum, which was also reflected by a high patient satisfaction score for the population studied (Eder & Watzek 1999; Isidor et al. 1999). It should also be mentioned that although manual dexterity is often reduced in RA patients (Stern et al. 1996, Waterhouse et al. 2005), this phenomenon did not appear to adversely affect the peri-implant or prosthodontic parameters for aftercare, especially for fixed dentures. However, according to the scores evaluated for removable dentures, the impaired manual dexterity may affect the peri-implant hygienic parameters (Bellamy et al. 2002, Tolle 2008). Advantages were noted for fixed dentures, suggesting that fixed solutions may be a more favourable treatment modality with regard to reduced/impaired manual dexterity and thus a factor for long-term implant stability. Nevertheless, it appears reasonable to suggest that the use of screw-type dental implant placement for patients with specific autoimmune disease can be successfully prescribed in systemically compromised patients provided that regular professional support and advice for optimal aftercare are followed.

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Clinical Relevance

Scientific rationale for the study: The clinical outcome and peri-implant findings for enosseal dental implants placed in patients with RA with/without concomitant CTD were evaluated.

Principal findings: A high implant survival and success rates were noticed for both isolated RA and RA+CTD patients. But peri-implant parameters such as bleeding index and marginal bone resorption differed significantly between patients with isolated RA and patients with RA+CTD, demonstrating differences between the different kinds of underlying disease.

Practical implications: Although the implant prosthodontic outcome was excellent, a distinction between isolated RA and RA with concomitant CTD should be made especially evaluating peri-implant parameters.