A 3-Year Retrospective Study of Cresco Frameworks: Preload and Complications

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ABSTRACT

Purpose: The aim of this retrospective clinical study was to evaluate the clinical outcome of fixed implant-supported complete prostheses on Astra or Brånemark implants when using either conventional cast frameworks or frameworks produced according to the Cresco Ti Precision method® (Cresco Ti Systems Sàrl., Lausanne, Switzerland).

Materials and Methods: Forty-six patients treated 3 years previously were divided into four groups according to implant system and framework design. Clinical examinations were performed and case records were scrutinized. The stability for each prosthesis retention screw was recorded as the torque profile and was monitored using the Osseocare® torque controller (Nobel Biocare AB, Göteborg, Sweden). Complications in association with implants and superstructures were registered. Patient opinions were recorded. The significance level was set to 5%.

Results: The Astra-Cresco group demonstrated a lower degree of prosthesis retention screw stability compared with the Astra group. No differences among the four groups were seen regarding plaque, bleeding on probing, or marginal bone resorption. The Brånemark group (Brånemark System®, Nobel Biocare AB) demonstrated more mechanical complications than the Brånemark-Cresco group. Mobile prostheses were found in the Brånemark and the Astra-Cresco groups. Fracture of veneer was seen in 20% of the prostheses and was more frequently found in the groups with mobile prostheses. Sixty percent of the prostheses showed reactions in the surrounding soft tissues. The most common reaction was mucosal proliferation. No differences were detected in the patients' opinions.

Conclusion: Within the limitations of this retrospective study, the following can be concluded: (1) compared with conventional frameworks, the Cresco distortion correction method does not provide a better clinical outcome after prosthesis connection in patients with fixed implant-supported complete prostheses; and (2) the two framework-producing methods behave differently on Astra implants compared with Brånemark implants concerning prosthesis retention screw stability, mechanical and biologic complications, and reactions in patients with fixed implant-supported complete prostheses.

KEY WORDS: complications, Cresco, dental implants, fixed implant-supported complete prostheses, prosthesis retention screw stability

During the last decades, the fixed implant-supported complete prosthesis (FISCP) has more and more frequently been used for treatment of the totally edentulous patient. Two of the implant systems with high success rates are the Brånemark System® (Nobel Biocare AB, Göteborg, Sweden) and the Astra Tech Dental Implant System® (AstraZeneca, Mölndal, Sweden).[1–5] Even though the results are generally good, various types of complications, such as biologic, mechanical, and acceptance, have been reported.[6–12] The causes of the complications have been explained in terms of the status of the patient, the surgical and prosthetic techniques, and the design and material of the different components of the implant system.[13–18]

The stability of the prosthesis retention screw (ie, the preload), depends on the fit of the screw joint, the tightening, and the external loading. Whether the fit of the FISCP to the implants influences the reported complications is a disputed question.[19–21] Misfit of the

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framework has been discussed in terms of the risk of fractures in implant and superstructure systems and reactions from the surrounding tissues, such as soft tissue proliferation, soreness, and fistulae.[19–21]

Conventional casting procedures for FISCP frameworks result in misfits between the frameworks and the implants owing to distortion.[22,23] One way to handle this problem is frameworks in gold alloys, which, after casting, are cut and soldered together. Laser welding of prefabricated titanium components, CAD/CAM procedures, and spark erosion or machine milling processes are other methods described.[24–26]

The Cresco Ti Precision method® (Cresco Ti Systems Sàrl., Lausanne, Switzerland) presents a partly new way of fabricating a metal framework, initially of titanium, for fixed implant-supported prostheses, with the aim of eliminating the unavoidable distortions created while casting the framework. This new method implies a horizontal sectioning of the cast framework. The coronal part of the framework is thereafter attached by a laser welding technique to new premachined cylinders mounted on a master cast. The coronal surfaces of the cylinders are cut in the same horizontal plane as the lower surface of the framework. According to the company, distortion problems can thereby be eliminated. Two published articles have described the method.[27,28]

One clinical study evaluating the clinical performance of the Cresco Ti Precision method has been presented.[29] Helldén and colleagues investigated the clinical and radiographic outcome in 60 partially or fully edentulous patients restored with Cresco implants and fixed prostheses fabricated according to the Cresco Ti Precision method in a 5-year prospective longitudinal study. Few mechanical complications were recorded. The authors attributed this to the passively fitting superstructures.[29] Oxby and colleagues made a clinical follow-up during 18 months of 29 single-tooth replacements on Cresco implants and customized abutments.[30] The test focused on mechanical complications. One prosthesis retention screw loosening was the only reported mechanical complication.[30]

TABLE 1 Number and Distribution of Fixed Implant-Supported Complete Prostheses

Group	A	AC	B	BC	Total
Upper jaw	8	7	8	7	30
Lower jaw	2	7	6	5	20
Total	10	14	14	12	50

A = Astra; AC = Astra and Cresco; B = Brånemark; BC = Brånemark and Cresco.

TABLE 2 Number of Patients and Age Distribution

Group	A	AC	B	BC	Total
Number of patients	9	12	14	11	46
Median age (yr)	59	73	70	71	70
Range (yr)	56–90	52–88	34–83	56–82	34–90

A = Astra; AC = Astra and Cresco; B = Brånemark; BC = Brånemark and Cresco.

The aim of this retrospective study was to compare the prosthesis retention screw stability (ie, preload) and the clinical outcome after prosthesis connection in patients treated with traditional frameworks versus frameworks produced with the Cresco Ti Precision method.

MATERIALS AND METHODS

Patients

All 118 patients who received FISCPs on Astra or Brånemark implants at the Department of Prosthetic Dentistry, Public Dental Service, St. Erik Hospital, Stockholm, during 1999–2000 were identified. Fifty-three patients with bone grafts, patients with a history of head or neck radiation treatments, and patients with remade or modified older FISCPs were excluded from the study, as well as patients who were not willing to have their FISCPs removed during the clinical examination.

The remaining 65 patients were offered a clinical examination, and the case records of those who participated in the clinical examinations were studied. The patients fit into four groups: patients with Astra implants and conventional FISCPs, patients with Astra implants and Cresco frameworks, patients with Brånemark implants and conventional FISCPs, and patients with Brånemark implants and Cresco frameworks (Table 1). The patients (excluding 19 dropouts; see below), 20 males and 26 females, were examined after a mean time of 42.7 months (range 36–49 months). The 46 patients were provided with one FISCP each except 4 patients, who were treated with maxillary and mandibular FISCPs. The median age of the patients was 70 years (range 34–90 years; Table 2). The distribution of the 276 implants is presented in Table 3.

TABLE 3 Distribution of Implants in Each Patient and Each Fixed Implant-Supported Complete Prosthesis

Implant	FISCP Number	R4	R3	R2	R1	L1	L2	L3	L4
Astra	3U		X	X	X	X	X	X	
(n = 57)	6U		X	X	X	X	X	X	
	7L			X	X	X	X		
	20U			X	X	X	X	X	
	23U		X	X	X	X	X	X	
	23L		X	X	X	X	X	X	
	27U			X	X	X	X	X	
	29U	X	X	X	X	X	X	X	X
	33U		X	X	X	X	X	X	
	44U		X	X	X	X	X		
Astra-Cresco	8L		X	X	X	X	X		
(n = 78)	17U		X	X	X	X	X	X	
	17L			X	X	X	X	X	
	18U		X	X	X	X	X	X	
	28L		X	X	X	X	X		
	34U		X	X	X	X	X	X	
	36U		X	X	X	X	X	X	
	37U		X	X	X	X	X	X	
	38L			X	X	X	X	X	
	41U		X	X	X	X	X	X	
	47L		X	X	X	X	X	X	
	48U		X	X	X	X	X	X	
	48L		X	X	X	X	X		
	49L		X	X	X	X	X		
Brånemark	1U			X	X	X	X		
(n = 76)	2U	X	X	X	X	X	X	X	X
	4U		X	X	X	X	X	X	
	10U		X	X	X	X	X	X	
	13U		X	X	X	X	X	X	
	14U		X	X	X	X	X	X	
	19U			X	X	X	X		
	26L			X	X	X	X	X	
	30L		X	X	X	X	X		
	35L			X	X	X	X	X	
	42U			X	X	X	X	X	
	43L		X	X	X	X	X		
	45L	X	X	X	X	X	X	X	
	50L			X	X	X	X		
Brånemark-Cresco	5L		X	X	X	X	X	X	
	12U		X	X	X	X	X	X	
(n = 65)	12L		X	X	X	X	X	X	
	16U		X	X	X	X	X	X	X
	21U			X	X	X	X		
	22L			X	X	X	X		
	25L		X	X	X	X	X		

Continued

TABLE 3 Continued

Implant	FISCP Number	R4	R3	R2	R1	L1	L2	L3	L4
Brånemark-Cresco	31U		X	X	X	X	X	X	
	32U		X	X	X	X	X	X	
(n = 65)	39U		X	X	X	X	X	X	
	40L			X	X	X	X		
	46U		X	X	X	X	X		

L = lower jaw; L1–L4 = first implant to fourth implant on the left-hand side of the midline; R4–R1 = fourth implant to first implant on the right-hand side of the midline; U = upper jaw.

Materials Used for the FISCPs

All FISCPs had acrylic veneers. In the Astra group, four of the frameworks were made of titanium and six of gold alloy. The Astra-Cresco group had all 14 frameworks made of titanium. In the Brånemark group, 11 frameworks were made of titanium and 3 of gold alloy. The Brånemark-Cresco group had titanium frameworks in all 12 FISCPs.

Prosthesis Retention Screw Stability

The torque profile for each FISCP retention screw was monitored using the Osseocare® torque controller (Nobel Biocare AB), a torque monitoring unit (DEC 600-0, Nobel Biocare AB), and a memory card (DEA 343-0, Nobel Biocare AB). A memory card reader (25865, Nobel Biocare AB) and the McRead® (Nobel Biocare AB) computer program were used for the analysis of the results, as described by Darwood.[31] The torque applied was measured as a function of the angular displacement of the screw, that is, loosening of stability.

Torque angle control analysis can be used to verify the clamping of a screw-retained joint. When a screw is tightened, the preload is responsible for keeping the joint closed. The preload is the compressive force acting across the joint. Almost all of the screw-tightening force applied counteracts the friction forces of the joint. A lesser part introduces the preload, that is, the elastic deformation of the joint.[32] The schematic curve in Figure 1 represents the curve achieved from the measurement at every single prosthesis retention screw on the display of the Osseocare equipment in this study. The initial, almost horizontal plateau in Figure 1 represents the screwdriver's initial rotation before it fits into the prosthesis retention screw slot. After the initial plateau, the schematic curve indicates that the torque

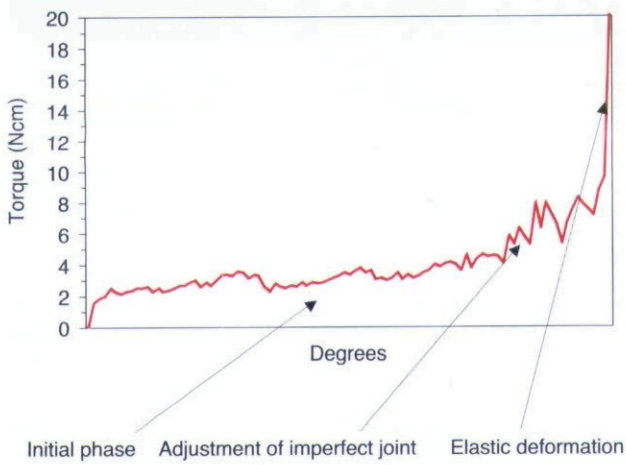

Figure 1 In the example below, after a nonlinear zone, owing to minor adjustments, a more linear zone corresponding to the elastic deformation of the joint is achieved.

increases and reaches a linear behavior. This linear part of the curve represents the elastic deformation of the joint. The zone where the curve leaves the initial plateau but has not yet reached the linear part represents adjustment of the imperfect joint. The estimated angular displacements in this study represent the adjustment zone and the elastic deformation zone.

The prosthesis retention screw fillings were removed, and one measurement was made at each prosthesis retention screw with the Osseocare equipment before the FISCPs were removed. The measurements were started with the first prosthesis retention screw on the right-hand side of the midline, followed by the first one on the left-hand side, the second on the right-hand side, and so on. One curve was achieved on the display from each measurement. The curves were printed, and the printings were read off three times independently of each other, and the mean value for these three readings was calculated.

For the human eye and at a distance of 25 cm, two points no closer than 100 μm from each other can be distinguished as individual points.[23] By using magnification lenses with ×2 magnification, one could expect a sensitivity of 50 μm at the same distance. The screws connecting the FISCPs to the implants with the largest pitch of thread in this study have a pitch of 0.4 mm. A gap of 50 μm between implant and framework, located by magnification lenses with ×2 magnification, can hereby correspond to an angular displacement of 45 degrees (360 degrees × 50 μm/0.4 mm). In our view, the 45-degree limit can be of clinical significance as a practical limit for acceptable loss of preload. Screw joints with an angular displacement of the FISCP retention screw of more than 45 degrees were therefore recorded as nonacceptable.

A torque level of 10 Ncm was used for the Astra group and the Brånemark group and 20 Ncm for the Astra-Cresco group and the Brånemark-Cresco group, according to the manufacturers' recommendations at the time of the FISCP delivery.

Error of the Method

As described above, the torque profile for each FISCP retention screw was monitored. One curve was achieved on the display from each measurement. The curves were printed, and the printings were read off three times independently of each other, and the mean value for these three readings was calculated. Twenty-five of the curves were randomly chosen for calculation of the error of the method. The standard deviation of the readings was calculated according to

$$SD = \sqrt{\sum d^2/2n}$$

where d is the difference between the first and the third reading and n is the number of readings.

Clinical Examination

The clinical examination of all patients was performed by the same dentist according to a protocol. In addition to what was registered at the clinical examination, complications described in the dental records were also registered if these complications occurred after the FISCP connection. The FISCPs were removed and replaced during the examination. In the protocol, the following parameters were registered:

- The presence or absence of plaque on the buccal, lingual, mesial, and distal surfaces of the abutments or frameworks penetrating the mucosa according to the visible plaque index, as suggested by Ainamo and Bay[33]
- The presence of bleeding in the marginal mucosa surrounding the mucosa-penetrating part of the constructions using a periodontal measuring probe (CP-12, Hu-Friedy, Chicago, IL, USA), which pressed the marginal mucosa vertically while itself being kept horizontal[34]
- Vertical or crater-shaped destruction of the periimplant bone according to intraoral or panoramic radiographs

- Biologic complications and reactions, such as implant loss, soft tissue proliferation, soreness, and fistulae
- Mechanical complications
- Adaptive complications expressed as patients' opinions on esthetics, phonetics, and patient comfort by using the visual analogue scale[35]

Statistics

Analysis of variance (ANOVA) was used to study the number of degrees necessary to tighten the prosthesis retention screws in each group and was also used when we compared groups and prosthesis retention screws in the different implant positions. If this ANOVA showed any significant differences, Tukey's test was applied to explore where the differences were to be found. Fisher exact test was used for the biologic and mechanical complications. The Kruskal-Wallis test was used for the visible plaque index and the presence of bleeding in the marginal mucosa. Descriptive statistics were applied for the patients' opinions. The significance level was set to 5%.

RESULTS

Dropouts

Six patients had deceased, six had moved to other parts of the country, and three were unwilling to participate in the study because of illness or old age. Four patients had to be excluded owing to technical complications with the measuring equipment during the registrations. Altogether, 71%, or 46 of the original 65 patients, participated in the study.

Prosthesis Retention Screw Stability

The mean values of the adjustment zone and the elastic deformation zone in the different combinations of groups and implant positions are shown in Figure 2. The Astra-Cresco group showed significantly higher values compared with the Astra group and the Brånemark-Cresco group ($p < .05$).

The Astra-Cresco group had significantly more screw joints with loss of prosthesis retention screw stability of more than 45 degrees than the Astra group ($p < .05$).

When we compared the four groups at each implant position, that is, the fourth to the first implant on the right-hand side of the midline and the left-hand side, respectively, no significant differences were found at six of the eight positions. Significant differences were, however, found at two implant positions. In the Brånemark group, the second implant on the right-hand side showed higher values than the corresponding implant in the Brånemark-Cresco group ($p < .05$). The third implant on the right-hand side in the Astra-Cresco group showed higher values than the corresponding implant in the Astra group ($p < .05$). But the number of implants varied among the patients. This meant, for example, that implant 3 on the right-hand side in some patients was the most posterior one; in others, it was the implant next to the most posterior

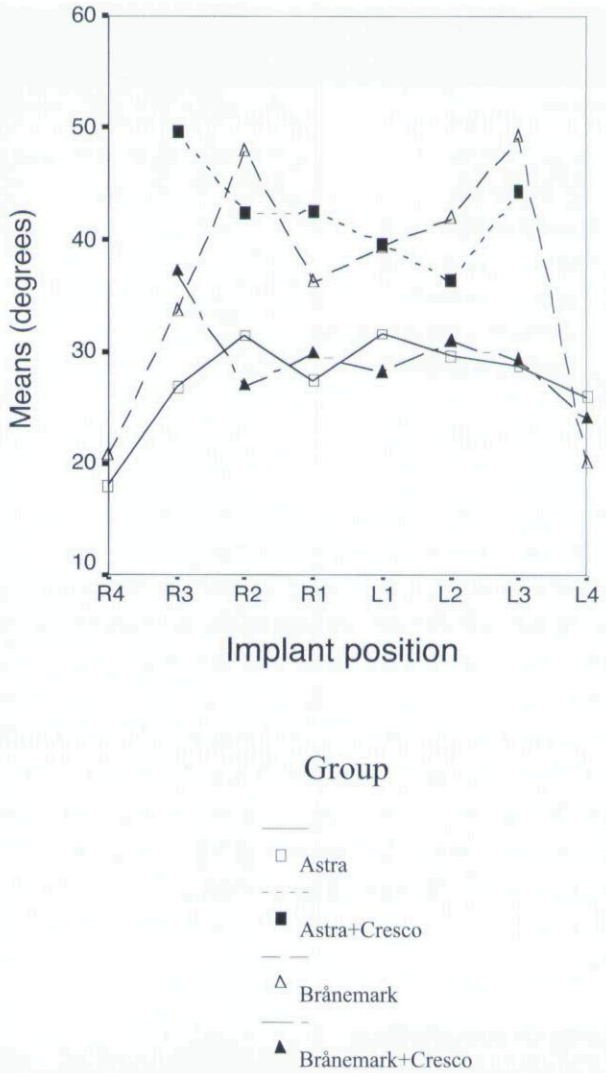

Figure 2 Mean values of the adjustment zone and the elastic deformation zone at different implant positions and in different groups. L1–L4 = first implant to fourth implant on the left-hand side of the midline; R4–R1 = fourth implant to first implant on the right-hand side of the midline.

TABLE 4 Plaque, Marginal Bleeding, and Bone Destruction at the Clinical Examination

Group	A	AC	B	BC	Total
Plaque (VPI %)	9.3	16.6	46.2	36.3	30.2
Bleeding in the marginal mucosa (%)	6.1	7.7	8.1	23.5	11.2
Vertical or crater-shaped periimplant bone destruction (% of implants showing a destruction)	14.1	11.1	1.2	6.2	7.6

VPI = visible plaque index.

one; and in some cases, it did not exist. We therefore

Plaque, Bleeding, and Marginal Bone Destruction

No statistical significant differences were recognized among the four groups concerning the presence or absence of plaque and bleeding and the percentage of implants showing vertical or crater-shaped destruction of the periimplant bone (Table 4). No differences could be seen whether the frameworks were made of titanium or gold alloy.

Mechanical and Biologic Complications and Reactions

No statistical significant differences in the distribution of complications and reactions during the studied period were detected among the four groups (Table 5)

TABLE 6 Patient Opinions on Esthetics, Phonetics, and Patient Comfort as Registered at the Clinical Examination

Group	A	AC	B	BC
Esthetics				
Median	98	92	94	87
Range	70–100	45–100	48–100	41–100
Phonetics				
Median	95	86	93	88
Range	80–100	50–100	56–100	40–100
Patient comfort				
Median	100	100	98	90
Range	88–100	70–100	55–100	39–100

A = Astra; AC = Astra and Cresco; B = Brånemark; BC = Brånemark and Cresco.
Visual analogue scale, 0–100.

shows that fracture of veneer appeared more frequently in the groups with mobile FISCPs.

The Astra group and the Brånemark-Cresco group had a significantly higher frequency of soft tissue reactions during the studied period compared with the Astra-Cresco group ($p < .05$). Proliferation of the periimplant soft tissues was the most common biologic reaction in all groups.

Patients' Opinions

The patients' opinions, expressed on visual analogue scales, are shown in Table 6. The Astra-Cresco group and the Brånemark-Cresco group showed a tendency toward lower phonetic values than the two other groups. Most patients reported that the phonetic problems vanished a few weeks after the prosthesis delivery. The esthetic and patient comfort values for the Brånemark-Cresco group showed a tendency to be lower than for the other groups.

DISCUSSION

The purpose of the present study was to compare the stability of prosthesis retention screws to implants in FISCP frameworks made by the Cresco technique or by the conventional casting technique and the clinical outcome after prosthesis connection.

Loss of stability of prosthesis retention screws, that is, loss of preload, can generally be caused by misfit, incorrect tightening, high loading, or a combination of these factors. Many steps are taken before the master cast can be made, and each of these steps influences the final fit of a future framework. Machining tolerance among the different implant system components leads to unavoidable gaps. For example, the discrepancy between impression copings and implants or abutments can be as large as 100 μm.[36] In the present study, new impression copings were used in the Astra-Cresco group and the Brånemark-Cresco group, but old and reused ones were used in the Astra and the Brånemark groups. This could have had an influence on the misfit. Distortion in the impression materials and expansion of dental stone during setting are other problems to handle.[37–40] Even if it is possible to manufacture a framework that fits acceptably to the master cast, it is quite another thing to avoid gaps in vivo.[41,42] It is also difficult to detect discrepancies, often subgingival, in vivo. Furthermore, a clinically acceptable framework fit can still induce a considerable amount of force acting between the implant and the prosthetic construction.[43] Patterson distinguished four qualities of fit.[44] If the mating surfaces are everywhere in contact without application of any external forces, we have a perfect fit. A passive fit is less than perfect, but application of any external forces to produce a perfect fit has a negligible effect on the implant-supported prosthesis. When external forces can produce a perfect fit, but the forces are detrimental to the performance of the prosthesis, Patterson refers to an active fit. If external forces cannot produce a perfect fit, he calls it a poor fit.[44] In brief, an absolutely passive framework fit to implants, that is, a perfect fit, is not achievable, and the acceptable misfit is unknown.[41,45]

As mentioned earlier, a gap of 50 μm between the FISCP framework and the implant can correspond to a loss of prosthesis retention screw stability, or angular displacement, of 45 degrees. Our study showed contradicting results when comparing the loss of prosthesis retention screw stability of Cresco frameworks with frameworks made by the conventional casting technique (see Figure 2). We generally found significantly higher values in the torque angle measurements of the Astra-Cresco FISCPs compared with the Astra FISCPs and the Brånemark-Cresco FISCPs. We also found significant differences, in some aspects, between the Brånemark group and the Brånemark-Cresco group. The loss of prosthesis retention screw stability in the single patient was probably caused by interacting factors, some known and others yet to be found. Although there were recommendations, we do not know the

exact torque used by the different prosthodontists at the time of prosthesis delivery. The Astra and the Brånemark concept and traditional framework manufacturing methods were well known to the prosthodontists and the dental technicians who treated the patients and made the frameworks. The Cresco system was a new experience to everyone involved. The Brånemark-Cresco system differs little from the Brånemark system because the impression copings are mounted directly to the implants. Apart from the Astra system, the Astra-Cresco system uses an insert in the marginal part of the implant before the impression coping is mounted on the implant. The application of the insert may complicate the impression procedure if one is not familiar with it but cannot explain the differences of screw loosening among the systems. As mentioned earlier, different machining tolerances among implant systems can be another factor influencing the final fit.

Burguete and colleagues stated that each screw joint needs its own torque to reach its optimum preload.[46] In our study, we used the same torque for all screw joints in an FISCP, as recommended by the manufacturers. Further more, Cantwell and Hobkirk reported that new prosthetic gold screws suffer a significant loss of preload over time.[47] Forty percent of the changes were seen within 10 seconds, but preload loss still occurred after 15 hours.[47] The optimum torques were thus not reached in the present study. Our conclusion is that no single factor can explain the differences of prosthesis retention screw stability among the four groups in the present study.

No differences were found among the four groups in our study regarding visible plaque and bleeding on probing. The mean plaque index was 30.2% (see Table 4) and is considered to be high. Median plaque indices of 2 to 15% after 3 years were reported in a prospective comparative study of Astra and Brånemark implants.[5] Arvidsson and colleagues found an absence of plaque on 80% of the measured surfaces in a 5-year prospective follow-up report of Astra implants in edentulous mandibles.[3] Our method of recording bleeding on probing, with the probe kept horizontal and the pressure vertical, can probably give a lower bleeding on probing value. The reason for using this method was to avoid interfering with the mucosal attachment to the mucosa-penetrating part of the constructions by causing bleeding by trauma. In a prospective 5-year multicenter study of the Cresco implantology concept, Helldén and colleagues used mesial and distal pressure by interdental brushes of the implants and finger pressure buccally and lingually to register periimplant tissue bleeding.[29] They found 15% of the mucosa bleeding.[29] The mean value for bleeding on probing in our study was 11.2%. Two other studies reported bleeding indices of 0 to 0.7%.[3,5]

The clinical importance of traditional clinical periodontal parameters as predictors for changes in periimplant bone height is yet unproven.[48] Changes in periimplant bone levels were not measured in this study. Different radiographic methods had been used at the baseline examinations, and the measuring faults were considered to be too high to allow bone-height comparison. Brägger concluded that measurements of periimplant bone levels are of limited value for scientific documentation unless sophisticated methods are used.[49] The present study just reported the presence or absence of vertical and crater-shaped destruction in the periimplant bone. No statistical significant differences among the four groups were found, which was confirmed by Engquist and colleagues.[5]

The influence of misfit on mechanical complications is unclear. Taylor and colleagues found some evidence between prosthesis misfit and prosthetic complications.[50] Another study stated that even though it seems logical in theory that complications can result from framework misfit, scientific evidence is still lacking.[51] In our study, the Brånemark group had a significantly higher frequency of framework fractures, screw fractures, and screw loosening according to the dental records (33.3%) compared with the Brånemark-Cresco group (0%). The latter group had, in some aspects, lower torque angle values as measured with the Osseocare equipment than the former group. This can be one explanation for the differences in mechanical complications. Another reason for these results can be the differences in the screw joints: gold screws versus titanium screws, various screw dimensions, or different torque levels.[46] In a 1-year follow-up study of FISCPs in 391 jaws with Brånemark implants, Jemt reported that 69.3% of the FISCPs were stable 2 weeks after FISCP insertion.[6] Almost all of the retightened gold screws showed stability at the second checkup 3 months after insertion.[6] In the present study, a high number of FISCPs in the Brånemark group, 26.7%, demonstrated mobility after 3 years. The causes of these results can be misfit and low preload in the prosthesis retention screw joint.

Clenching and high chewing forces can be other factors involved. High loading can be one of the main reasons for the fact that fracture of veneer was more frequently found in the groups with mobile FISCPs.

The Astra-Cresco group showed significantly higher torque angle values compared with the Astra group, but no differences were found concerning mechanical complications. The higher values for the former group can indicate a greater misfit, but this misfit was probably compensated by higher torque and consequent preload. A higher preload reduces the risks of screw loosening and screw fractures.[52] Since up to 90% of the applied torque can be needed to overcome the friction problems in a screw joint, one cannot solve the problem of loss of prosthesis retention screw stability just by increasing the torque.[32] Twenty percent of the FISCPs in this study had veneer fracture during the 3 years of follow-up, which is similar to the results reported by Göthberg and colleagues.[12]

Misfit among implants, abutments, and frameworks has been regarded as one reason for soft tissue reactions.[10] In the present study, however, the Astra group and the Brånemark-Cresco group had a significant higher degree of soft tissue reactions than the Astra-Cresco group, the group with the highest values for Osseocare-measured loss of prosthesis screw stability (see Table 5 and Figure 2). Probably the differences in loss of prosthesis screw stability were too small to influence the degree of soft tissue reactions. Since the vast majority of FISCPs and implants survive, the periimplant tissues can obviously tolerate a certain degree of misfit.[53] Sixty percent of the FISCPs in our study had a history of soft tissue reactions, but only 1 implant of 276 was lost during the follow-up period (see Table 5). Esposito and colleagues discussed and described the soft tissue reactions around Brånemark implants with late failures.[54] They concluded that failed implants were surrounded by chronic inflammatory soft tissues and that hyperplastic tissues around stable implants, which many patients with soft tissue reactions in our study had, were distinguished by an acute inflammatory process, a process unlikely to be the etiologic factor for late implant losses. In a 3-year retrospective study, 20 cases of soft tissue reactions leading to dental visits in a group of 75 patients were reported.[12] Like Göthberg and colleagues,[12] we scrutinized the dental records, but we also made a clinical examination with the specific aim of searching for complications and reactions. This can be one of the reasons why our figures are so much higher.

Can the material in the mucosa-penetrating part of the constructions influence the tissue response? In an interesting beagle study, Abrahamsson and colleagues showed that abutments made of commercially pure titanium or ceramic allowed the formation of a mucosal attachment.[55] If the abutments, on the other hand, were made of gold or dental porcelain, the soft tissue margin receded to the implant and bone resorption took place. No difference between titanium or gold alloy frameworks concerning this issue was demonstrated in our study.

When the patients gave their opinions on the esthetics, phonetics, and comfort of the prosthetic constructions, no significant differences among the groups of patients could be seen. Esthetic problems were more common among patients with high expectations of the treatment. Earlier studies have demonstrated that adaptation depends to a large degree on how well the patient's needs and wishes have been met by the given treatment.[56,57] As for phonetics, Köndell and colleagues found it to be the most frequent complication in patients with FISCPs.[58] In our study, most patients reported that the phonetic problems vanished within a few weeks after delivery of the prostheses.

Some questions have been answered by this study, but others still remain:

1. If superstructures and the screw joints are made stronger, will the number of mechanical complications decrease?
2. Will the superstructures lose their alleged shock-absorbing potentials[59]?
3. If so, will this result in negative effects on the implant tissue interface in the long run (ie, will there be an increasing number of late implant failures)?

Further studies, both prospective and longitudinal, are necessary to answer these questions.

CONCLUSIONS

Within the limitations of this retrospective study, the following can be concluded:

1. Compared with conventional frameworks, the Cresco distortion correction method does not provide a better clinical outcome after prosthesis connection in patients with FISCPs.

2. The two framework-producing methods behave differently on Astra implants compared with Brånemark implants concerning prosthesis retention screw stability, mechanical and biologic complications, and tissue reactions in patients with FISCPs.

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