

Ten-year survival rates of fixed prostheses on four or six implants ad modum Brånemark in full edentulism

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A series of 156 consecutive fully edentulous patients were rehabilitated by means of fixed prostheses on either 4 or 6 screw-shaped titanium implants. This retrospective study calculated survival rates for both prostheses and individual implants. Only patients with a 10-year follow-up were considered. The implant lengths were 10 (90%) or 7 mm. They were all inserted after pretapping. In the mandible 13 and 59 prostheses were installed on respectively 4 and 6 implants. In the upper jaw the respective numbers were 14 and 70. Both groups (4 versus 6 implants) were age- and gender-matched. A reduced jaw bone volume was the major reason for limiting the number of implants to 4. Although a tendency existed for an increased failure rate in patients with only 4 implants, the survival rate for both individual implants and prostheses was the same in both groups at the end of the 10-year observation period. The present tendency of some clinicians to install as many implants as possible in full edentulism should be seriously questioned.

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Denture function in edentulous patients is often inadequate (Kerschbaum 1993). A large variety of surgical approaches involving bone grafts or osteotomies have been proposed in a more or less trial-and-error fashion (De Koomen 1982; Sugar & Hopkins 1982). The well-documented long-term results of fixed prostheses on two-stage pure titanium screw-shaped oral implants developed by Brånemark has offered a reliable treatment alternative since the 1980s (Breine & Brånemark 1980; Adell et al. 1981). More recent studies indicate that, after a learning curve, results significantly improve (van Steenberghe et al. 1987; Albrektsson et al. 1988; Adell et al. 1990), in centers with a team approach and stringently defined surgical and prosthetic guidelines.

Thus, cumulative survival rates for individual implants reach respectively 95% and 90% for the lower and upper jaw. For fixed prostheses, cumulative survival rates above 95% are reported for both jaws.

Although the reported success rates for fixed prostheses in edentulous patients are similar whether 4 or 6 implants are used (Adell 1985), there is a growing tendency to install as many implants as possible (Bahat 1993). This is due to an undue simplification of the biomechanics of tissue-integrated endo-prostheses, where healing time, degree of mineralization and bone turnover at the interface are difficult to quantify (Roberts et al. 1984; Skalak 1985). The loading capacity cannot be reduced to the amount of bone-implant contact surface.

This study consists of a retrospective analysis of a series of consecutive patients fully edentulous in 1 or 2 jaws who were rehabilitated by means of either 4 or 6 two-stage pure titanium screw-shaped implants. All patients had received implants at least 10 years ago. The hypothesis was that the same survival rate would be obtained whether 4 or 6 implants were used to sustain the fixed prosthesis.

Material and methods

The study was performed on 156 patients who were all surgically treated by one surgeon (PIB) between 1968 and 1978. The prosthetic treatment was performed following a homogenous protocol during this entire period. Both the surgical and prosthetic protocols are extensively described elsewhere (Adell et al. 1985; Zarb & Jansson 1985). The patient's age, gender, time length of edentulism, degree of resorption and the bone quality of the jaw treated, state of the antagonistic jaw and number of inserted implants can be found in Table 1. The degree of bone resorption and of bone quality were read from the available preoperative orthopantomograms according to the classification system proposed by Lekholm & Zarb (1985).

Ninety percent of the installed implants had a 10 mm length, the rest being 7 mm. All implants had morphology that became later known as the standard Brånemark System® (Nobelpharma, Göteborg, Sweden). This means that all insertion sites had to be pre-tapped before the fixtures were installed. These insertion sites were disposed in an archwise fashion between the two maxillary sinusses or in between the two mental foramina. The decision to install either 4 or 6 implants was taken by the surgeon on the basis of the available space. Whenever possible, 6 implants were installed (Fig. 2).

After a healing time of 3–4 and 5–8 months in the lower and upper jaws respectively, abutment surgery took place. In the following weeks a fixed prosthesis was screwed on top of the abutments.

Table 1. Patients' characteristics according to the number of inserted implants

	Upper jaw		Lower jaw	
	4 Implants	6 implants	4 Implants	6 implants
Patients	14(56)[11] 13	70(420)[91] 64	13(52)[6] 13	59(354)[24] 59
Male	6(24)[6]	28(162)[35]	6(24)[2]	16 (96)[3]
Female	8(32)[5]	42(258)[56]	7(28)[4]	43(258)[21]
Implant length				
10 mm	(50)[8]	(389)[76]	(51)[6]	(51)[6]
7 mm	(6)[3]	(31)[6]	(1)[0]	(0)[0]
Antagonistic jaw				
Full denture	1 (4)	–	10(40)[6]	41(246)[17]
Implant prosthesis	3(12)[3]	18(108)[34]	2(8)	14 (84)[6]
Teeth	3(12)[7]	24(144)[30]	1(4)	1 (6)
Bridge on teeth	1 (4)	14 (84)[18]	–	1 (6)
Removable prosthesis on teeth	6(24)[1]	14 (84)[9]	–	2 (12)[1]
Bone quality*				
1	–	–	–	–
2	–	–	7(28)[4]	29(174)[23]
3	9(36)[5]	43(258)[43]	6(24)[2]	26(156)[1]
4	5(20)[6]	27(162)[48]	–	4 (24)
Jaw anatomy*				
A	–	–	1 (4)	3 (18)
B	–	11 (66)[10]	4(16)[2]	17(102)[3]
C	5(20)[4]	37(222)[36]	4(16)[1]	25(150)[6]
D	9(36)[7]	20(120)[39]	4(16)[3]	14 (84)[15]
E	–	2 (12)[6]	–	–
Age (years)				
20–40	3(12)	18(108)[10]	1 (4)	4 (24)[3]
40–60	8(32)[11]	38(228)[70]	6(24)[3]	4(240)[18]
60–80	3(12)	14 (84)[11]	6(24)[3]	15 (90)[3]
Time of edentulism				
0–1	–	6 (36)[5]	3(12)	10 (60)[2]
2–5	3(12)	18(108)[18]	1 (4)	13 (78)[4]
6–10	–	12 (72)[21]	2 (8)[2]	7 (42)[6]
>10	11(44)[11]	34(204)[47]	7(28)[4]	29(174)[12]

*=Lekholm & Zarb (1985).

()=number of inserted implants.

[]=number of lost implants.

Bold=number of patients with a stable prosthesis after 10 years.

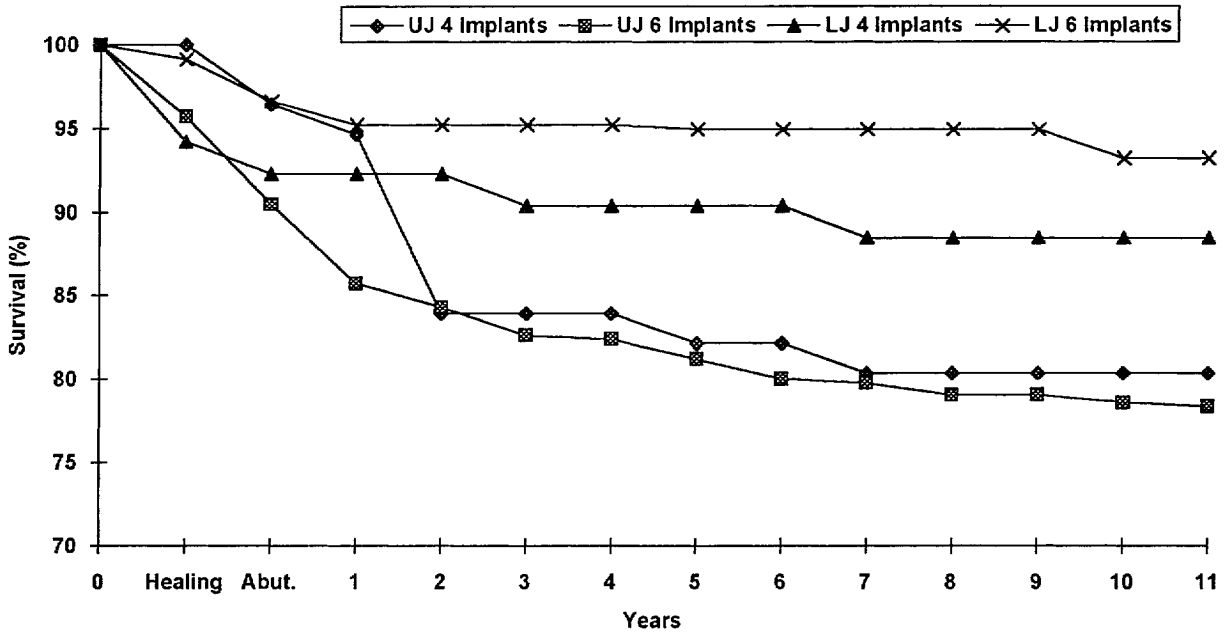


Fig. 1. Annual survival rates for individual implants belonging to either the 4 or 6 implants prostheses groups in the upper and lower jaws. Calculations were made from time of fixture placement.

These prosthetic suprastructures were all made of gold with an acrylic veneering on top of them. The distal cantilever length as read from the orthopantomograms was 1–35 mm and 3–40 mm for the upper and lower jaws respectively.

The assessment of individual fixtures was done at annual controls, but prostheses were only removed if complications occurred. Intraoral control radiographs were taken at abutment connection time and annually up to 10 years of follow-up. Any marginal bone loss of more than 1 mm after the first year of occlusal loading or patient complaints concerning one of the implants led to removal of the prosthetic suprastructure to check individual

implant stability. The slightest mobility – as determined by rocking or tapping the abutment back and forth in between two instrument handles – led to immediate implant removal.

This report defines survival rate as the percentage of load-bearing implants that do not demonstrate symptoms of pain, mobility or infection. Using life table statistics, cumulative survival percentages are calculated for the 4 groups considered (upper and lower jaws, 4 or 6 implants). The null hypothesis tested by means of a non-paired *t*-test was that the long-term survival rate of fixed prostheses was not influenced by the number of supporting implants.

Results

The two treatment modalities were compared in the lower jaw; all installed prostheses remained stable after 10 years, independent of the number of installed implants (4 or 6). Except for some repairs of the veneering material, loosening or fractures of the gold screws that connect the prostheses with the abutments, no complications occurred. In the upper jaw, 1 of the 14 prostheses supported by 4 fixtures was lost, whereas this happened in 6 of 70 prostheses on 6 fixtures. The loss of these prostheses was loss of osseointegration and/or fracture of the supporting implants.

The survival rates for individual implants in the lower jaw were 88.4% and 93.2% for prostheses on 4 or 6 implants. The respective figures for the

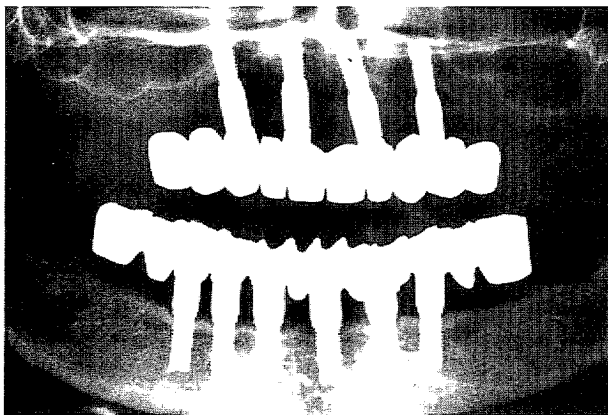


Fig. 2. Patient treated with 4 implants in the upper jaw and 6 implants in the lower jaw.

upper jaw were 80.3% and 78.3% (Fig. 1). Thus, the null hypothesis was accepted ($P > 0.05$). If one considers loss of fixture(s) patientwise for the two treatment modalities, in the upper jaw, 8 of 13 patients with prostheses on 4 fixtures and 26 of 67 patients with prostheses on 6 fixtures lost one or more implants. For the lower jaw, these figures were respectively 5 of 14 and 11 of 59. Although there was a significantly increased risk for a patient to lose one or more implants when only 4 instead of 6 are installed to support a fixed prosthesis, the probability of maintaining the latter functional at the end of a 10-year period was equal in both groups.

Table 1 reports the distribution of failures according to the available bone quality and quantity. The number of failed 7-mm implants can also be distinguished. There seems an increasing risk of failure with reduced bone height. Anamnestic factors such as smoking habits or surgical aspects such as dehiscences or fenestrations could not be analyzed.

Discussion

When treatment results of edentulism by endosseous implants are evaluated, their numbers are mostly not considered as a variable (Ahlqvist et al. 1990). This is surprising if one considers the costs – hardware and time for surgery – involved for the surgeon and patient. This study encourages clinicians to evaluate this factor more carefully in treatment planning. If a limited arch length remains in between anatomical landmarks, 4 endosseous implants seem sufficient to carry a fixed prosthesis. Indeed, even if patientwise the incidence of individual implant failures for prostheses on 4 implants in the upper jaw is increased, the excellent long-term survival of the prosthesis calls for reappraisal of the optimum number of implants to be used. There is definitely no argument to increase the number of implants unduly once a minimum of 4 can be installed. Especially in the upper jaw, where there is an increased tendency to install more implants in the molar areas by the use of sinus inlay grafts, the implications of such more demanding surgery should be weighed with the good long-term results presented here.

Of course, according to theory, the fraction of an applied bite force on a dental prosthesis that is transmitted to a particular fixture is generally less when 6 fixtures are used in comparison to 4 (Brunski & Skalak 1992). But this does not necessarily translate into a clinical advantage. Since osseointegrated implants can help maintain a proper bone height by giving a positive stimulus to bone remodeling (Hoshaw et al. 1994), the optimum num-

ber of implants might also depend on such factors as stress shielding (Huiskes & Hollister 1993).

The use of an increased number of implants also means an increased risk of failure or complications from a purely statistical point of view. This logic was not followed here since, from a clinical viewpoint, patient-related statistics are more meaningful. Then, the higher risk of implant loss when only 4 are installed implies a new surgical intervention to reach the minimum number of abutments. This agreement is clinically highly relevant.

One can conclude that, for the implant system investigated, the number of implants of 10 mm used for a planned full arch reconstruction can be either 4 or 6. Prostheses on such artificial abutments can be maintained for a decade and more with high predictability.

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Résumé

156 patients totalement édentés ont reçu des prothèses fixes placées sur 4 ou 6 implants en titane vissés. Cette étude rétrospective a eu pour but de calculer le taux de survie tant des prothèses que des implants individuels. Seuls les patients qui avaient leurs prothèses *in-situ* depuis dix années ont été pris en considération. Les longueurs d'implants étaient de 10 (90%) ou 7 mm. Ils ont tous été placés après taraudage. Dans la mandibule 13 et 59 prothèses ont été installées sur 4 et 6 implants, respectivement. Au niveau du maxillaire supérieur ces nombres étaient de 14 et 70. Les deux groupes (4 versus 6 implants) étaient équivalents du point de vue âge et sexe. Un volume osseux réduit représentait la raison majeure limitant le nombre d'implants à 4. Bien qu'il y ait une tendance à l'augmentation du taux d'échecs lorsque seulement 4 implants avaient été insérés, le taux de survie tant pour les implants individuels que pour les prothèses était le même dans les 2 groupes à la fin de l'observation de 10 ans. La tendance actuelle de certains cliniciens à installer autant d'implants que possible chez les édentés complets devrait donc être sérieusement remise en question.

Zusammenfassung

Eine Serie von 156 vollständig zahnlosen Patienten wurde mit festsitzenden Rekonstruktionen auf entweder 4 oder 6 Implantaten rehabilitiert. Diese retrospektive Untersuchung berechnete die Überlebensrate sowohl für die Rekonstruktionen als auch für die einzelnen Implantate. Nur Patienten, welche über einen Zeitraum von 10 Jahren beobachtet werden konnten, wurden in die Untersuchung miteinbezogen. Die Längen der Implantate betragen 10 mm (90%) oder 7 mm. Alle Implantate wurden eingesetzt, nachdem zuvor ein Gewinde vorgeschritten wurde. Im Unterkiefer wurden 13 Rekonstruktionen auf 4 Implantaten bzw. 59 Rekonstruktionen auf 6 Implantaten eingegliedert. Im Oberkiefer wurden 14 Rekonstruktionen auf 4 Implantaten bzw. 70 Rekonstruktionen auf 6 Implantaten befestigt. Individuen beider Gruppen (4 gegen 6 Implantate) wurden gemäss Alter und Geschlecht einander zugeordnet. Ein beschränktes Volumen an Kieferknochen war der Hauptgrund

für die Eingliederung von lediglich 4 Implantaten. Obwohl eine Tendenz für eine erhöhte Misserfolgsrate bei Patienten mit nur 4 Implantaten bestand, war die Ueberlebensrate sowohl für die einzelnen Implantate als auch für die Rekonstruktionen am Ende der zehnjährigen Beobachtungsperiode in beiden Gruppen dieselbe. Die heutige Einstellung von manchen Klinikern, bei zahnlosen Patienten so viele Implantate wie möglich zu setzen, sollte ernsthaft in Frage gestellt werden.

Resumen

Se rehabilitó una serie de 156 pacientes consecutivos totalmente edéntulos por medio de prótesis fija sobre 4 o 6 implantes de titanio con forma de tornillo. Éste estudio retrospectivo calculó la tasa de supervivencia para ambas prótesis e implantes individuales. Solo se consideraron pacientes con un seguimiento de 10 años. Las longitudes de los implantes fueron de 10 (90%) o 7 mm. Se insertaron todos después del pretapping. Se instalaron en la mandíbula 13 y 59 prótesis en 4 y 6 implanta respectivamente. En el maxilar superior los números respectivos eran 14 y 70. Ambos grupos (4 contra 6 implantes), donde edad y género se correlacionaron. La principal razón para limitar el número de implantes a 4 fue un volumen óseo mandibular reducido. Aunque existió una tendencia para un aumento de la tasa de fracaso en pacientes con sólo 4 implantes, la tasa de supervivencia para implantes individuales y prótesis fue el mismo en ambos grupos al final de los diez años de período de observación. La presente tendencia de algunos clínicos a instalar tantos implantes como sea posible en edentulismo completo se debe cuestionar.

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