

Case report

A 41-year history of a mandibular subperiosteal implant

Schou S, Pallesen L, Hjørting-Hansen E, Pedersen CS, Fibæk B. A 41-year history of a mandibular subperiosteal implant.
Clin Oral Impl Res 2000; 11: 171–178. © Munksgaard 2000.

**Søren Schou^{1,3}, Lars Pallesen¹,
Erik Hjørting-Hansen^{1,3},
Carsten S. Pedersen²,
Bent Fibæk⁴**

¹Departments of Oral & Maxillofacial Surgery and ²Prosthodontics, School of Dentistry, Faculty of Health Sciences, University of Copenhagen; ³Department of Oral & Maxillofacial Surgery, University Hospital (Rigshospitalet), and ⁴Department of Oral & Maxillofacial Surgery, Roskilde County Hospital, Denmark

The subperiosteal implant was originally described in the 1940s. The inadequate long-term results of subperiosteal implants are in contrast to the excellent results documented for endosseous osseointegrated oral implants. Consequently, subperiosteal implants and other soft-tissue-anchored implants should not be used presently. Furthermore, these implants are seldom seen today, because they generally were removed rather shortly after placement. The present report documents a full 41-year history of a mandibular subperiosteal implant inserted in 1957 by focusing upon the consequences of not removing an implant in spite of continuous periods of complications during 4 decades. Implant exposure, inflammation, infection, and fistula formation occurred persistently. Total implant removal was refused by the patient in 1973. After 25 years without control, tremendous resorption of the mandible was observed in 1998. Consequently, the entire implant was then removed. Placement of osseointegrated oral implants was impossible without extensive autogenous bone grafting. The present report has demonstrated that regular control of patients with subperiosteal implants is mandatory. Furthermore, subperiosteal implants should definitely be removed, if continuous periods of complications occur.

Key words: oral implants – subperiosteal implants – complications

Søren Schou, Department of Oral & Maxillofacial Surgery, School of Dentistry, Faculty of Health Sciences, University of Copenhagen, 20 Nørre Allé, DK-2200 Copenhagen N, Denmark
Tel.: +45 35 32 66 15
Fax: +45 35 32 66 25
e-mail: ss@odont.ku.dk

Accepted for publication 22 March 1999

The subperiosteal implant (SI) was originally described in the early 1940s (Dahl 1943). However, the worldwide use of SI was not initiated until after the publication by Goldberg & Gershkoff (Goldberg & Gershkoff 1949). The treatment outcome after placement of mainly complete mandibular SI has previously been evaluated (Table 1) (Bodine 1974; Golec 1980; Mercier et al. 1981; Young et al. 1983; Bailey et al. 1988; James et al. 1988; Golec 1989; Yanase et al. 1994; Bodine et al. 1996). Although acceptable 5-year results have been documented, the long-term results are generally inadequate with survival rates of only 50–60% after 15 years.

Innovations involving technique, implant design,

implant material, and implant coating have been performed. However, no study has ever documented success rates of SI comparable to those of endosseous osseointegrated oral implants (Albrektsson et al. 1986; Shulman 1988; Albrektsson & Sennerby 1991). Consequently, very few cases of long-term use of SI have been published (Bodine et al. 1996). The purpose of the present report is therefore to document a long-term use of a mandibular SI inserted in 1957. The full 41-year history will be presented by focusing upon the consequences of not removing a mandibular SI in spite of continuous periods of complications during 4 decades.

Table 1. Follow-up studies of complete mandibular subperiosteal implants

Author	Implant type	Patients	Implant survival rates	Comments
Bodine 1974	27 complete mandibular subperiosteal implants	Average age at insertion: 44.8 years	5 years: 96% 10 years: 67% 16 years: 52%	All patients were examined or followed by mail annually
Golec 1980	Complete mandibular subperiosteal implants	76 women, 24 men	4 years: 100% 5 years: 96% 6 years: 92%	No information about evaluation methods
Mercier, Cholewa & Djokovic 1981	17 complete mandibular subperiosteal implants	17 women, mean age at insertion: 54 years	Evaluated after a mean observation period of 34 months: Failures: 17% Successful: 60% Fair: 23%	Evaluation according to well-defined criteria
Young, Michel & Moore 1983	Complete mandibular subperiosteal implants	11 of 25 patients were contacted; 7 of these were examined	5 years: 90% 6 years: 75%	Evaluation according to well-defined criteria
Bailey, Yanase & Bodine 1988	74 complete mandibular subperiosteal implants	57 women, 17 men, mean age at insertion: 53 years	14 years: 86%	All patients were examined annually
James, Lozada, Truitt, Foust & Jovanovic 1988	147 complete mandibular subperiosteal implants	No information	5 years: 98% 10 years: 87% 13 years: 78%	No information about evaluation methods
Golec 1989	Complete mandibular subperiosteal implants	130 women, 66 men	5 years: 99% 8 years: 97% 10 years: 96%	No information about evaluation methods
Yanase, Bodine, Tom & White 1994	81 complete mandibular subperiosteal implants	63 women, 18 men, mean age at insertion: 53 years	5 years: 95% 10 years: 79% 15 years: 60%	All patients were recalled for follow-up, if possible. In addition, telephone interviews and questionnaires were used
Bodine, Yanase & Bodine 1996	41 consecutively inserted complete mandibular subperiosteal implants	22 women, 19 men, mean age at insertion: 43.6 years	5 years: 95% 10 years: 76% 15 years: 60% 20 years: 50% 9 implants functioning 21 to 36 years after insertion (5 more than 30 years)	Results based mainly on mailed questionnaires. In addition, clinical evaluation was performed irregularly by various persons

Case report

A 37-year-old woman was in 1957 referred to Department of Oral & Maxillofacial Surgery, Royal Dental College, Copenhagen, Denmark due to retention and stability problems with the lower denture. The patient was otherwise healthy and received no medication. The maxillary and mandibular soft-tissue-borne removable dentures were made several years ago after extraction of all teeth due to periodontal disease. The clinical examination revealed inadequate stability and retention of the lower denture. The radiographic examination demonstrated no pathologic changes of the jaws, but moderate resorption of the mandibular alveolar process (Fig. 1). It was decided to install a complete mandibular SI.

The implant was inserted in September 1957 by using a 2-stage procedure and local anesthesia. The mandibular alveolar process was exposed through an incision on the top of the entire alveolar crest

and a direct impression (COE-flex[®], COE Laboratories, Inc., Chicago, IL, USA) was taken. Finally, the mucosa was sutured. An implant meshwork with a 4-post design was fabricated in chrome-cobalt alloy on a cast. The sutures were removed the following day and the implant was inserted through the previously made incision. The initial fit of the implant was optimal. The flaps were adjusted without tension and vertical mattress sutures were placed. Penicillin (Dipenicillin, 400,000 IE, IM) was administered preoperatively and once a day for 7 days postoperatively.

A dehiscence developed during the first post-operative week exposing nearly the entire anterior part of the implant. However, the implant was completely covered by mucosa after 1 month due to secondary granulation. Consequently, a removable full-arch bridge with acrylic resin teeth was made and inserted in February 1958.

Radiographs taken 1 year after implant placement demonstrated accurate implant fit to the

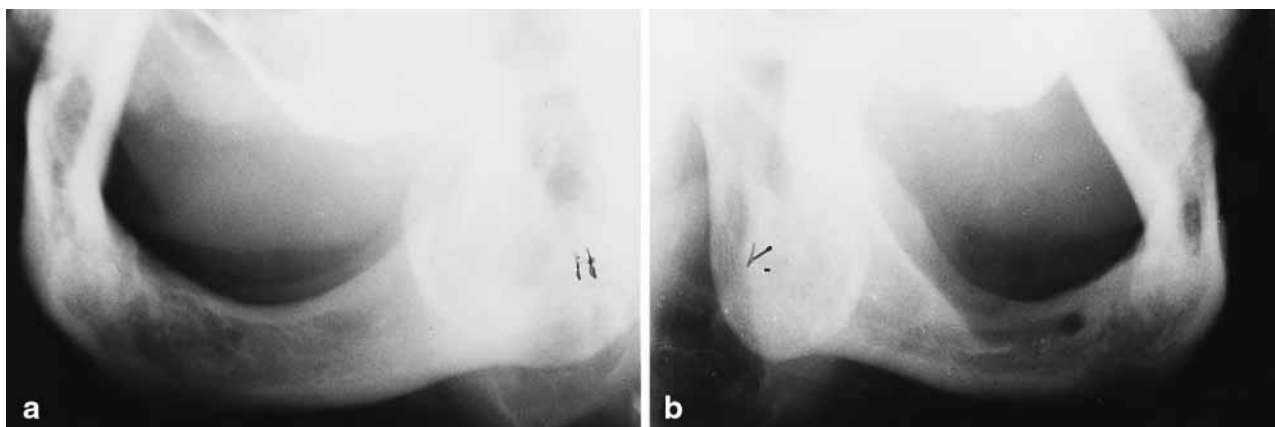


Fig. 1. Radiographs of the right (a) and left (b) side of the mandible with moderate atrophy of the alveolar process before implant placement. No pathologic changes are present.

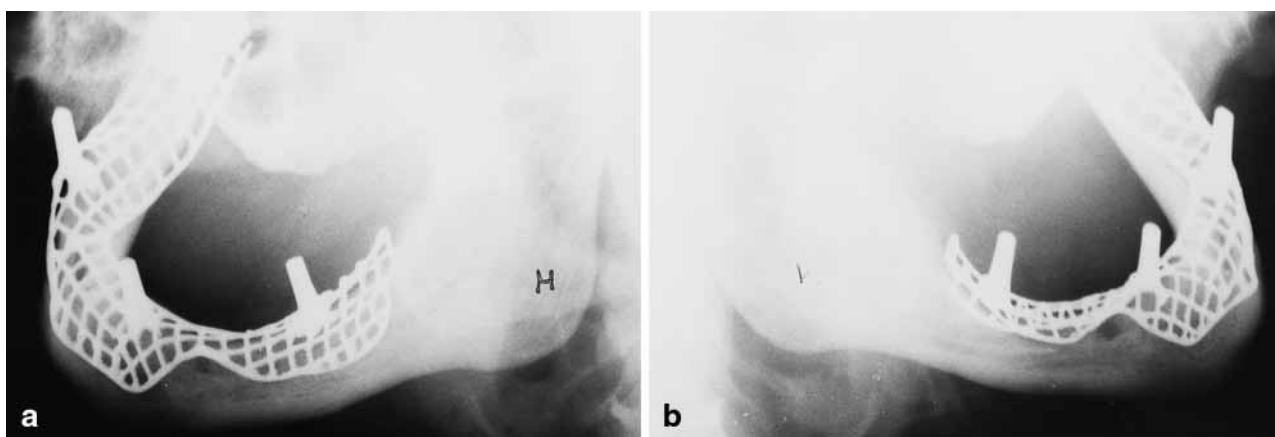


Fig. 2. Radiographs of the right (a) and left (b) side of the mandible 1 year after implant placement. No radiolucency between implant and alveolar process can be identified.

mandible (Fig. 2). However, the patient visited the clinic repeatedly during the following 15 years due to continuous periods of pain, fistula development, inflammation, and even infection. The intervals between the visits varied extensively. When infection was present approximately once every second month, daily visits normally for 1 week were necessary. Although mainly the right premolar and molar regions were affected, the location varied involving the entire implant during these years. Healthy soft tissues were re-established by local application of antibiotics, but only for a short period of time (Fig. 3). Extensive alveolar atrophy occurred rather quickly (Fig. 4) and progressed the following years (Figs 5, 6).

Due to continuous periods of infection and exposure of the right side of the implant, total implant removal was strongly recommended in 1973. However, the patient refused and only the right posterior part of the implant was removed in gen-

eral anesthesia. No initial complications occurred postoperatively.

Appointments for follow-up were ignored the following 25 years, apparently because the patient was afraid of total implant removal. Continuous episodes of infection were treated by the patient herself by rinsing and application of bees' wax and various types of unknown oils. Her general practitioner prescribed systemic antibiotic therapy 2 times during this period.

The patient consulted the clinic in October 1998 due to severe implant problems. The function of the implant has according to the patient been acceptable since her last visit at the clinic in 1973. However, increased implant mobility has compromised function for the past 5 years. Therefore, the patient then requested implant removal. The clinical examination demonstrated extensive swelling of the submental and submandibular lymph nodes. Major parts of the implant were exposed and cov-

ered by extensive amounts of plaque and calculus (Fig. 7). The implant was mobile in all directions. Radiographic examination revealed tremendous mandibular height reduction (Fig. 8). In addition, extensive labial resorption had occurred.

The implant was removed (Fig. 9) in local anesthesia. Only minor incisions were necessary due to the extensive implant exposure. Therefore, the postoperative healing period was uneventful. Reconstruction with autogenous bone graft from the iliac crest and osseointegrated implants will be considered. However, due to recent severe pneumonia, the general health condition of the patient is presently not adequate for major surgical procedures in general anesthesia.

Discussion

Although several types of oral implants have been used during the past 50 years, subperiosteal, blade-

vent, and endosseous osseointegrated implants have mainly been utilized (Albrektsson et al. 1986; Shulman 1988; Albrektsson & Sennerby 1991). The excellent long-term results documented for a number of osseointegrated oral implant systems are in contrast to the results of SI and other soft-tissue-anchored implants (Albrektsson et al. 1986; Shulman 1988; Albrektsson & Sennerby 1991). A recent preliminary experimental study has indicated that SI can be osseointegrated by using membranes and a bovine bone substitute (Bio-Oss®, Geistlich Söhne, Wolhusen, Switzerland) (Aaboe et al. 1999). However, the use of soft-tissue-anchored implants is presently not considered "lege artis" (Albrektsson et al. 1986; Shulman 1988; Albrektsson & Sennerby 1991; Yanase et al. 1994). Furthermore, surgical techniques have been developed during the past decade enabling predictable bone regeneration, if inadequate bone volume is present for placement of osseointegrated implants (Buser et al. 1994). In addition, studies are also emerging documenting high success rates

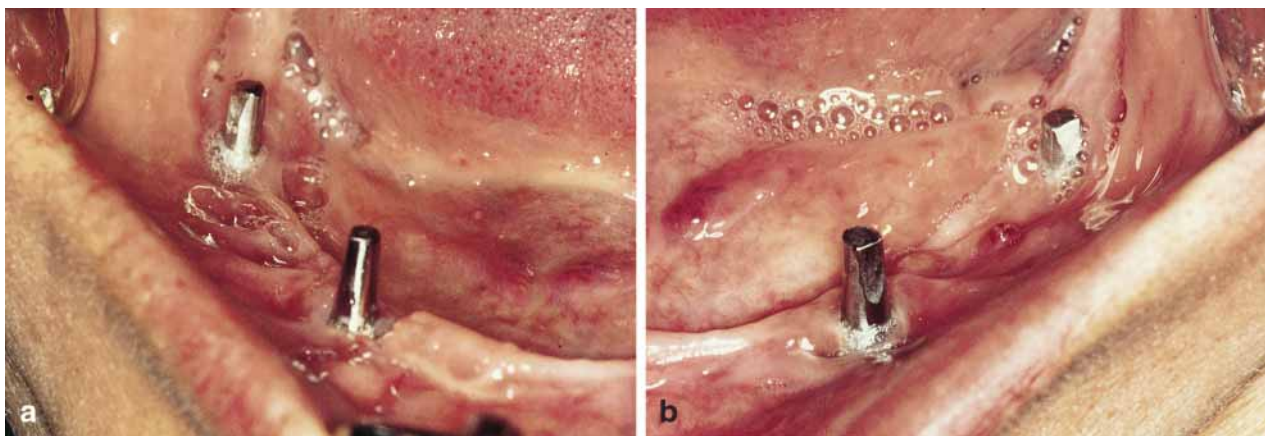


Fig. 3. Photographs of the right (a) and left (b) side of the mouth 4 years after implant placement documenting healthy peri-implant soft tissues.

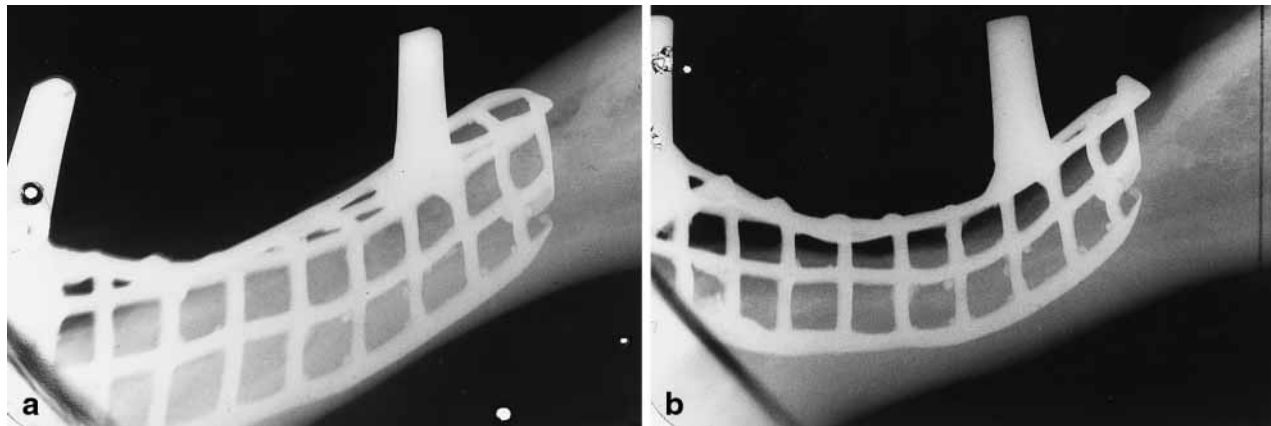


Fig. 4. Radiographs of the left posterior part of the mandible taken 2 (a) and 4 (b) years after implant placement. Resorption has already occurred after 4 years.

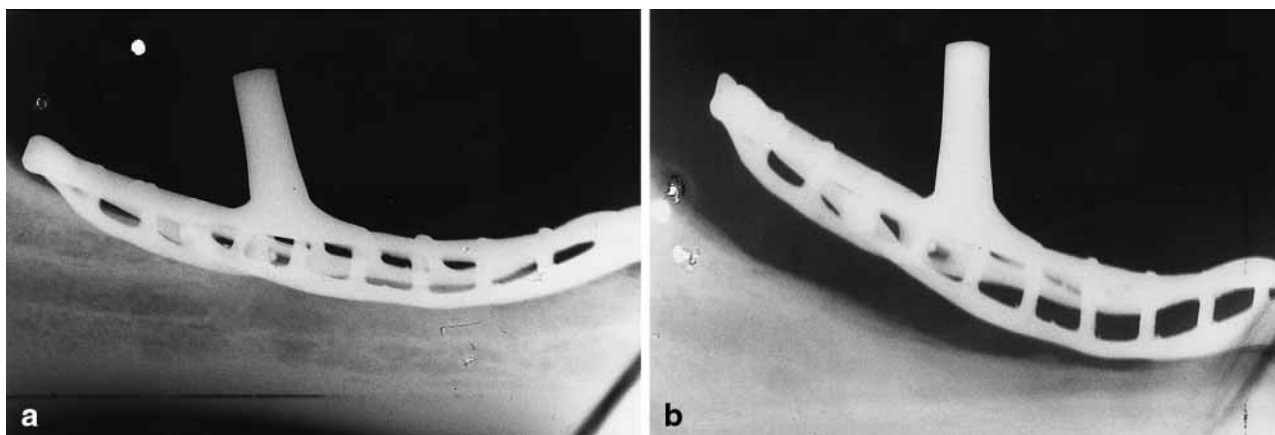


Fig. 5. Radiographs of the right posterior part of the mandible taken 4 (a) and 15 (b) years after implant placement. Extensive resorption has occurred after 15 years.

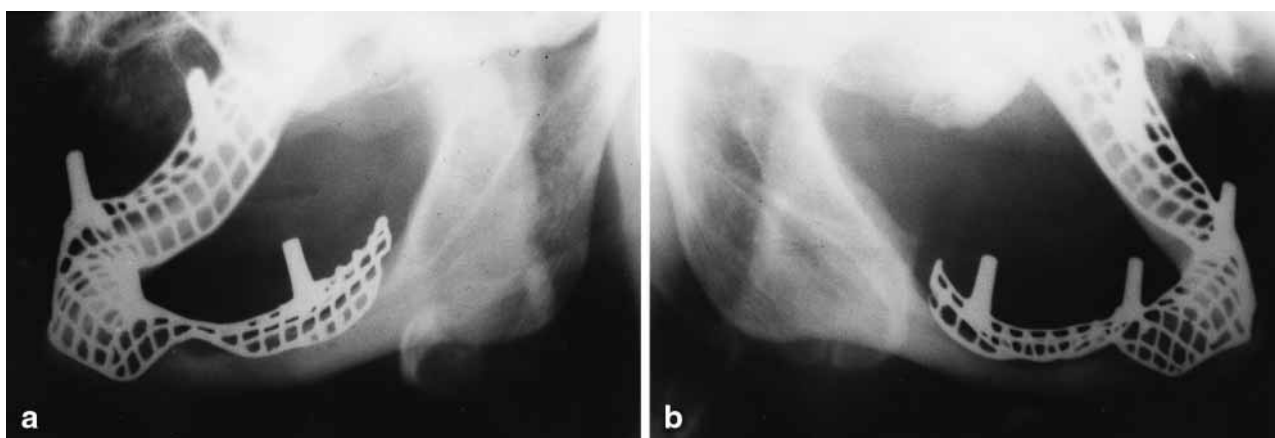


Fig. 6. Radiographs of the right (a) and left (b) side of the mandible 12 years after implant placement demonstrating extensive bone resorption.

of osseointegrated implants inserted in regenerated bone (Buser et al. 1996; Nyström et al. 1996; Tong et al. 1998). Therefore, no indications for SI are present today.

It is generally accepted that the outcome of implant treatment should be evaluated according to well-defined success criteria (Mercier et al. 1981; Albrektsson et al. 1986; Albrektsson & Sennerby 1991). All except 1 study of mandibular SI have exclusively evaluated implant survival (Table 1). The present report clearly demonstrated that although the implant was present in the oral cavity of the patient, it could not be considered as a successful implant for a very long period of time. Similar observations may be present in the above-mentioned follow-up studies, thereby further compromising the result of SI.

Due to the inadequate long-term results, SI are seldom seen today. Only 1 study has observed survival of a SI nearly as long as the present report, namely 36 years (Bodine et al. 1996). Several types

of complications occurred during the 41-year period, including pain, primary exposure of the implant meshwork, inflammation, infection, fistula formation, late implant exposure, bone resorption, and implant mobility. Similar complications have previously been observed (Obwegeser 1959; Weiskopf 1960; Bodine 1963, 1974; Golec 1980; Mercier et al. 1981; Young et al. 1983; Bailey et al. 1988; Golec 1989; Balshi 1993; Yanase et al. 1994; Kurtzman & Schwartz 1995; Bodine et al. 1996).

Primary implant exposure occurred shortly after insertion in the present case. However, the entire implant was covered by mucosa due to secondary granulation after 1 month. Previous studies have also documented healing of early implant exposures (Obwegeser 1959; Bodine 1963; Golec 1980; Mercier et al. 1981; Golec 1989). In contrast, late exposures do normally persist (Obwegeser 1959). Removal of the exposed part of the implant or implant parts with continuous periods of complications have been performed with successful re-

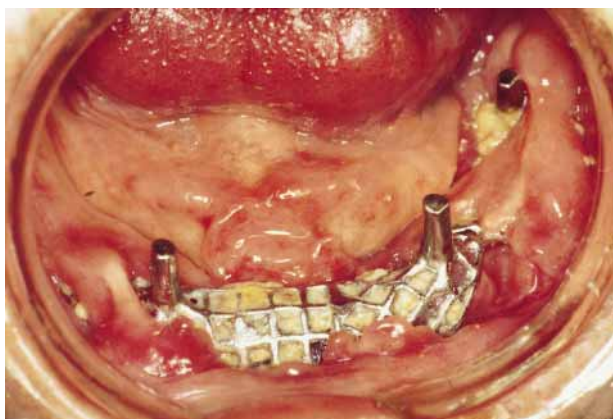


Fig. 7. Photograph 41 years after implant placement. Major parts of the implant were exposed.



Fig. 9. Implant after removal demonstrating severe calculus and plaque formation due to long-term exposure of the implant.

sults (Bodine 1963; Young et al. 1983; Bailey et al. 1988; Golec 1989; Yanase et al. 1994; Bodine et al. 1996). The patient was lost to follow-up shortly after removal of the posterior right part of the implant. Consequently, the outcome can not be evaluated in the present case.

The most common types of complications were inflammation and infection also in the present case. These complications are normally treated by systemic use or local application of antibiotics (Golec 1980; Yanase et al. 1994; Bodine et al. 1996). By using these methods, healthy peri-implant tissues were re-established, but only for a short period of time. Extensive bone resorption occurred concomitantly with the previously mentioned periods of inflammation and infection. Tooth loss and use of soft-tissue-borne dentures inevitably cause continuous residual ridge resorption, but normally not as quickly as in the present SI case (Atwood & Coy 1971; Tallgren 1972). However, it is unknown whether the resorption was

mainly caused by pressure on the bone surface from the SI or by the continuous periods of inflammation and infection. However, progressive bone resorption took place during periods even when treatment was initiated immediately after detection of inflammation and infection.

Several studies have demonstrated minimal mean marginal bone loss around osseointegrated implants (Schou et al. 1992). However, severe focal bone loss may develop. If marginal bone loss occurs, it is always rather localized. In the present case, generalized tremendous bone resorption took place involving the entire mandibular alveolar process. In addition to the reduced height of the mandible, extensive resorption from the labial aspect had occurred. Similar advanced bone resorption has never previously been reported. The atrophy was so advanced that placement of osseointegrated implants was impossible without extensive autogenous bone grafting. The patient could probably have been treated exclusively by osseointe-

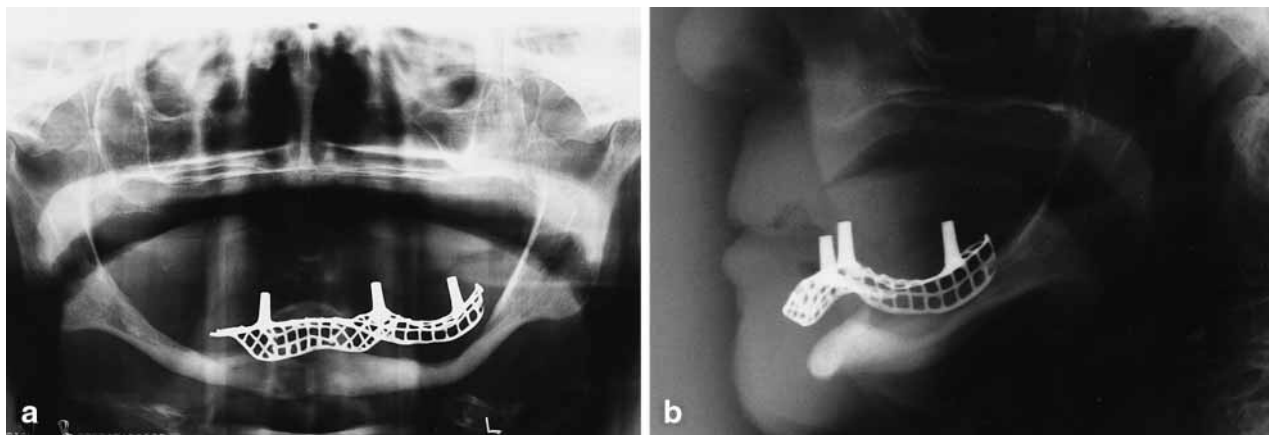


Fig. 8. Radiographs 41 years after implant placement demonstrating tremendous bone resorption (a and b). Please note the pronounced labial resorption.

grated implants, if the SI was removed several years ago. Consequently, the present report has demonstrated that regular control of patients with SI is mandatory. In addition, implant removal should be performed, if continuous periods of infection occur. A possible systemic risk of continuous periods of infection can also not be ignored.

Résumé

L'implant sous-périosté a été décrit depuis les années 1940. Les résultats à long terme inadéquats des implants sous-périostés sont en contraste avec les excellents résultats qui sont disponibles actuellement. En conséquence, les implants sous-périostés et les implants accrochés aux tissus mous ne doivent plus être utilisés. De plus, ces implants sont rarement vus aujourd'hui parce qu'ils sont généralement enlevés peu de temps après leur placement. Le rapport présent documente une histoire de 41 années d'un implant sous-périostal mandibulaire inséré en 1957 en se référant essentiellement aux conséquences du non-enlèvement d'un implant malgré les périodes continues de complications durant quatre décennies. L'exposition de l'implant, l'inflammation, l'infection et la formation de fistule étaient très fréquentes. L'enlèvement complet de l'implant a été refusé par le patient en 1973. Après 25 années sans contrôle, une résorption extrêmement importante de la mandibule a été observée en 1998. Suite à cela, l'entièreté de l'implant a été enlevé. Le placement d'implant ostéointégré était impossible sans greffe osseuse autogène importante. Le rapport présent a montré que le contrôle régulier de patients avec ce type d'implant est obligatoire. De plus, les implants sous-périostés doivent être absolument enlevés si plusieurs processus de complications se passent.

Zusammenfassung

Das subperiostale Implantat wurde ursprünglich in den 40er Jahren zum ersten Mal beschrieben. Die unbefriedigenden Langzeitergebnisse von subperiostalen Implantaten stehen in einem krasen Gegensatz zu den hervorragenden Langzeitergebnissen, welche für enossale osseointegrierte orale Implantate dokumentiert sind. Daraus folgt, dass subperiostale Implantate und andere weichteilverankerte Implantate in der heutigen Zeit nicht mehr verwendet werden sollten. Des weiteren können solche Implantate heute kaum mehr gesehen werden, da sie meist schon kurz nach der Eingliederung wieder entfernt werden mussten. Der vorliegende Bericht dokumentiert die komplette 41-jährige Geschichte des subperiostalen Implantats im Unterkiefer, welches 1957 eingesetzt worden war. Das Belassen des Implantats hatte mehrere Episoden von Komplikationen über vier Jahrzehnte zur Folge. Immer wieder kam es zu Implantatexpositionen, Entzündungen, Infektionen und Fistelbildungen. Im Jahr 1973 verweigerte der Patient die komplette Entfernung des Implantats. Nach 25 Jahren ohne eine Kontrolle konnte 1998 eine ausgeprägte Resorption des Unterkiefers beobachtet werden. In der Folge wurde nun das gesamte Implantat entfernt. Die Eingliederung von osseointegrierten oralen Implantaten war ohne ausgedehnte autologe Knochentransplantate unmöglich. Der vorliegende Bericht hat gezeigt, dass regelmässige Kontrollen bei Patienten mit subperiostalen Implantaten unbedingt erforderlich sind. Des weiteren sollten subperiostale Implantate entfernt werden, wenn mehrere Episoden von Komplikationen auftreten.

Resumen

El implante subperiostico fue originalmente descrito en 1940. Los resultados inadecuados a largo plazo de los implantes sub-

periosticos se encuentran en contraste con los resultados excelentes documentados para implantes orales endoóseos osteointegrados. Consecuentemente, los implantes subperiosticos y otros implantes anclados a tejidos blandos no deberían usarse en el presente. Más aún, estos implantes raramente se ven hoy en día, porque generalmente fueron retirados al poco de ser colocados. El presente artículo documenta una historia completa de 41 años de un implante subperiostico mandibular insertado en 1957 enfocando las consecuencias de no retirar un implante a pesar de los continuos periodos de complicaciones durante cuatro décadas. Exposición del implante, inflamación, infección y formación de fistulas ocurrieron persistentemente. El paciente se opuso a la retirada total del implante en 1973. Tras 25 años sin control se observó una gran reabsorción de la mandíbula en 1998. Consecuentemente el implante entero fue retirado. La colocación de implantes orales osteointegrados era imposible sin el injerto extensivo de hueso autógeno. El presente artículo ha demostrado que el control regular de pacientes con implantes subperiosticos es obligatorio. Más aún, los implantes subperiosticos deberían ser definitivamente retirados si ocurren periodos continuos de complicaciones.

要旨

骨膜下インプラントが最初に紹介されたのは1940年代である。骨膜下インプラントの長期成績は、骨性統合の骨内口腔インプラントの優れた成績とは対照的に、不適切なものである。その結果骨膜下インプラントや、その他の軟組織に固定する様式のインプラントは現在用いられなくなった。さらにこれらのインプラントは一般に埋入後かなり短期間に抜去されたので、今日ほとんど見ることはない。本報告は1957年に埋入された後、40年間連続的に合併症が生じたにもかかわらず抜去されなかった下顎の骨膜下インプラントがもたらした結果に焦点をあてた、同インプラントの41年間の完全な記録である。インプラントの露出、炎症、感染、フィステルの形成が持続的に生じたが、患者は1973年に全インプラントの抜去を拒否した。その後全くコントロールしない状態で25年が過ぎ、下顎骨の大幅な吸収が1998年に観察された。その結果今度はインプラント全体を抜去するにいたった。骨性統合の口腔インプラントの埋入は、大々的な自家骨移植なしには不可能であった。本報告は骨膜下インプラントの患者の定期的なコントロールが必須であることを実証している。さらに骨膜下インプラントは合併症が続く場合、即座に抜去するべきである。

References

- Aaboe, M., Schou, S., Hjørtting-Hansen, E., Helbo, M. & Vikjær, D. (2000) Osseointegration of subperiosteal implants using bovine bone substitute and various membranes. *Clinical Oral Implants Research* 11: 51–58.
- Albrektsson, T., Zarb, G., Worthington, P. & Eriksson, A.R. (1986) The long-term efficacy of currently used dental implants: A review and proposed criteria of success. *International Journal of Oral and Maxillofacial Implants* 1: 11–25.

- Albrektsson, T. & Sennerby, L. (1991) State of the art in oral implants. *Journal of Clinical Periodontology* **18**: 474–481.
- Atwood, D.A. & Coy, W.A. (1971) Clinical, cephalometric, and densitometric study of reduction of residual ridges. *Journal of Prosthetic Dentistry* **26**: 280–295.
- Bailey, J.H., Yanase, R.T. & Bodine, R.L. (1988) The mandibular subperiosteal implant denture: A fourteen-year study. *Journal of Prosthetic Dentistry* **60**: 358–361.
- Balshi, T.J. (1993) Mandibular subperiosteal implant replaced with osseointegrated implants. *Implant Society* **3**: 6–7.
- Bodine, R.L. (1963) Implant dentures: Follow-up after seven to ten years. *Journal of the American Dental Association* **67**: 352–363.
- Bodine, R.L. (1974) Evaluation of 27 mandibular subperiosteal implant dentures after 15 to 22 years. *Journal of Prosthetic Dentistry* **32**: 188–197.
- Bodine, R.L., Yanase, R.T. & Bodine, A. (1996) Forty years of experience with subperiosteal implant dentures in 41 edentulous patients. *Journal of Prosthetic Dentistry* **75**: 33–44.
- Buser, D., Dahlin, C. & Schenk, R.K. (1994) *Guided bone regeneration in implant dentistry*, 1st edition, 1–270. Chicago: Quintessence Publishing Co., Inc.
- Buser, D., Dula, K., Lang, N.P. & Nyman, S. (1996) Long-term stability of osseointegrated implants in bone regenerated with the membrane technique. *Clinical Oral Implants Research* **7**: 175–183.
- Dahl, G. (1943) Om möjligheten för implantation i käken av metallskelett som bas eller retention för fasta eller avtagbara proteser. *Odontologisk Tidskrift* **51**: 440–449.
- Goldberg, N.I. & Gershkoff, A. (1949) The implant lower denture. *Dental Digest* **55**: 490–495.
- Golec, T.S. (1980) The mandibular full subperiosteal implant – clinical review of 100 cases. *Dental Survey* **56**: 32–38.
- Golec, T.S. (1989) The mandibular full subperiosteal implant – A ten-year review of 202 cases. *Journal of Oral Implantology* **15**: 179–185.
- James, R.A., Lozada, J.L., Truitt, P.H., Foust, B.E. & Jovanovic, S.A. (1988) Subperiosteal implants. *Journal of the California Dental Association* **16**: 10–14.
- Mercier, P., Cholewa, J. & Djokovic, S. (1981) Mandibular subperiosteal implants. *Journal of the Canadian Dental Association* **47**: 46–51.
- Kurtzman, G.M. & Schwartz, K. (1995) The subperiosteal implant as a viable long-term treatment modality in the severely atrophied mandible: A patient's 40-year case history. *Journal of Oral Implantology* **21**: 35–39.
- Nyström, E., Ahlqvist, J., Kahnberg, K.-E. & Rosenquist, J.B. (1996) Autogenous onlay bone grafts fixed with screw implants for the treatment of severely resorbed maxillae. *International Journal of Oral and Maxillofacial Surgery* **25**: 351–359.
- Obwegeser, H.L. (1959) Experiences with subperiosteal implants. *Oral Surgery, Oral Medicine and Oral Pathology* **12**: 777–786.
- Schou, S., Holmstrup, P., Hjørtting-Hansen, E. & Lang, N.P. (1992) Plaque-induced marginal tissue reactions of osseointegrated oral implants: A review of the literature. *Clinical Oral Implants Research* **3**: 149–161.
- Shulman, L.B. (1988) Surgical considerations in implant dentistry. *Journal of Dental Education* **52**: 712–720.
- Tallgren, A. (1972) The continuing reduction of the residual alveolar ridges in complete denture wearers: A mixed-longitudinal study covering 25 years. *Journal of Prosthetic Dentistry* **27**: 120–132.
- Tong, D.C., Rioux, K., Drangsholt, M. & Beirne, O.R. (1998) A review of survival rates for implants placed in grafted maxillary sinuses using meta-analysis. *International Journal of Oral and Maxillofacial Implants* **13**: 171–182.
- Weiskopf, J. (1960) Erfahrungen mit 65 subperiostalen metallgerüst-implantationen. *Deutsche Zahnärztliche Zeitschrift* **15**: 1129–1144.
- Yanase, R.T., Bodine, R.L., Tom, J.F.M.D. & White, S.N. (1994) The mandibular subperiosteal implant denture: A prospective survival study. *Journal of Prosthetic Dentistry* **71**: 369–374.
- Young, L., Michel, J.D. & Moore, D.J. (1983) A twenty-year evaluation of subperiosteal implants. *Journal of Prosthetic Dentistry* **49**: 690–694.