A Six-Year Study of Hydroxyapatite-Coated Root-Form Dental Implants

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ABSTRACT

Background: *The effect of hydroxyapatite coating of dental implants is controversial. The long-term fate of hydroxyapatite-coated implants has been the subject of some criticism.*

Purpose: *The aim of this retrospective study was to assess the clinical outcome of hydroxyapatite-coated cylindrical root-form endosseous Impladent dental implants (LASAK Ltd, Prague, Czech Republic) during a six-year course.*

Methods: *Three-hundred and ninety-one consecutively placed implants were used in 169 patients and followed for four to six years. Interval and cumulative success of implants and prostheses survival was tabulated. Marginal bone loss was measured.*

Results: *Of the total number of implants, 98.5% achieved initial osseointegration. The cumulative success was 98.3% after one year, 97.0% after three years, 92.8% after five years and 90.4% after six years. The prostheses survival at the end of the study was 100% for fixed bridges totally supported by implants, 96.5% for fixed bridges with combined implant and tooth support, 94.2% for single crowns, 90.9% for mandibular overdentures and 81.3% for maxillary overdentures. Marginal bone loss averaged 2.4 ± 0.8 mm at the end of five years.*

Conclusion: *The success rate of the investigated hydroxyapatite-coated implants was comparable with the data presented in the literature and with the results of the similar implants without hydroxyapatite-coating. However, the marginal bone loss was of interest. Longer monitoring of the implants is necessary.*

Un Estudio de Seis Años Sobre Implantes Dentales de Raíz con Recubrimiento de Hidroxiapatita

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RESUMEN

Antecedentes: *El efecto del recubrimiento de los implantes dentales con hidroxiapatita es un asunto controversial. El destino a largo plazo de los implantes recubiertos con hidroxiapatita ha sido objeto de críticas.*

Propósito: *El objetivo de este estudio retrospectivo fue evaluar los resultados clínicos de los implantes dentales endo-óseos de raíz con recubrimiento de hidroxiapatita de la marca Impladent (LASAK Ltd., Praga, República Checa), durante el transcurso de seis años.*

Métodos: *Un número de 391 implantes colocados consecutivamente, fueron usados en 169 pacientes, y sujetos a seguimiento por un período de 4 a 6 años. Se tabuló el éxito de lo implantes – por intervalos y de forma cumulativa – así como la supervivencia de las prótesis. Se midió la pérdida de hueso marginal.*

Resultados: *El 98.5% de los implantes alcanzó óseo-integración en la fase inicial. El éxito cumulativo fue de 98.3% después de un año, 97.0% después de tres años, 92.8% luego de cinco años, y 90.4% tras seis años. La supervivencia de las prótesis al final del estudio fue de 100% para puentes fijos sopor-*

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tados totalmente por implantes, 96.5% para puentes fijos con combinación de soporte sobre dientes e implantes, 94.2% para coronas solas, 90.9% para sobredentaduras mandibulares, y 81.3% para sobredentaduras maxilares. La pérdida marginal de hueso tuvo un promedio de 2.4 ± 0.8 mm al final de los cinco años.

Conclusión: *La tasa de éxito de los implantes recubiertos con HA investigados, resultó comparable a los datos presentados en la literatura, y a los resultados de implantes similares sin revestimiento de HA. Sin embargo, la pérdida marginal de hueso fue una alerta: se necesita monitorear los implantes por un período más largo de tiempo.*

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INTRODUCTION

The effect of the hydroxyapatite (HA) coating of dental implants is controversial. The potential short-term advantages of the coating are well documented (1). The HA surface reduces the necessity for surgical precision during the preparation of the bone bed as well as for the immobility of an implant, and improves the prognosis of implant placement in bone of lower density (2–7). The long-term fate of the HA-coated implants has been the subject of some criticism. The instability of the HA in a biological environment and troublesome management of infection of the porous surface of the implant when the loss of marginal bone exceeds the height of the titanium cervical collar are counted among the most frequently discussed disadvantages (2, 3, 8). This negative characteristic of the HA coating, however, has not been proven conclusively (3, 9, 10).

MATERIAL AND METHODS

The sample included all the patients who received Impladent implants (LASAK Ltd, Prague, Czech Republic) during the period from March 1997 to March 1999. Observation ended March 2003 (Fig. 1). One-hundred and sixty-nine patients

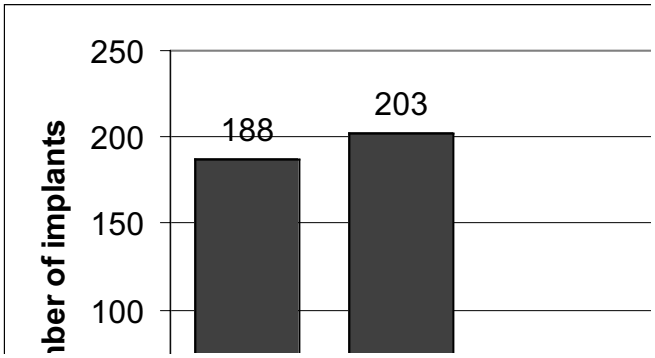

Fig. 1: Frequency of implant placement during the follow-up period.

(81 males and 88 females) with a mean age (± SD) of 45.1 ± 17.2 years) were studied. Three-hundred and ninety-one implants were placed (2.3 mean for patient). The endosseous implants studied were cylindrical, smooth or threaded root-form HA-coated. The implant diameter was 3.6 mm with lengths of 8, 10, 12 or 14 mm (Fig. 2). The thickness of the HA coating was 50 μm, and was formed by spraying HA particles, 56-162 μm in size, on a core of Ti-6Al-4V titanium

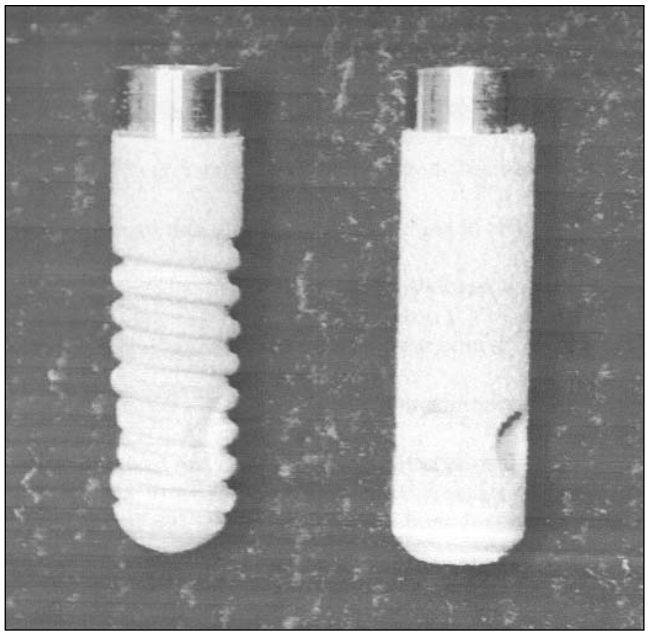

Fig. 2: Implants used in the study.

alloy in plasma flame. The implant placements were carried out according to the following indications: single-tooth, partially edentulism (two or more implants) and complete edentulism.

The implants were inserted under local anaesthesia using the original Swedish protocol (11). Bone type was assessed using the method recommended by Lekholm and Zarb (12). All study subjects were free of systemic disease, which could adversely affect soft or osseous implant healing (13) except for three patients with adult onset diabetes mellitus (two diet controlled and one on an oral hypoglycaemic drug).

For the purpose of statistical analysis, data was collected from the upper and lower jaw, threaded and smooth implants, and short (10 mm or less) or long (over 10 mm) implants, separately. The suprastructures were categorized into five groups: single crowns, fixed bridges supported totally by implants, fixed bridges with combined implant and tooth support, maxillary overdentures and mandibular overdentures.

During the last follow-up visit, the following parameters were recorded: clinical symptoms, the presence of a suprastructure and the marginal bone loss. The marginal

bone loss was measured using the panoramic or intraoral radiograph, with precision of 0.5 mm using the long cone technique of intraoral radiography. In the statistical analysis, a possible association between marginal bone loss and heavy smoking was evaluated. Heavy smoking was defined as consumption of 15 or more cigarettes a day.

A successful implant was defined as: clinically stable, free of pain or neurological disorder, free of peri-implant infection or inflammation, functional dental prosthesis, and marginal bone loss not exceeding one-third of the length of the implant. All implants that did not satisfying these criteria were considered as failed. Non-osseointegration at the end of the healing period was described as a primary failure, and failing of the prosthetically loaded implant as a secondary failure. When patients did not respond to a recall, their implants were classified as lost to follow-up. These implants were excluded from further statistical analysis.

Dental prosthetic suprastructures were categorized as successful, if they were functional at the time of the last follow-up visit. Suprastructures which were removed due to the secondary implants failure or not placed since the primary implants failed, were considered as failed.

The implant success rate was expressed by input-output statistics (14) and in the form of a life-table analysis. To perform the statistical analysis of the success rate and for analysis of the marginal bone loss, a log rank test and a two-sample t-test were used.

RESULTS

During the follow-up period, a total of 391 implants were inserted into 169 consecutively treated patients. Two-hundred and ten (53.7%) were in the maxilla, and 181 (46.3%), in the mandible. The implants were most commonly located in the anterior maxilla (40.2%), followed by the posterior and anterior mandible (24.3% and 22.0%, respectively), and the posterior maxilla (13.6%). Ninety-one per cent of implants were over 10 mm in length, and 9% were 10 mm or less in length. Threaded and smooth implants were used with approximately equal frequency (50.6% and 49.4 %, respectively). In the maxilla, threaded implants predominated (86.9%), whereas those in the mandible were mostly smooth (80.3%). The numbers of implants related to individual suprastructure types are given in Table 1.

Table 1: Numbers of implants as related to types of suprastructures

Type of suprastructure	Implants	
	Maxilla	Mandible
Single crown	42	19
Fixed bridge (Totally supported by implants)	52	57
Fixed bridge (Combined implant and tooth support)	71	41
Overdenture	45*	64**

Note: * bars, ** ball attachments

One-hundred and fifty-two patients (89.9%) with a total of 361 implants (92.3%) accepted the follow-up protocol. The period of follow-up of all implants was four to six years, the average being five years. The mean period between implant placement and prosthetic loading was six months in the maxilla and four months in the mandible.

The healing period was evaluated for 391 implants and was successful 98.5% (six implants failed to achieve initial osseointegration). Thirty implants were lost during the 4–6 year follow-up. The remaining 361 implants achieved a 91.7% success rate (30 or 8.3% failed). There were six primary and 24 secondary failures (Table 2). The life-table analysis is presented in Tables 3 – 5. The difference between the maxilla and mandible was not statistically significant ($p > 0.05$).

Table 2: Primary and secondary failures

	Jaw		Implant type		Implant length	
	Maxilla	Mandible	Threaded	Smooth	Long	Short
Primary failure	4	2	4	2	6	0
Secondary failure	16	8	14	10	22	2

Table 3: The life-table analysis for the whole sample

Interval (yr)	No entering interval	No failed	Interval success rate (%)	Cumulative success rate (%)
0–1	361	6	98.3	98.3
1–2	355	2	99.4	97.8
2–3	353	3	99.2	97.0
3–4	350	0	100.0	97.0
4–5	350	15	95.7	92.8
5–6	155	4	97.4	90.4

Table 4: The life-table analysis for the maxilla

Interval (yr)	No entering interval	No failed	Interval success rate (%)	Cumulative success rate (%)
0–1	196	4	98.0	98.0
1–2	192	2	99.0	96.9
2–3	190	0	100.0	96.9
3–4	190	0	100.0	96.9
4–5	190	11	94.2	91.3
5–6	67	3	95.5	87.2

Table 5: The life-table analysis for the mandible

Interval (yr)	No entering interval	No failed	Interval success rate (%)	Cumulative success rate (%)
0–1	165	2	98.8	98.8
1–2	163	0	100.0	98.8
2–3	163	3	98.2	97.0
3–4	160	0	100.0	97.0
4–5	160	4	97.5	94.6
5–6	88	1	98.9	93.6

The mean marginal bone loss (± SD) after five-year follow-up was 2.4 ± 0.8 mm (2.6 ± 0.9 mm in the maxilla and 2.3 ± 0.7 mm in the mandible, $p > 0.05$). The mean bone loss in the group of heavy smokers (13.4% of the implants) was 3.0 ± 1.0 mm whereas in the group of the other patients was 2.3 ± 0.8 mm ($p < 0.01$).

At the time of the final follow-up visit, 94.3% of the suprastructures were functional. The highest success rate was attained with the fixed bridges supported totally by implants (100 %), followed by the fixed bridges with combined implant and tooth support, the single crowns (96.5% and 94.2%, respectively), and mandibular overdentures (90.9%). The lowest value was found for maxillary overdentures (81.3%). The statistical comparison of all five types of suprastructure showed that the sample was homogeneous.

DISCUSSION

The difference in success rate between the smooth and threaded implants was minimal and statistically insignificant. The worst results were found in implants supporting maxillary overdentures, which concurs with data reported in the literature (14, 15).

The success rate of the implants healing period was 98.5%, which is comparable with three other studies where the primary implant failure percentage ranges from 1.1% to 3.1% (16, 17, 18) and rarely, falls below 1% (2, 19–21).

Marginal bone loss is an important parameter in the long-term prognosis of implants. In the course of the first year, the loss should reach a maximum of 1–1.5 mm (11, 22), and rarely as high as 2 mm (15). In subsequent years, the marginal bone loss should not exceed 0.2 mm annually (23). However, the findings reported in most of the five-year studies (0–1.2 mm) lie far below the limit (24–26). Our result (2.4 ± 0.8 mm) is marginally acceptable.

The five-year success rate of endosseous root-form osseointegrated implants has been well documented in the literature. It is mainly reported as ranging from 92% to 100% (24, 27–32). Identified 92.8% is within this limit. In a previously published five-year study of implants with the same design but without an HA coating (33), a similar result (94.8%) was reached. The success rate attained for the upper jaw is usually less than the rate attained for the lower jaw (34–36). However the difference in our study was not statistically significant.

CONCLUSION

The success rate of the investigated HA-coated implants was comparable with the data presented in the literature and with the results of the similar implants without HA-coating. Nevertheless the marginal bone loss 2.4 ± 0.8 mm was of interest. Longer monitoring of the implants is necessary.

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CONTINUING MEDICAL EDUCATION

Answer to Image and Diagnosis

Diagnosis

Intracranial haemorrhage due to vitamin K deficiency, as the first symptom of extrahepatic biliary atresia.

Comment

Biliary atresia, defined as the complete or partial absence of the extrahepatic biliary system, has an incidence of approximately one in 10 000 live births worldwide. Untreated, this disorder produces biliary obstruction and eventual hepatic failure, although the Kasai portoenterostomy and, more recently, orthotropic liver transplantation have significantly improved survival rates. The pathogenesis of biliary atresia appears multifactorial, including improper development of and inflammatory damage to the biliary tree. The increased bleeding tendency was due to a vitamin K deficiency, probably caused by cholestasis-induced malabsorption of this fat soluble vitamin and which was further exacerbated by the absence of vitamin K supplement at birth. Therefore extrahepatic biliary atresia should be considered in each infant with a bleeding diathesis associated with cholestasis.