Clinical and radiologic assessment of possibilities for endosseous implants and osseointegrated prostheses in 55-year-old edentulous subjects

Maarit A. M. Salonen, Kyösti S. Oikarinen, Aune M. Raustia, Matti Knuuttila and Kauko K. Virtanen

Department of Prosthetic Dentistry and Stomatognathic Physiology, Department of Oral and Maxillofacial Surgery, and Department of Periodontology and Geriatric Dentistry, Institute of Dentistry, University of Oulu, Oulu, Finland

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To determine how many 55-year-old edentulous subjects were suitable candidates for implant-retained overdentures or fixed implant bridges and how many of them might be interested in such treatment, case histories were reviewed, and clinical and radiologic examinations were performed on 146 subjects (100 women, 46 men) in a medium-sized city in northern Finland. Numbers and lengths of implants required in altogether 16 regions in the upper and lower jaw were evaluated. The commonest implant length was 8 mm in the upper jaw and 16 mm in the lower jaw. Construction of an implant-retained fixed bridge would have been possible in the upper jaw in 121 subjects (83%) and of an overdenture in all lower jaws. Information about the benefits of the treatment is important because, although the percentage of subjects who were suitable candidates for implant-retained prostheses was high, few subjects were aware of or interested in this type of treatment. □ *Dental implantation, endosseous; denture, complete*

Maarit Salonen, Department of Prosthetic Dentistry and Stomatognathic Physiology, Institute of Dentistry, University of Oulu, Aapistie 3, SF-90220 Oulu, Finland

The number of edentulous individuals is steadily decreasing, in Finland as elsewhere. The mean age of individuals wearing complete dentures is increasing (1). These facts mean that those needing prosthetic treatment for edentulousness increasingly consist of elderly individuals, mostly women, owing to the fact that they live longer than men. A long period of edentulousness and postmenopausal osteoporosis result in advanced resorption of the alveolar process (2, 3), difficulty in retention and stability of dentures, inadequate chewing function, and craniomandibular disorders (CMD), particularly in elderly subjects (4, 5).

It has also been reported that loss of all permanent teeth and wearing of removable dentures (with associated apprehension about denture loosening) affect social life, psychologic status, and self-confidence (6). In a study by Blomberg & Lindquist (6) 73% of edentulous subjects had nervous disorders secondary to their edentulousness. In some cases this was the main reason for early retirement (7).

A method of inserting titanium implants into the edentulous jaws, originally described by Brånemark et al. (8), has become popular; it has substantially increased possibilities of improving the retention of removable prostheses. In many cases it has been possible to restore the dentition by using implant-retained fixed bridges.

Although the outcome of implantation has been well documented, few epidemiologic investigations of the possibilities of using implants or constructing implant-retained prosthesis in edentulous subjects in particular age groups have been conducted. The aim of the study reported here was to deter-

Table 1. Number of subjects, mean edentulous periods, and ages of dentures

Total number of subjects	146
Women	100
Men	46
Mean edentulous time, years	
Upper jaw	27.2
SD	12.1
Lower jaw	23.2
SD	9.5
Mean age of dentures, years	
Upper jaw	9.8
SD	8.9
Lower jaw	9.1
SD	7.7

mine suitability of 55-year-old edentulous subjects for implantation.

Materials and methods

An epidemiologic study was conducted in a 55-year-old population in a medium-sized city of 100,000 inhabitants in northern Finland. They were invited to participate in a clinical and radiologic assessment of their oral health status, oral health habits, and needs for dental treatment. Of the 1012 55-year-old individuals in the city in 1990–91, 780 attended for examination, of whom 247 were edentulous. An inquiry was mailed to the 228 drop-out subjects, of whom 121 subjects answered. Of these, 40% stated that they were edentulous. The part of the study reported here relates to the 146 edentulous subjects (100 women, 46 men) (15% of the age group) who were able to take part in the clinical and radiologic examination with regard to the possibilities of implantation in their upper and lower jaws. Data on the subjects are shown in Table 1. The participants were asked about their knowledge about and interest in implantation. The questions were 'Do you know what endosseous implantation or so-called artificial root treatment means?'. If the subject was not aware of the treatment, it was explained, and we therefore asked 'Are you interested in improving the retention of your dentures with implants (artificial roots)?' and 'If not, why?'.

Degrees of alveolar resorption were evaluated clinically and from gypsum casts. Our estimation is based on the scale described by Lekholm & Zarb (9); in our study their scores A and B represented slight, score C moderate, and scores D and E severe alveolar resorption.

Possibilities of implantation in the upper jaw were evaluated both in gypsum casts and in panoramic radiographs (PM 2002 CC, Planmega, Helsinki, Finland) in relation to the first molar, first premolar, canine, and lateral and central incisor regions and, in the lower jaw, the first molar and the second and first premolar regions. Altogether 16 implant sites per subject were evaluated. The anterior parts of the mandibles, from canine to canine, were not evaluated separately because in this region there was enough bone for at least two implants.

Two thousand three hundred and thirty-six implant sites were evaluated, 1460 in the upper and 876 in the lower jaw (Table 2). Fourteen upper-jaw regions were excluded from evaluation because of difficulties in measurements resulting in poor-quality radiographs.

Table 2. Total numbers of implant sites and numbers of implant sites that could have been implanted in upper and lower jaws of 146 edentulous subjects

	Upper jaw		Lower jaw	
	n	%	*n*	%
Total no. of implant sites	1460		876	
No. of implant sites evaluated	1446	99	876	100
No. of implant sites suitable for implantation	938	65	469	54

A Bonefit stensil (Institut Straumann AG, Waldenburg, Switzerland) that took account the panoramic radiograph magnification of 1.2 was used to evaluate the possibility of inserting Bonefit endosseous implants 6, 8, 10, 12, 14, and 16 mm long.

Contraindications in relation to implantation were recorded also from panoramic radiographs—that is, the proximity of the sinus maxillaris, sinus nasalis, and canalis incisivum in the upper jaw and foramen mentale and canalis mandibularis in the lower jaw not allowing insertion of the shortest, 6-mm implant. Findings of impacted teeth, root remnants, cysts, infections, foreign bodies (amalgam), and alveolar sockets after recent tooth extraction were also recorded.

The thickness of alveolar processes was measured from gypsum casts, using a caliper (Fig. 1). The minimum alveolar-process thickness on a gypsum cast allowing implantation was evaluated to be 10 mm. The thickness of the mucosa was assumed to be 3 mm on top, buccal, and oral sides of the processus alveolaris (10), and the minimum width of alveolar bone needed for implantation was assumed to be 4 mm (11). The width of the processus alveolaris was measured on each implant site on the gypsum cast, and the implant length was determined by the implant stencil measuring the corresponding site in the panoramic radiograph.

It was considered possible to construct implant-retained overdentures on two to four implants, and a fixed bridge on five implants or more, in relation to both the upper and lower jaws.

Statistical analyses were performed with the chi-square test.

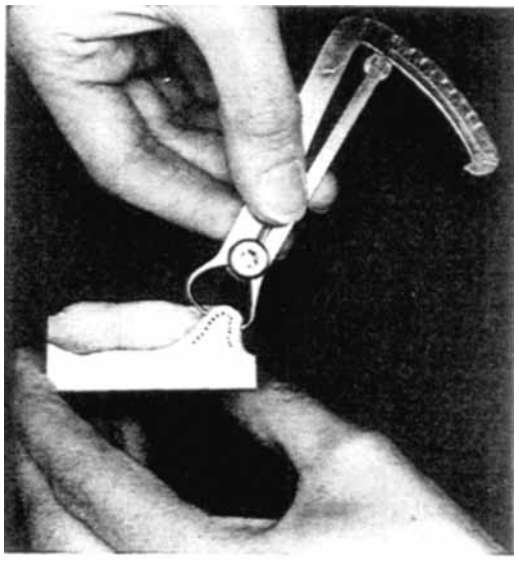

Fig. 1. The width of the alveolar processus was measured on the cast with a caliper. The thickness of the mucosa was estimated to be 3 mm in the top, buccal, and palatal sides of the processus alevolaris, and the real bone width was calculated accordingly.

Results

One thousand four hundred and seven of the 2322 regions evaluated (61%) were considered suitable for implantation (Table 2).

It would have been possible to insert 938 implants in the upper jaws of 145 subjects (mean, 6.5 implants per subject) and 469 implants in the lower jaws of 146 subjects (mean, 3.2 implants per subject). The number of implants of various lengths in the 16 regions evaluated is shown in Fig. 2. In the upper jaws the commonest implant site in which implantation was possible was the canines (267 implants), followed by the lateral incisors (235 implants). The least suitable area for implantation was the first molar; 59 implant sites could be used for implantation, 44 of them bilaterally. The commonest maximum length of upper-jaw implants was 8 mm (316 implant sites); the least common was 16 mm (14 implant sites). In the lower jaw the first premolar implant site was suitable for implantation in 145 subjects (Fig. 2). The posterior region of the mandible was suitable for implantation in 30% of subjects, and in 43 subjects the first molar implant site was suitable for implantation bilaterally. The commonest implant lengths were 14 and 16 mm (182 implant sites), and the least common 6 mm (4 implant sites).

In the posterior part of the upper jaws maxillary sinus proximity would have prevented implantation in 297 implant sites (34% of all canine, first premolar, and first molar implant sites); the first molar region

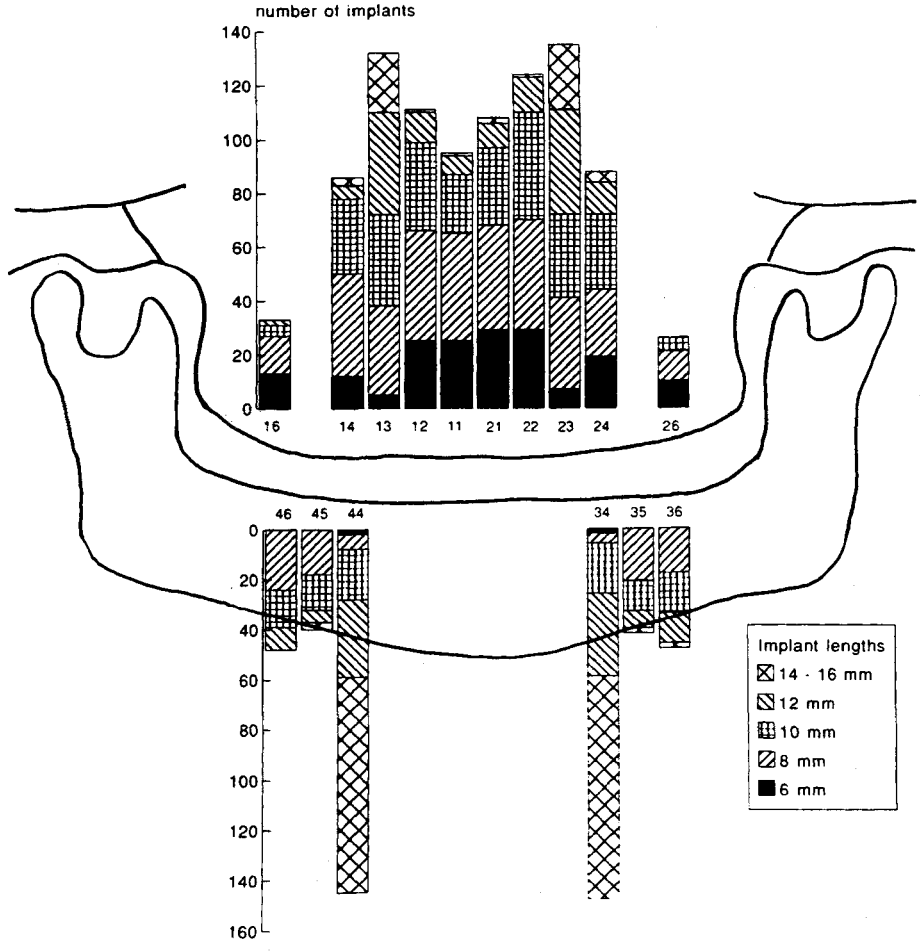

Fig. 2. The number of implants of various lengths that could have been inserted in 16 implant sites in the upper and lower jaws of 146 edentulous subjects.

was particularly affected by this constraint (Table 3). In relation to the anterior part of the maxilla, the proximity of the sinus nasalis and the canalis incisivum would have been contraindications in 101 implant sites. In the lower jaw the foramen mentale and the canalis mandibularis would have prevented implantation in 400 second premolar and first molar implant sites (68%) (Table 3). A fresh extraction socket was seen in the right first premolar implant site and root remnants in 18 implant sites in the upper and lower jaws.

The number of subjects and regions by extent of alveolar resorption are shown in Table 4. On the basis of clinical evaluation and assessment of gypsum casts, 66% of the subjects had moderate or severe alveolar resorption in the upper jaw, and 62% in the lower jaw. More implant sites were suitable for implantation in maxillas with severe resorption than in slightly or moderately resorbed maxillas (chi-square = 9.5; df = 2; $p = 0.009$), and 59% of the implant sites in mandibles showing slight alveolar resorption were suitable for implantation as opposed to

Table 3. Obstacles to implantation in various implant sites in the upper jaw (total 1446 regions) and the lower jaw (total 876 regions)

	Implant sites										
Upper jaw	16	14	13	12	11	21	22	23	24	26	Total
Maxillary sinus	67	53	7					7	50	113	297
Nasal sinus			1	17	15	16	17				66
Incisal canal					21	14					35
Residual root	6	3						1	2	4	16
Cyst				1		1	1				3
Residual infection	1	1									2
Impacted tooth			1	1							2

	Implant sites						
Lower jaw	46	45	44	34	35	36	Total
Mental foramen	1	100			100	1	202
Mandibular canal	97	3			3	95	198
Foreign body		2			1	1	4
Residual root		1				1	2
Extraction socket			1				1

49% of implant sites in mandibles showing severe alveolar resorption (chi-square = 6.1; df = 2; $p = 0.048$) (Table 4).

Only 22 subjects (15%) stated they would be interested in implant-retained fixed-bridge or removable dentures (Table 5). On the basis of the number of implants that could be inserted, fixed implant-retained bridges could have been constructed in the upper jaw of 121 subjects (83%) in five or more implants. Two subjects could not be implanted at all. In the lower jaw an implant-retained prosthesis could be inserted in all subjects. Overdenture treatment was possible in 91 subjects (62%), and a fixed implant-retained bridge would have been possible in 55 subjects (38%) (Table 5).

On comparing clinical and radiologic data

Table 4. Number of subjects and of implant sites suitable or not suitable for implantation on the basis of degree of alveolar resorption in upper and lower jaws

		Implant sites						
		Total,		Suitable for implantation		Not suitable for implantation		
Degree of alveolar resorption	Subjects, *n*	*n*	%	*n*	%	*n*	%	Significance*
Upper jaw								
Slight	50	496	34	311	63	185	37	
Moderate	60	600	41	376	63	224	37	
Severe	35	350	24	251	72	99	28	$p = 0.009$
Total	145	1446	100	938		508		
Lower jaw								
Slight	55	330	38	194	59	136	41	
Moderate	58	348	40	178	51	170	49	
Severe	33	198	23	97	49	101	51	$p = 0.048$
Total	146	876	100	469		407		

* Statistical analysis: chi-square test.

Table 5. Number of implants it would have been possible to insert in upper and lower jaws of subjects interested and not interest in implants. The lines separate cases in which the overdenture treatment or fixed implant-retained bridge could have been possible

	No. of implants possible to insert, *n*	Subjects interested in implants		Subjects not interested in implants		Total no. of subjects		
		n	%	*n*	%	*n*	%	
Upper jaw, *n* = 145	0	0	0	2	2	2	1	
	1	0	0	1	1	1	1	
	2	2	9	7	6	9	6	
	3	1	5	2	2	3	2	
	4	3	14	6	5	9	6	Overdenture
	5	0	0	10	8	11	8	Fixed bridge
	6	5	23	17	14	21	14	
	7	3	14	20	16	23	16	
	8	3	14	35	28	38	26	
	9	3	14	9	7	12	8	
	10	2	9	14	11	16	11	
Lower jaw, *n* = 146	0	0	0	0	0	0	0	
	1	0	0	0	0	0	0	
	2	17	77	74	60	91	62	Overdenture
	3	2	9	4	3	6	4	Fixed bridge
	4	0	0	7	6	7	5	
	5	0	0	9	7	9	6	
	6	3	14	30	24	33	23	

on subjects interested in and not interested in implants, no differences were found in the number of implants it would have been possible to insert (Table 5), in anatomic circumstances, or in the extent of alveolar resorption in the upper and lower jaws.

Discussion

In planning implant treatment, patient selection is critical. Selection needs to take into account clinical status, results of oral examination, and results of assessments of gypsum casts and radiographs (8, 12). The results of follow-up studies show that long-term success rates with implants in edentulous upper and lower jaws and with implant-retained prosthesis are 78–100% (13–15). However, few epidemiologic studies have been conducted in which the possibilities of implanting and of arranging implant-retained prostheses in edentulous subjects have been investigated (16, 17). In one Swedish study using panoramic radiographs implant treatment was found to be possible in the maxilla in 80% of 67 subjects (16).

Despite some disadvantages, review of panoramic radiographs (18) and gypsum-cast analyses is a reliable and easy way of evaluating a subject's suitability for implantation. To obtain more detailed information, sonography (10) or clinical measurement (19), computed tomography (16, 20), or a new Finnish multimodal radiography system (Scanora) (21) could also provide detailed information about morphology and quality of bone.

Of all the regions evaluated, 61% could have been implanted (65% in the upper jaw, 54% in the lower jaw). Most implants were, however, short (6–10 mm). In a large multicenter study it has been shown that implants suitable for anchorage of overdentures in maxillas are most often short (7 mm) (14).

The proximity of anatomic obstructions

to implantation due to advanced alveolar resorption, sinus maxillaris, sinus nasalis, and canalis incisivum in the upper jaw and foramen mentale and canalis mandibularis in the lower should, however, be considered only relative contraindications, because the height of alveolar bone can be increased preoperatively or in conjunction with implantation by bone grafting (22–25) or using guided tissue generation (26). Nervus alveolaris inferior can be transpositioned during implant insertion (27), and implants can be inserted immediately into extraction sockets (28).

The maximum number of implants that can be inserted in anterior parts of both jaws (between the maxillary sinuses and mental foramina) varies from four to six (8, 29, 30). A fixed, implant-retained bridge can be constructed on these. A short cantilever part, however, can result in aesthetic and functional problems or worsen the prognosis of anterior implants (29, 31, 32). Such potential problems might have been prevented in 22 subjects in relation to the upper jaw and in 43 subjects in relation to the lower jaw if the fixed bridges could have been extended onto implants in the region of the first molar bilaterally. Aesthetic, functional, and hygienic problems arising from fixed, implant-retained bridges (14, 29, 33) could be solved with an overdenture (34) here in at least 24 upper jaws and 62 lower jaws.

Alveolar resorption was evaluated clinically as severe in both jaws in 25% of subjects. In a previous study of the same subjects, 25% of upper and 45% of lower dentures were found objectively to exhibit poor stability and retention (35). Results of recent studies show that implant failure is commonest when short (7–13 mm long) or narrow implants are used and when they are inserted into jaws affected by difficult anatomic circumstances or when the quality and quantity of bone are poor (14, 36). Implant treatment of such subjects is, however, often necessary. For this reason, new types of implants suitable for use in patients with extremely atrophic mandibles have been introduced (37).

Our material of 146 edentulous 55-year-old subjects represents an age group in which menopausal problems, osteoporosis, advanced alveolar resorption, and other changes in the oral cavity related to aging create problems for denture retention, stability, and masticatory function (2, 5, 38). As reported by Palmqvist et al. (17), despite the benefits of implant treatment to improve oral function (39) and to decrease the rate of alveolar resorption (40), minimal interest in implantation is observed among the edentate, being only 15% in this study.

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