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General Dental Practitioners and Implant Suprastructures

Abstract: Patients with implants inserted by one consultant oral and maxillofacial surgeon whose suprastructures were made either by general dental practitioners (GDPs) or the Consultant Service were reviewed and compared. A total of 88 patients with 224 implants inserted over a 12-year period (1991–2003) were identified and contacted while 28 patients with 83 implants volunteered to be examined. Implants survived equally well with GDP- and consultant-produced suprastructures.

Clinical Relevance: Successful placement of implant suprastructures is possible in general dental practice, with appropriate mentoring.

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Since the first osseointegrated dental implant, dated to the pre-Columbian era, much development has occurred.[1] Today, restoration of the dentition with dental implants is a growing treatment entity. Implant usage in the United Kingdom has been slower than Europe to gain acceptance and the UK experience with root form implants is growing.

The Brånemark,[2,3] IMZ[4] and ITI[5,6] dental implant systems have been extensively and objectively researched, as have other systems, and have been found to be reliable for prosthetic restoration of both occlusion and aesthetics. There are many other current systems, with some involving a two-stage procedure for insertion.

The ITI Straumann system requires no further surgery to expose the implant for fitting of the abutment/ suprastucture following that for its insertion.[5,6]

Wood and Hajjar[5] suggested a mentor approach in the education of GDPs by a Consultant in Restorative Dentistry until the GDP was competent to provide the suprastructure on osseointegrated root form implants. This approach educates and enables the GDP to be involved at every stage in his/her patient's implant treatment and provides easy access to a dentist for the patient's follow-up care.

No studies have previously been undertaken which compare GDP with hospital consultants in the construction of implant suprastructures on osseointegrated implants. This paper reports the 12-year experience of the use of ITI Straumann implants inserted by one consultant oral and maxillofacial surgeon with the suprastructures planned and fitted either by a hospital consultant or a GDP. Implant survival with GDP suprastructures are compared with those undertaken by a hospital consultant. Patient volunteers were examined and their implant survival, periodontal condition, radiographic bone appearance, smoking experience and their opinion of their treatment was reported in this paper.

Method

Several meetings (1990–91), inviting all local GDPs to Arrowe Park Hospital, Wirral, were organized to discuss the mentor process described by Wood and Hajjar[5] for the GDP treatment of patients with implants. It was agreed that all future implants inserted at Arrowe Park Hospital, Wirral, would be treated with the ITI system. Each GDP who wished could be involved in his/her patient's treatment planning and subsequent suprastructure construction under supervision of a consultant if required. The implants were to be inserted by one consultant oral and maxillofacial surgeon, while subsequent follow-up care, on the successful completion of a GDP constructed implant suprastructure, was to be undertaken by the GDP. GDPs were encouraged to attend various courses run by ITI Straumann in the use of its implants, but all GDPs were to have access to the hospital service for advice if requested.

A consultant in restorative dentistry and the oral and maxillofacial surgery consultant worked to agreed implant treatment plans on those suitable patients initially referred to the consultant in restorative dentistry.

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The hospital initially bulk purchased a number of implants to enable some patients to be treated with implants. The selection of patients for implants was on a first come, first served basis until the implant stock was exhausted, whether the suprastructures were to be made by a GDP or consultant. Some additional patients were treated under private contract.

It was understood that NHS care was cash limited and that not every suitable patient could be accepted for NHS implant treatment.

Criteria for patient selection

Patients were selected for treatment if they satisfied the criteria described by Buser *et al*.[6] and did not smoke. Only non-smokers who were generally fit and well motivated, and who were able to maintain good oral hygiene measures, were accepted for implant treatment.

All patients were informed that no guarantee of implant success could be given and that the implants were unlikely to be retained permanently. A full discussion about the patient's future treatment was always undertaken and the individual responsibility of the treating clinicians explained to the complete understanding of every patient prior to treatment. Any patient financial consideration was discussed with them and they were given an estimate of any cost of the treatment as the GDP suprastructures were made under private contract, there being no NHS fee. Patients were asked to consider their future treatment should their other teeth be lost. It was considered imperative that, before undergoing an initial implant treatment, consideration was made of what was to be done if or when other teeth were lost, as future NHS treatment may not be available.

An agreed treatment plan between the GDP/consultant and the consultant oral and maxillofacial surgeon was first established and explained to the patient so that a joint (restorative/surgeon) treatment plan was undertaken. Diagnostic wax-ups were used prior to commencement of treatment so that the patient had a clear understanding of the aimed final result.

Selection of implants

In all cases, the ITI Straumann implant system was used. The implants selected were hollow cylinder and/or solid screws, 3.3, 3.5, 4.0, 4.1 and 4.8 mm in diameter and used as recommended by the manufacturer and detailed by Wood and Hajjar.[5] Generally, solid screw implants were used in the posterior maxilla, but always the longest and largest implant possible was inserted.

Surgical procedure

Surgery was generally undertaken under a local anaesthetic without intravenous sedation. General anaesthesia was given when bone grafting or more extensive surgery and/or other procedures were required. Any pre-implant surgery was undertaken prior to the insertion of implants. Prophylactic antibiotics were prescribed for all patients, penicillin being the drug of choice, unless the patient was hypersensitive, when erythromycin was used. A surgical stent was used to aid the placement of implants when necessary.

Suprastructure construction

The GDPs were recommended to use laboratories approved by the manufacturer for suprastructure construction, while hospital suprastructures were made by ITI-approved technicians. This ensured that a trained technician with a full working knowledge of the implant system worked to a monitored standard. The GDP's patient's suprastructures were planned and fitted by the GDP assisted, when asked, by a consultant.

Patient analysis

Patients that had implants inserted at Arrowe Park Hospital, Wirral, between 1991 and 2003 were identified and the case notes reviewed. This retrospective analysis was considered by the Hospital Ethics Committee to be an audit and their approval was not therefore deemed necessary.

Each patient was telephoned/written to and asked to attend a review clinic so that his/her implants could be inspected after 10 years at no cost to them.

The same interviewer (GDW) conducted telephone interviews with patients who could not attend the clinic. Patients were asked to confirm the following:

- Whether or not their implants were still present;
- If any implants had been lost;
- If more implants had been inserted;
- If any problem had been identified;
- Any benefits/complaints of their treatment.

All patients attending the review clinic were seen by a final year dental student supervised by a consultant. The following demographic details were recorded:

- Age;
- Smoking habits;
- Number, position and type of implants used;
- By whom suprastructure constructed;
- Date of insertion and loading of each implant;
- Medical history;
- Parafunctional habits;
- The impact on the patient of the implant treatment.

Each patient had his/her periodontal pocketing measured by probing the peri-implant pocket depth (average of four readings for each implant) and any bleeding on deep probing measured, and noted. The immediate post-operative orthopantomogram (OPG) radiograph was used to obtain a ratio of implant length to bone height and compared to a similar measure on a current OPG. Finally, the patient's opinion of the treatment was recorded.

Results

A total of 85 patients (28 male, 57 female), with an age range of 20 to 81 years (mean 49.03 years and standard deviation, SD, of 16.77 years), were identified. A total of 222 implants (82 hollow cylinder and 140 solid screw) used to provide fixed single tooth restorations (45 patients with 70 implants), fixed bridges (23 patients with 72 implants), full mouth reconstruction (6 patients with 40 implants) and overdentures (11 patients with 40 implants) were identified (Table 1).

Four patients had died since

	SINGLE		LONG SPAN		FULL MOUTH		OVERDENTURE		
	GDP	CONS	GDP	CONS	GDP	CONS	GDP	CONS	TOTAL
No. Patients	36	9	18	5	3	3	3	8	85
No. Implants	53	17	59	13	17	23	12	28	222

Table 1. Number of patients and implants with GDP/consultant suprastructures.

treatment, but their relatives confirmed that the patients had died with symptom-free functional implants. These patients were excluded from the study.

In addition to the three hollow cylinder 3.5 mm implants lost (one fractured in road traffic accident, one lost 2 weeks after insertion, one of 14 lost in a full mouth reconstruction) and, previously reported,[5] three others have been shed. The additional failed implants were hollow cylinder 3.5 mm replacing maxillary incisor teeth, which had been functional and aesthetically acceptable for more than 10 years. Two of these patients had another implant inserted while the third had a denture made by their GDP. A total of six implants had thus been lost over the investigation period.

One patient with an overdenture suffered soft tissue hyperplasia as a result of tissue mobility that was treated with a palatal mucosal graft and the insertion of an extension screw. The overdenture was retained and remains fully functional, although it has been relined.

Four patients (5 implants) were lost to follow up. Thirty patients agreed to a clinical examination and 28 attended. Of the 28, five patients had active caries and one implant had some mobility and another a pus exudate. Four patients (23 implants) had restarted smoking but all the implants remain firm, functional and aesthetically acceptable, while two implants had been lost amongst the non-smokers in this group.

The highest periodontal probing depths were found in the non-smokers, with four patients having one pocket greater than 6 mm (Figure 1). Survival in the non-smokers was 90.24 months (SD 41.6 months) and in the smokers 103.8 months (SD 43.2 months).

The statistical method of a boxplot[7] was used to show the shape of the distribution of this data and can indicate any outliers (or extreme value) should they exist. The summary statistics gleaned from the boxplot are the median, 25th and 75th percentile. Therefore this type of graph is suitable for using in cases of discrete data or where the data are skewed. In the case of periodontal pocket depths measured in this study, owing to the lack of variance from the boxplot, it is best presented in the form of a bar chart (Figure 1).

No significant difference in bone loss using the Student's paired 't' test[7] was found when the ratios of mean bone length/mean implant length obtained from the OPG radiographs were compared.

All patients found the implant treatment worthwhile, and those freed from wearing a prosthetic appliance were most thankful for no longer having to wear one. Patients who had implant-retained prostheses commented particularly on the improved retention and their ability to chew.

Implant survival (Table 2) of the total group was 77.8 months (SE 5.51). When loaded it was 72.95 months (SE 5.45). Implant survival with suprastructures made by a GDP was 77.21 months (SE 6.44), while

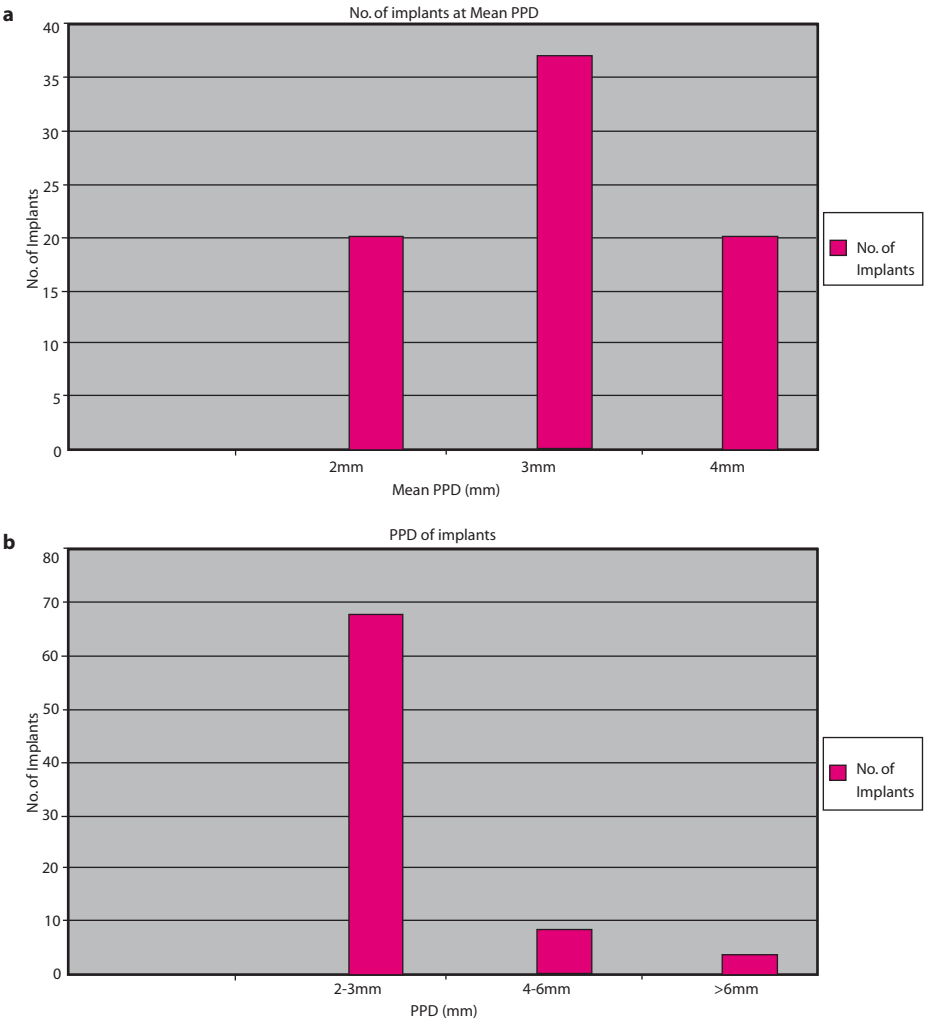

Figure 1. (a, b) Number of implants and periodontal probing depth (PPD).

Survival period of implants (months)		Number of implants inserted		Number of implants loaded	
0–20		43		47	
21–50		34		29	
51–100		32		38	
101–125		32		50	
126–160		82		59	
Mean survival (months) Standard Error (S.E.)		77.8 5.51		72.95 5.45	
	No. of Patients	No. of Implants	No. Lost	Survival (months)	Loaded (months)
GDP	59	142	4	77.21 (SE 6.44)	72.19 (SE 6.33)
Consultant	25	82	1	79.28 (SE10.80)	74.84 (SE10.85)

Table 2. Implant survival (January 1991–October 2003) excluding failed implants.

for the consultant it was 79.28 months (SE 10.8), while loaded implant survival for the GDP was 72.19 months (SE 6.33) and for the consultant was 74.84 months (SE 10.85). The GDPs have lost 4 implants and the consultants 1 implant. One implant was lost one week after insertion, being one of the first the surgeon had inserted.

The Kaplan-Meier[7] survival statistical technique was used to analyse the implant survival (time to implant failure) data. The probability of an event is estimated each time an event is observed. Implant failure was classed as an event, whilst death, a patient lost to follow-up, or success of the implant were all entered into the analysis as 'censored' survival times. A cumulative survival curve was plotted for the data as a whole and then split into the factor of whoever treated the patient (ie GDP or consultant). These two groups were then evaluated to investigate any significant difference in terms of survival time to implant failure. This was done using the non-parametric log rank test. No significant difference was found between GDP- or consultant-made suprastructures, both for the data as a whole or when sub-divided into telephone or examined groups.

Discussion

It appears that the patients had significant health gains and all were pleased to have undertaken their implant treatment.

Conceivably, those patients lost to follow up and/or not identified could have lost their implants or been dissatisfied with their treatment. It could be argued that the data collected by telephone interview cannot be totally relied upon in that patients' personal testimonies could be viewed as purely anecdotal and therefore lacking validity. However, on the balance of probability, a patient is unlikely to state that his/her implant is in place and functional when it is not. Furthermore, the interview owes its popularity to a general belief that it is a reliable and trustworthy means of collecting data.[8] Within healthcare studies, the interview is regarded as both an appropriate method and a preferred mode of communicating with patients.[8,9] In addition, there is no evidence to suggest a significant difference between the mean implant survival times for the data as a whole, or when sub-divided into the telephone or examined groups. It is therefore reasonable to assume that the data for the examined group is representative of the whole group.

Few practitioners have sufficient numbers of implant patients, reviewed over long periods of time with sufficiently accurate documentation, for statistical evaluation of their results,[10,11] and there are few randomized controlled trials of any management alternatives for oral implant rehabilitation.[12] Prospective studies of one individual over 20–30 years would represent a life time's work, while retrospective studies often have data lost and are therefore too incomplete to allow meaningful analysis.

How to define implant success and perform analysis on long-term results remains a controversy. Radiographic variables described in the literature are usually negative criteria, with their absence deduced as success. Peri-implant bone loss greater than 0.2 mm after the second year following implantation is considered failure by Albrektsson *et al*.,[10] while Naert *et al*.[12] regard clinically firm, inflammation-free implants to be successful. Input-output statistics in which quotients are calculated by dividing the implant failure rates by the total implants do not permit statements with sufficiently high confidence intervals, whereas failure rate analyses enable a more meaningful calculation of success.[13] The problems involved with analysis of long-term implant systems results have been discussed by Willer *et al*.[4]

Schnitman and Schulman,[14] The National Institutes of Health Consensus Conferences[15] and Albrektsson[10] laid down guidelines for objective assessment of implant success. Their recommendations included measurement of gingival inflammation, implant mobility (less than 1 mm in any direction), infection and significant or progressive supporting bone loss. These variables have been measured in 28 patients.

An absolute assessment of peri-implant bone loss using radiographic measurement is not possible.[15] The periapical radiograph is best suited for a reproducible position for later analysis,[16] while dental panoramic radiographs are of less use because of their inferior image and the ability to modify the angulation of the X-ray tube.[16,17] The analysis of the OPG radiographs was an attempt to obtain an objective measure of bone loss as all the patients had both immediate postoperative and current OPG radiographs. The index of implant length to bone height immediately after implant insertion and following recent examination using OPG radiographs was hoped to overcome radiographic distortion. The method demonstrated no significant bone loss over the investigation period. However, all implants had more than 66% of their length with supporting bone (using

the OPG) after 5 years, which was one of the criterion laid down by NIH.[13,14]

Wie *et al*.[17] found periodontal probing to be the most accurate means of detecting peri-implant destruction. While a probing depth of 4-6 mm may be indicative of false pocketing associated with peri-implant mucositis, if there is no periodontal attachment to stop the probe, probing may not be a good indicator of bone/attachment loss.[11,18] Reporting mean periodontal depths will not necessarily uncover deep pocketing, (Figure 1a), therefore the distribution of implant pocket depths has been reported (Figure 1b). This method has revealed pocket depths of 6 mm. Bleeding on deep probing (BODP) remains controversial as Lekholm[19] and others[18] demonstrated BODP in the absence of sulci inflammation. It was suggested that the bleeding represented wounding rather than peri-implant pathology. The validity of conventional periodontal indices unmasking peri-implant pathology is questionable.[11,19]

Smoking has an adverse effect on the long-term retention of implants.[15] In the present study, even with the strict initial patient selection criteria, evidence of active caries and smoking was found. It begs the question 'How can highly motivated patients be identified?' and 'Are smoking, oral hygiene and caries significant issues in the assessment of potential implant patients?' The patients identified in this study with such pathology/habits have yet to compromise their implant treatment.

The principles of crown and bridge construction (retention, occlusion, aesthetics) are the same as for natural teeth when fitting suprastructures to osseointegrated implants, but occlusal implant load must always be considered. In this study, GDPs and consultants provided equally successful implant suprastructures. More implants have been lost in the GDP suprastructure group, but this group have made more suprastructures and three of these implants had been lost after 10 years of function. Crown and bridge conservation is core work for most GDPs and thus implant suprastructures with appropriate GDP training should remain within their clinical remit.

Should it be now that implant suprastructure construction is in the domain of the GDP? Should undergraduate dental students be required to undertake implant suprastructure construction as part of their training to equip them for general practice? It was less than 30 years ago that only the most skilled amongst us were allowed as undergraduates to undertake the construction of a bridge, while now bridges are an integral part of the undergraduate course. Implants are here to stay and perhaps undergraduates should be taught to their potential and gain practical experience, especially in suprastructure construction, as part of their dental courses.

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