Demographics of implant placement and complications of a patient subgroup in a dental hospital population

Précis
A significant number of complications occurs following implant placement, but most of these are minor. Patients with implant-supported overdentures have more complications than those with fixed prostheses. Patients should be advised that ongoing maintenance of implant prostheses should be anticipated.

Abstract
Statement of problem: Little has been reported about the demographics of implant placement in the Irish population and the complications that occur. This is important in terms of service planning and providing patient information.

Purpose: The purpose of this study was to construct a database of patients who had implants placed in the Dublin Dental School & Hospital from 2000 to 2006. Also, we wanted to compare the complications that occurred in patients who had overdentures to those with a fixed prosthesis.

Methods: Hospital records were searched for all patients who had implants placed over a seven-year period and we recorded demographic information, as well as details of the implant site, implant type and restoration. Patients who had four or more implants placed for an implant-supported overdenture or fixed prosthesis were invited to attend for a clinical examination.

Results: A total of 1,111 implants were placed in 452 patients over the study period – half of the implants supported single crowns, while the other half supported mainly overdentures and full arch fixed prostheses, with few fixed partial dentures. The 40- to 60-year-olds had the greatest number of implants placed of any age group and most implants were placed in the anterior region. Patients with implant-supported overdentures recorded more complications (52%) compared to those with fixed prostheses (32%). The most common complications associated with both treatments were gingival inflammation and peri-implant mucositis. Overdentures additionally had a significant number of retentive clip fractures.

Conclusions: Implant-supported overdentures and fixed prostheses were both clinically successful. However, patients and clinicians should be aware that soft tissue and mechanical complications are common.

Introduction
For many years, only one treatment was available for the management of edentulism – conventional dentures. These rely on the form of the remaining bony ridge for support and retention, but even when the dentures are judged to be excellent, many edentulous patients cannot eat certain foods or speak clearly because of lack of denture retention.1 Today there is a range of other prostheses available to restore an edentulous arch, including: an implant-retained and tissue-supported overdenture; an implant-supported (and retained) overdenture; or, an implant-supported fixed prosthesis. Unfortunately, the majority of studies evaluating the outcomes of these prostheses have not used validated instruments, which makes direct comparisons difficult. Hence, prosthodontists are limited in making treatment planning decisions and in
Previous studies have mainly compared overdentures supported by two implants (simple overdentures) with fixed complete dentures,13 or did not distinguish between different types of overdentures.16-18 However, the profile of a patient who receives two implants to stabilise their denture is considerably different from a patient who is generally younger, has more available bone and is potentially suitable for a fixed prosthesis or a 'complex' overdenture. For the purposes of treatment planning and patient information, it would be more meaningful to compare the complications of fixed prostheses and overdentures supported by four or more implants.

In this study we sought to compare the complications occurring in patients who had implant-supported overdentures to those who had a fixed prosthesis. However, there was no database of Irish patients who had implant treatment. Indeed, even though osseointegrated dental implants have been placed in Ireland since the 1980s, there were no basic demographic data available regarding implant patients or the types of prostheses they received. In order to provide a context to assess complications, the first aim of this study was to begin documenting the implant patient population in Ireland. A database was constructed of all Dublin Dental School and Hospital patients treated with implants between 2000 and 2006. This database reflects the type of demand for implant treatment in the Irish population and reveals the trends in treatment provision.

From this database, patients were identified who received at least four implants in an edentulous arch and either a fixed prosthesis or overdenture. The second aim of this study was to compare the complications that occurred in patients with these prostheses. Patients were examined clinically and their records checked for the occurrence of complications. This allowed for a direct comparison between fixed and overdenture-supported prostheses, which could be useful for treatment planning and patient information.

### Materials and methods

#### Implant database

In the first part of this study a database was constructed that recorded the details of every implant placed and restored in the Dublin Dental School and Hospital from 2000 to 2006. Surgical day lists were hand searched to compile a list of patients who had dental implants placed and a search of the hospital's electronic patient record system was also carried out. The charts for these patients were then hand searched for the types of implants placed, their lengths, diameters and sites, as well as the prostheses they supported over the seven-year period. Demographic details on all patients who received implants were noted. The database was designed so that data could be analysed on an implant or patient basis. Patients were excluded from the database if their records were unavailable for analysis or if the implants had not yet been restored. Charts that were unavailable for analysis were requested a second time at a later date in order to maximise the chance of recording every implant.

#### Analysis of clinical complications with fixed prostheses versus removable overdentures

The objective of this part of the study was to compare the complications
that occurred with complete implant fixed prostheses and those that occurred with removable implant-retained prostheses (overdentures). A minimum of four implants was required for the overdenture group to facilitate a meaningful comparison between the overdenture and fixed prosthesis patients. Fifty edentulous patients who had received a total of 62 implant prostheses (either an overdenture or a complete implant fixed prosthesis or both), constituted the study population. Treatment was carried out by staff and postgraduate students of the Dublin Dental School and Hospital. All patients had worn their prosthesis for at least one month and they agreed to participate in the study by signing a written consent. Exclusion criteria included patients who had either the surgical or restorative phases carried out elsewhere, or patients who had psychological problems or learning difficulties, which precluded them from participation.

**Ethical considerations**

Ethical clearance for the study was obtained from the Research Committee at the Faculty of Health Sciences, Trinity College Dublin. All patients who were asked to participate in the study had received information leaflets and signed the consent forms. The confidentiality of the patients’ information was guaranteed.

### Data collection

Eligible patients were mailed: 1. an introductory letter from the Director of the Graduate Prosthodontic Program; and, 2. a package, which included a cover letter, information leaflet and consent form. Patients were invited to attend for a check-up appointment at no charge. A clinical examination was carried out and any necessary adjustments or repairs of the prostheses were carried out. Advice regarding oral hygiene and maintenance of the prostheses was also given. Details of any complications, including their timing, were recorded, and note was taken of the length of time between the surgical phase and prosthesis delivery.

### Results

#### Implant database

A total of 1,111 implants were placed in 452 patients during the period from January 2000 to January 2007. The numbers of implants placed annually increased exponentially during this period, going from 55 fixtures in 2000 to 393 in 2006 (Figure 1).

The implants supported 731 prostheses: 74% of these prostheses were single implant restorations, 7% were fixed partial dentures, 12% were implant overdentures and 7% were implant fixed complete prostheses (Figure 2). The number of implants supporting single restorations was almost equal to the number supporting multi-unit restorations. A total of 542 (49%) implants supported a single prosthesis, 104 (9%) supported a fixed partial denture, 234 (21%) supported an overdenture and 231 (21%) supported a fixed complete prostheses (Figure 3).

With regard to the anatomic distribution of the implants, 58.5% of implants were placed in the maxilla and 41.5% were placed in the mandible. The anterior maxilla, followed by the anterior mandible, were the two most common sites for implant placement, with 32% and 22%,
respectively, of the total number of implants placed in these regions (Figure 4). Conversely, the posterior maxilla and mandible were the sites that received the smallest number of implants.

The implants used during the study period came from five different manufacturers. The greatest number was supplied by Biomet 3i (69.8%), followed by Straumann (13%) and Branemark/Nobel Biocare (11.5%). Astra and Bicon implants constituted the remaining 4.3%.

The mean age of the patients who received dental implants was 53.4 years. The age group that most frequently received dental implants was the 40- to 60-year-olds, with 38.5% of the implants being placed in this group (Figure 5). The next most represented age group was 20- to 40-year-olds, followed by the 60- to 80-year-olds. Only 1% of implants were placed in over 80-year-olds and 2% in the 0-20 years age group (Figure 5).

Complications: overdenture group
Twenty-five patients were identified from the database who had overdentures placed on four or more implants. These patients (mean age 57.5; 11 males, 14 females) attended for examination and had their records searched.

Of the 25 patients who received an overdenture prosthesis, 13 experienced at least one complication (52%) (Table 2). The most common complication that occurred in this group was gingival inflammation or hyperplasia of the tissues surrounding the implants and Dolder bars (Figure 6). This occurred in five out of the 25 patients (20%). Peri-implant mucositis was the next most commonly occurring complication, occurring in four patients (16%). This is defined as a “reversible inflammatory process in the soft tissues surrounding a functioning implant” and clinical features are mainly swelling and redness.

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Table 2: Number and type of complications in overdenture group (n=25).

<table>
<thead>
<tr>
<th>Overdenture complications</th>
<th>Number of patients affected</th>
<th>% of patients affected</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soft tissue complications</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gingival inflammation/hyperplasia</td>
<td>5</td>
<td>20</td>
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<tr>
<td>Peri-implant mucositis</td>
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<td>16</td>
</tr>
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<td>Peri-implantitis</td>
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<td>8</td>
</tr>
<tr>
<td>Denture stomatitis</td>
<td>2</td>
<td>8</td>
</tr>
<tr>
<td>Mechanical complications</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Clip fracture</td>
<td>3</td>
<td>12</td>
</tr>
<tr>
<td>Loosening of retentive mechanism</td>
<td>2</td>
<td>8</td>
</tr>
<tr>
<td>Fractured temporary prosthesis base</td>
<td>2</td>
<td>8</td>
</tr>
<tr>
<td>Prosthesis screw loosening</td>
<td>2</td>
<td>8</td>
</tr>
<tr>
<td>Prosthesis screw fracture</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>Other</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Implant loss</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>Neuro-sensory disturbance</td>
<td>2</td>
<td>8</td>
</tr>
<tr>
<td>Speech</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>Aesthetics</td>
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<td>4</td>
</tr>
</tbody>
</table>

Table 3: Number and type of complications in fixed complete prosthesis group (n=37).

<table>
<thead>
<tr>
<th>Fixed prosthesis complications</th>
<th>Number of patients affected</th>
<th>% of patients affected</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soft tissue complications</td>
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<td></td>
</tr>
<tr>
<td>Peri-implant mucositis</td>
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<tr>
<td>Peri-implantitis</td>
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<td>8</td>
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<tr>
<td>Mechanical complications</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fractured teeth</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Fractured temporary prosthesis base</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Prosthesis screw loosening</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>Other</td>
<td></td>
<td></td>
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<tr>
<td>Implant loss</td>
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<td>Neuro-sensory disturbance</td>
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<td>5</td>
</tr>
<tr>
<td>Aesthetics</td>
<td>1</td>
<td>3</td>
</tr>
</tbody>
</table>

FIGURE 4: Distribution of implants anatomically.
FIGURE 5: Age profile of patients who received implants (percentage of implants in each group).
Peri-implantitis occurred in two patients (8%). Peri-implantitis is an “inflammatory process additionally characterised by loss of peri-implant bone”. Clinical symptoms include presence of an inflammatory lesion in the peri-implant mucosa and the loss of peri-implant bone. Bleeding on probing, as well as bone loss on radiographs, had to occur for a diagnosis of peri-implantitis to be made. Only one patient in the group lost an implant and this was due to peri-implantitis. Two patients (8%) experienced denture stomatitis. The second group of complications was mechanical; clip fracture occurred in three patients (12%) (Figure 7), loosening of the retentive mechanism in two patients (8%), fracture of the temporary denture prosthesis in two patients (8%) and fracture of the acrylic base in one patient (4%) (Table 2). Prosthesis screw loosening occurred in two patients (8%) and screw fracture occurred in one patient (4%).

Two patients (8%) reported a neuro-sensory disturbance, which was transitory, one patient (4%) had speech difficulty, which resolved after a few weeks, and one patient had the prosthesis remade as they were unhappy with the aesthetic appearance of the teeth (4%).

Complications: fixed complete denture group
Out of the 37 patients who received a fixed complete prosthesis (mean age 56; 12 males, 25 females), 12 patients experienced at least one complication (32%) (Table 3). Peri-implant mucositis accounted for the most common complication, occurring in five out of the 37 patients (14%) (Figure 8). Peri-implantitis occurred in three patients (8%) and implant loss occurred in two patients (5%). Mechanical complications included prosthesis screw loosening in two patients (5%), fractured teeth in one patient (3%) (Figure 9) and fracture of a temporary denture in one patient (3%) (Table 2). Temporary neuro-sensory disturbance was reported in two patients (5%) and one patient had the prosthesis remade as they were unhappy with the aesthetic appearance of the teeth (3%).

Discussion
While the main purpose of the database in this project was to identify our study population, namely patients who had received a fixed complete implant prosthesis or an implant-retained overdenture with at least four implants, it also provided some useful data about implant
treatment provided in the Dublin Dental School and Hospital over a seven-year period. Prior to this, there was no record of any details of implants placed or restored in the Dublin Dental School and Hospital. This database will be useful for further research, including the calculation of survival/success data. As data were recorded for implants, as well as patients, it will be useful to identify populations who received a particular type of implant or prosthesis.

The number of implants placed each year reflects the ever-increasing popularity of implants as a treatment modality. There was a seven-fold increase in the number of implants placed between the years 2000 and 2006. Implant dentistry has enjoyed an expansion of new applications, techniques, materials and devices since the early 1980s. Together with documented high success rates, this has resulted in the number of dental implants procedures increasing steadily worldwide, reaching an estimated one million dental implants placed per year.22 Anecdotally, most of the increase in treatment has been patient driven and there is a high level of interest in implants among patients.

In this study, 452 patients received 1,111 implants, with an average of 2.45 implants per patient. Lazara and co-workers documented the placement of 1,969 implants in 653 patients over a five-year period, with an average of 3.03 implants placed per person.20 The average age of patients in our study was 56.7 years, with the highest percentage of patients being in the 40- to 60-year age group (38.5%). Other studies have reported a similar trend. Mundt, in 2006,21 reported on private practice results of 663 implants in 159 patients and found the average age to be 54 years. The average age of patients in a study carried out in a dental school in Spain was found to be 44.5 years.22 In a retrospective study carried out on 1,925 consecutively placed implants in a private practice, Wagenberg and Fournon reported the average age to be 57.9 years.23 This could be a reflection of the age when patients tend to lose their teeth or begin to have problems wearing dentures due to advancing resorption. It could also be due to an improved financial situation during this time frame. Advancing age in itself would appear not to be a contraindication to implant treatment based on the results of this study; 26% of the total number of implants placed were in the 60- to 80-year old group. Indeed, Lazzara found that the largest percentage of patients (31%) in his report was in the 61- to 70-year-old age group.20 With regard to the type of prosthesis supported by the implants, nearly half (49%) of the implants placed supported a single tooth restoration, only 9% supported a fixed partial denture, 21% supported overdenture prostheses and 21% supported fixed complete prostheses. In a five-year retrospective study, Penarrocha reported that only 10% of implants supported a single unit prosthesis, 26.5% supported a fixed partial denture, 44% supported an overdenture and 19.5% supported a fixed complete denture.22 The high number for the single unit prostheses and the relatively low number for the fixed partial dentures seems to reflect a preference in this hospital to place a separate implant for each missing tooth and/or the tendency to place conventional restorations where larger edentulous spaces exist.

A higher proportion of implants was recorded in the maxilla (58.5%) than the mandible (41.5%) in this study. This is similar to other authors; 58% maxilla, 42% mandible by Mundt21 and 62% maxilla, 38% mandible by Wagenberg.23 Possible explanations of the higher proportion in the maxilla may be tooth loss due to trauma or a higher demand in the maxilla for aesthetic reasons. Indeed 32% of all implants placed in this study were in the anterior maxilla and a similar figure (29.5%) was recorded in Wagenberg’s study.23 Only 11.5% of all implants were placed in the molar region (5.5% maxilla, 6% mandible) in this study. This is likely due to the increased surgical risks posteriorly and may reflect lower patient demand for implants outside the aesthetic zone. Other studies report a much higher percentage of implants in the molar region: 33% in the molar region21 and 24% (10.5% maxilla, 13.5% mandible) by Wagenberg.23 Implant overdentures are generally accepted as having greater complication rates than fixed prostheses. Walton reported that removable implant-supported prostheses required three times as many adjustments and twice as many repairs compared to fixed prostheses.16 In a later study, she found that maintenance appointments were longer for the removable implant-supported prostheses and the repair costs 60% higher than for fixed prostheses.18 In this study, 52% of the patients who received an overdenture prosthesis required at least one complication; the corresponding figure in the fixed complete denture prosthesis group was 32%. The average follow-up periods were 25.5 months (range of three to 66 months) and 24 months (range three to 80 months) for the overdenture and fixed groups, respectively. This is a reasonable period in which to assess complications, as previous studies indicate that the highest maintenance requirements for implant-supported prostheses occur during the first year of function.16-18 Hemmings and co-workers noted that after the first year, fixed implant-supported prostheses required more maintenance than removable prostheses.

While the figures for complications in this study seem high, it should be noted that the majority of the complications were minor in nature. A complication was defined by Goodacre24 as “A secondary condition that developed during or after implant surgery or prosthesis placement”. He also stated that: “The occurrence of a complication does not necessarily indicate (and most of the time does not indicate) that substandard dental care was provided and also does not necessarily mean that clinical failure has occurred”. Nonetheless, patients should be advised that complications are likely to occur following implant treatment and this will necessitate further visits.

One patient in the overdenture group (4%) and two patients in the fixed group (5.4%) suffered from implant loss, the cause of which was deemed to be peri-implantitis. In the overdenture group, nearly half of the complications that occurred were related to the soft tissues (44%). Gingival inflammation/hyperplasia was the most common of these (20%) followed by peri-implant mucositis (16%) and denture-stomatitis (8%). General observations included a lack of space to permit adequate hygiene under the Dolder bar and a low awareness among the patients of the existence of these complications. Goodacre, in his meta-analysis, reported a similar figure of 19% for gingival hyperplasia/inflammation associated with overdenture prostheses.17 The fixed group had a much lower incidence of soft tissue complications (13.5%), as is generally reported in the literature.25

With regard to mechanical complications, a higher incidence was also observed with the overdenture group (36%) compared to the fixed
group (8%). Fracture or loosening of retentive clips is described as the most common mechanical problem with implant overdentures.\textsuperscript{15-18} Goodacre\textsuperscript{11} also reported a high incidence of mechanical complications, with 30% of overdenture prostheses suffering from a loss of their retention mechanism – 16% of these being related to clip fracture. In this study, a slightly lower incidence of clip fracture occurred (12.5%). Earlier studies found that fractured screws were the most frequent mechanical complication with fixed prostheses,\textsuperscript{10,15,16} while later studies noted this problem less often.\textsuperscript{17,18} In the present study, no fractured screws were observed in the fixed prosthesis group (though one occurred in the overdenture group). This trend most likely reflects improved screw properties, geometry and coatings,\textsuperscript{26} along with the routine use of abutment-level prostheses and calibrated torque drivers. Similarly, there were no failures of the fixed prosthesis frameworks, which may be due to the use of milled titanium structures and conservative cantilevers. Neuro-sensory disturbance was the most common surgical complication to occur, affecting two patients (8%) in both groups. All patients recovered completely in a short time. This is very close to the mean incidence of 7% reported by Goodacre.\textsuperscript{11} He also reported a slightly higher incidence in patients who were having implants placed in association with implant overdentures, presumably due to the more extensive bone resorption typically seen in these patients. The incidence of aesthetic complications was very low in both groups, with only one patient in each group having the prosthesis remade due to unsatisfactory appearance of the teeth. This is surprising given the statistically significant higher proportion of overdenture patients who were less satisfied with the aesthetic outcome of their prosthesis (unpublished data). It may be that patients who were less satisfied with their prostheses failed to voice their concerns to the treating dentist. A study by Riefel has shown that successful direct communication with patients is an important factor in determining patient satisfaction.\textsuperscript{27} Surprisingly, no complications with speech were reported in the fixed group and only one patient in the removable group experienced this complication. In a crossover study comparing maxillary fixed prostheses with overdentures, Heydecke reported that subjects made a significantly higher percentage of sounds correctly with overdentures compared to fixed prostheses.\textsuperscript{24} It has also been suggested that patients' ability to adapt and time are responsible for the low frequency of speech complications.\textsuperscript{24}

Conclusions

- There was a dramatic increase in the provision of implants in the Dublin Dental School and Hospital between 2000 and 2006;
- the demographics of patients receiving implants was similar to that found in international studies;
- there was no difference in implant or prosthesis survival between fixed complete dentures and implant-supported overdentures;
- implant overdentures were associated with a higher number of complications (52%) than fixed prostheses (32%). The most common findings were: gingival inflammation; peri-implant mucositis; and, clip fracture; and,
- in the fixed prosthesis group, peri-implant mucositis and peri-implantitis were the most common complications.

References


