Outcomes of Implant Prosthodontic Treatment in Older Adults

(Résultats du traitement par prothèse sur implant chez les personnes âgées)

• S. Ross Bryant, BSc, DDS, MSc, PhD, FRCD(C) •
• George A. Zarb, BChD, DDS, MS, MS, FRCD(C) •

Sommaire

Les personnes âgées devraient représenter un nombre de plus en plus important des personnes ayant besoin de prothèses dentaires sur implant. Toutefois, au départ, cette biotechnologie a été étudiée pour des patients édentés d'âge moyen, et non pour les personnes âgées. Un taux élevé de succès et une perte de la crête osseuse minimale ont été rapportés en ce qui concerne les implants dentaires réalisés dans ce groupe. Aujourd'hui, les résultats d'études effectuées à l'Université de Toronto appuient clairement les rapports antérieurs selon lesquels les personnes âgées réagissent aux implants dentaires de la même manière que les adultes plus jeunes, malgré leur tendance aux maladies systémiques, notamment à l'ostéoporose. Cependant, une quantité et une qualité insatisfaisante de l'os de la mâchoire, en particulier une atrophie du maxillaire supérieur, ont nuit au succès de l'implant. De plus, la mise en place d'implants dans des zones qui avaient été édentées pendant des périodes plus courtes était associée à une plus grande perte de la crête osseuse, une découverte qui pourrait avoir des conséquences pour les adultes plus jeunes en train de subir un tel traitement. Maintenant, le principal défi auquel nous sommes confrontés lorsque nous devons prendre une décision pour traiter des dentitions partiellement ou complètement édentées dans une société vieillissante consiste à différentier les résultats du traitement, en particulier les évaluations aidées par les patients (y compris les analyses économiques), des diverses options qu'offre la dentisterie prothétique aux personnes âgées.

Mots clés MeSH : *aging/physiology; dental implants; osseointegration; dental prosthesis, implant-supported*

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It is anticipated that older adults will constitute an increasingly substantial proportion of individuals needing implant prosthodontic treatment. People are living longer, and the problem of missing teeth continues to be more prevalent among elderly people than among other age groups.[1,2] Unfortunately, wound healing and jawbone quantity and quality may be compromised in older adults.[3] Furthermore, oral hygiene may be compromised because of age-related frailties.[4] Consequently, it cannot be assumed that oral implant osseointegration will be equally successful in adults of all ages. The aim of this paper is to review scientific efforts examining the outcomes of implant prosthodontic treatment in older adults, with a specific focus on recent studies at the University of Toronto.

Initial reports of the functional and esthetic impact of oral implant prostheses have generally been favourable from the perspectives of both the dentist and the patient.[5-7] Scientific evidence for the long-term success of bone-anchored dental prostheses began with the seminal investigation by Brånemark and others[8] of predominantly middle-aged edentulous patients with advanced resorption of the residual ridge. However, additional implant surgery was required to replace failed implants in 3 out of every 10 jaws treated, ostensibly in sites with unfavourable bone anatomy. Subsequent publications have verified the long-term efficacy of a complete fixed dental prosthesis (Figs. 1a, 1b and 1c) supported by 4 to 6 implants in patients who had problems wearing dentures.[9,10] Maladaptive experiences with complete lower dentures have also been resolved by an overdenture prosthesis (Figs. 2a, 2b and 2c) using just 2 implants,[11,12] and prosthodontic options for partially edentulous patients have also improved dramatically with implant prostheses.[13,14] Such studies suggest a high mean

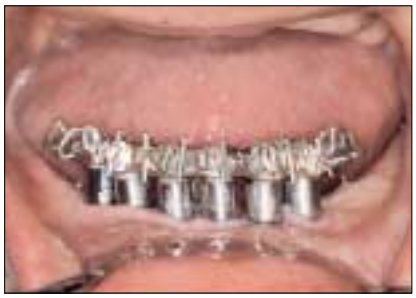

Figure 1a: *Framework try-in for complete mandibular fixed implant-supported prosthesis.*

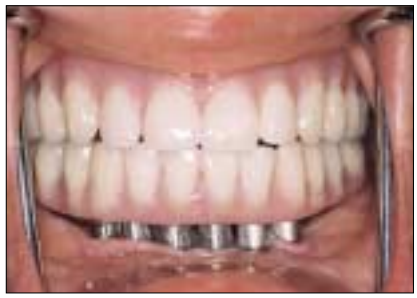

Figure 1b: *Final prosthesis for complete mandibular fixed implant-supported prosthesis.*

Figure 1c: *Post-treatment smile with complete mandibular fixed implant-supported prosthesis.*

Figure 2a: *Bar and clip assembly for complete mandibular implant overdenture prosthesis.*

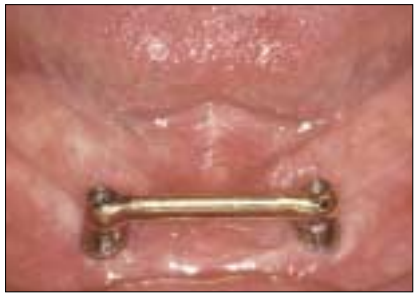

Figure 2b: *Final bar for complete mandibular implant overdenture prosthesis.*

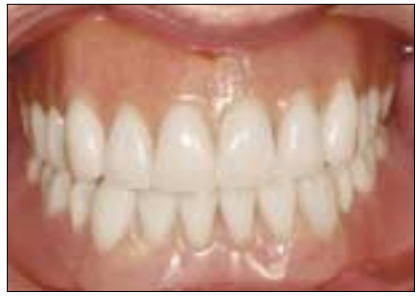

Figure 2c: *Final prosthesis for complete mandibular implant-supported overdenture prosthesis.*

rate of success for oral implants in the edentulous jaws of predominantly middle-aged patients, in the range of 80% to 90% over 10 years, accompanied by mean crestal bone loss proximal to the implants of less than 0.1 mm annually after the first year of function. Despite age-related tendencies for systemic illness, including osteoporosis, among older adults, recent outcome studies in the Implant Prosthodontic Unit (IPU) at the University of Toronto[15,16] support earlier reports that the outcomes of oral implant therapy are comparable among older and younger adults.[17,18] However, these studies[15,16] also support earlier reports that rates of implant success and crestal bone loss may be influenced by age- and site-specific aspects of jawbone condition.[19-22]

Jawbone Condition and Success of Oral Implants

Human jawbone tends to undergo age-related atrophy. This phenomenon is expressed over a lifetime as increased cortical porosity and decreased density of cancellous bone.[23] Furthermore, aging is associated with a risk of vertical resorption of the jaws, mediated largely through periodontal infection or tooth loss.[23] Both advanced resorption and poor bone quality have been associated with below-average success rates for oral implants over the short term.[19-22] Consequently, it is tempting to presume that the success of oral implants may be compromised in older adults.

Researchers are starting to distinguish the significance of these and myriad other age- and site-specific factors. A recent study in the IPU[16] found that cumulative implant success in the mandible did not differ with jawbone quality, designated according to the Lekholm–Zarb (LZ) classification[24] (Fig. 3). That study involved 485 implants placed in 114 consecutively treated edentulous mandibles of patients who were followed for periods of 4 to 17 years after prosthesis placement. The cumulative success rate (CSR) exceeded 81% for all mandibular bone quality groups (LZ types 1 to 4). However, the outcome was different for 132 implants placed in 25 edentulous maxillae in the same study. The CSR was 88% in LZ type 3 maxillae (with good-density cancellous bone) but only 67% for implants in LZ type 4 maxillae (with low-density cancellous bone). Variation in jawbone quantity may have an even more profound influence on implant outcomes, at least in the maxilla. In this regard, cumulative long-term implant success in the edentulous mandible did not differ with degree of resorption.[16] The CSR for mandibles exceeded 83% for all LZ jawbone quantity groups (LZ types A to E). However, the CSR of implants in LZ type A and B maxillae, where some alveolar bone remained, exceeded 95% but was only 50% or less among implants in more resorbed

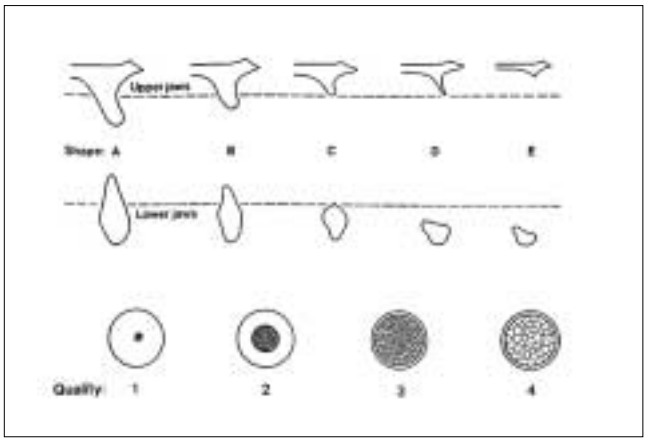

Figure 3: *Lekholm–Zarb classification of edentulous anterior jawbone shape (quantity) and quality. Shape (types A though E) reflects a range of resorptive patterns relative to the demarcation of the alveolar and basal jawbone (dotted line). Quality (types 1 through 4) reflects a range of cortical and cancellous patterns, both of which have been employed frequently in planning oral implant treatment. Reproduced with permission of Quintessence Publishing.*

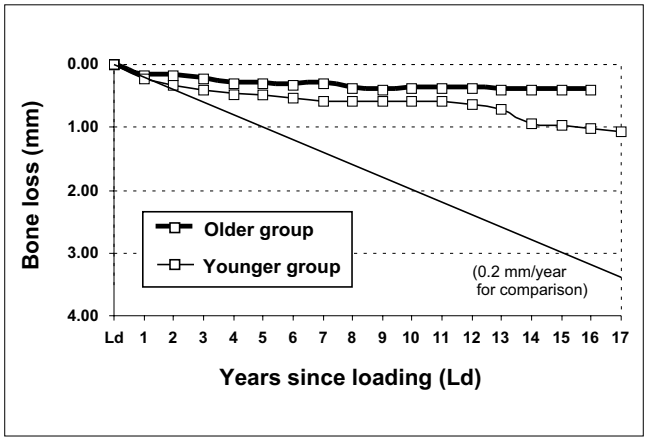

Figure 5: *Cumulative mean annual bone loss for matched older and younger patients with complete prostheses.[16] Ld = loading. There was no significant difference (p < 0.05) between the 2 groups. (Independent samples Student t-test.)*

maxillae. It is anticipated that improved measures of density of cancellous bone and other aspects of jawbone quantity and quality may prove to be even better predictors of implant outcomes.

Jawbone Condition and Loss of Crestal Bone Around Oral Implants

Aging has long been associated with a tendency for some loss of alveolar bone height, due primarily to poor oral hygiene and associated periodontitis.[25] In more recent studies, the mean loss of crestal bone around teeth was 0.3 mm per year among those at least 70 years of age at the outset of a 10-year observation period and less than 0.15 mm per year among younger cohorts.[26] Aging has also been associated with tooth loss, which has in turn been associated with even more

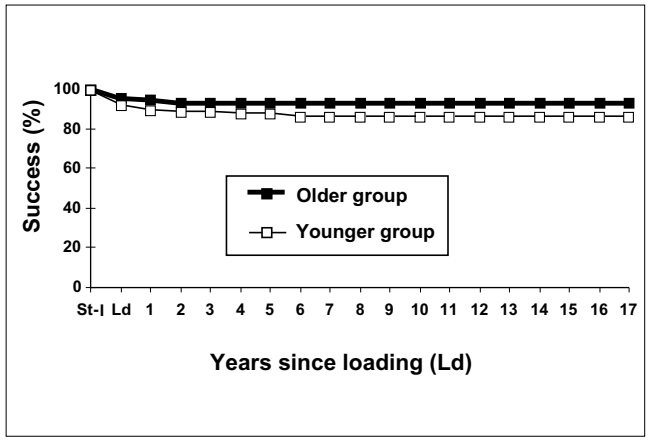

Figure 4: *Implant survival for matched older and younger patients.[16] St-I = stage I, Ld = loading. There was no significant difference (p < 0.05) between the 2 groups (Wilcoxon statistic).*

dramatic rates of alveolar bone resorption than that found around aging teeth. In Tallgren's classic study,[27] the average vertical resorption of anterior jawbone exceeded 2 mm during the first year after the extraction of teeth and insertion of complete dentures. After 10 years the rate of resorption of the residual ridge diminished to 0.05 mm per year in the edentulous maxilla and 0.2 mm per year in the edentulous mandible.

Adell and others[28] examined mean annual loss of crestal bone around implants primarily in zone I, anterior to a vertical line through the mental foramina, of otherwise mixed age- and site-specific groups. During the first year of loading, crestal bone loss exceeded 0.5 mm in both jaws. The rate then slowed to 0.1 mm per year for implants in both jaws. Resorption rates of the same order of magnitude or less have also been reported for implants in anterior and posterior zones of completely and partially edentulous patients.[29,30] In view of the tendency for residual ridge resorption to slow with time, it has been hypothesized that the pace of crestal bone loss will be faster around implants in alveolar bone (less resorbed) than around those in basal bone (more resorbed), particularly in areas rendered edentulous recently. In this regard, Lindquist and others[31] found that shorter preoperative periods of edentulism and less preoperative resorption could predict part of the ensuing resorption of crestal bone observed among implants studied over a 10-year period.

Bryant's recent IPU study[16] also supported this hypothesis. He found that implants placed in bone soon after extraction (which usually involved younger adults) tended to be associated with above-average crestal bone loss, approaching 0.1 mm annually after the first year of loading. In comparison, implants placed many years after extraction (which usually involved older adults) demonstrated below-average resorption and approximated no bone loss over time. This finding was corroborated by a tendency for below-average crestal bone loss among implants placed in more resorbed jaws (LZ types C, D and E). In contrast, no such relationship was found between bone loss patterns and LZ jawbone quality. Paradoxically these

findings can be considered particularly favourable because they suggest that oral implants have a significant potential to maintain the height of the residual ridge after tooth loss, especially in the mandible. The rate of vertical bone loss experienced around implants early in the edentulous period, approaching 0.1 mm annually,[16] was dramatically less than the rate of bone loss observed under complete dentures early in the edentulous period, which initially exceeded 1 mm annually.[27] This finding suggests some concern for younger adults who have been edentulous for short periods at the time of implant placement. For example, above-average crestal bone loss of 0.15 mm annually in a 25-year-old implant patient could lead to a total loss of 6 mm over the ensuing 40 years. On the contrary, there is good reason to suppose that such mildly elevated rates of bone loss in younger adults would tend to diminish with time, as Tallgren[27] observed under complete dentures.

Outcomes of Oral Implant Treatment in Older and Younger Adults

Notwithstanding these age- and site-specific observations, several studies,[15-18] including those from the IPU,[15,16] suggest that old age itself will not influence the outcome of oral implant therapy involving either partial or complete prostheses. No difference in long-term success of oral implants was found between older and younger groups in the IPU studies, despite the fact that the older patients had more physical frailties and systemic illnesses.[15,16] The older group was 60 to 74 years old at the time of implant insertion (Stage I), whereas the younger group was 26 to 49 years old, and all patients were followed for a period of 4 to 17 years after prosthetic loading. In each group there were 45 complete or partial prostheses matched closely on the basis of sex, implant number and location, prosthetic plan, condition of the opposing dentition and year of implant placement.[15,16] At the most recent follow-up, the CSR was 92.0% for 190 implants placed in the older group and 86.7% for 184 implants placed in the younger group (Fig. 4).[16] Furthermore, the mean annual loss of crestal bone observed around the implants in the edentulous jaws in both groups was less than 0.05 mm per year after the first year of loading (Fig. 5).[16]

The effects of poor oral hygiene have not been documented specifically among elderly patients with oral implants. However, in an earlier IPU study of a patient group with a wide age range, Apse and others[32] found that accumulation of plaque was not related significantly to rates of peri-implant bone loss or oral implant failure, at least for threaded titanium implants.

Regarding other physiologic and psychosocial outcomes related to implant prosthodontic treatment, no studies have specifically compared older and younger groups. Nonetheless, oral function (usually assessed as masticatory efficiency) associated with complete fixed and complete removable implant prostheses is reportedly excellent.[5,7] Interestingly, nutritional adequacy may not be any better with implant prostheses than it is with traditional complete dentures.[33] Patient satisfaction with oral implant prostheses is also reportedly good.[6,7,34-36] However, only recently have there been prospective attempts to document improvements in the quality of life of oral implant patients.[37-39] These efforts suggest that some patients will perceive substantial benefit from oral implant prostheses in terms of the costs and consequences experienced in particular clinical study conditions. Unfortunately, there remain unresolved problems regarding the credibility and stability of quality of life measurements in the overall context of health, including the oral health of elderly people.[40-42] Furthermore, despite the relatively high cost of implant treatment, economic analyses related to oral implants have remained very theoretical to date.[43,44] Ultimately, because of a lack of evidence-based rigour,[45] implants may be seen as a panacea for virtually every patient who seeks prosthodontic care. Although it appears likely that older adults will fare just as well with oral implant prostheses as younger adults, more research is needed to distinguish patient-mediated outcomes of the various prosthodontic treatment options for older people with depleted dentitions or complete edentulism.

Discussion

There now exists compelling evidence that osseointegrated oral implants can be used in a diversity of age- and site-specific prosthodontic applications. The major criteria for clinical success of osseointegration are immobility of individual implants accompanied by a lack of pain, pathologic problems and crestal bone loss[46,47] In studies from the IPU at the University of Toronto, which used these criteria, the osseointegration of Brånemark implants was equally successful in matched groups of older and younger adults with complete and partial edentulism. In particular, cumulative implant success in both groups exceeded 86.7% over 4 to 17 years after loading.[16] This finding corroborated the results of other studies from the IPU (see review by Elsubeihi and Zarb, page 103 in this issue) and elsewhere, which suggest that osseointegration success may not be affected by the common illnesses associated with aging, including cardiovascular disease, osteoporosis, hypothyroidism and diabetes mellitus. These results reaffirm a positive response to all 3 of the questions posed by Zarb and Schmitt[48] in relation to the implant prosthodontic management of older adults: that osseointegrated implants can and should be prescribed for elderly patients, that successful osseointegration can be maintained as patients age despite their physical and medical frailties, and that the principles of osseointegration can be reconciled with various prosthodontic techniques to help ensure that this treatment is accessible to older adults. Certainly age alone should not be used to exclude patients from a prescription of oral implants for the management of complete or partial edentulism. Rigorous application of established surgical and prosthodontic protocols will meet routinely with predictable outcomes if the patient is able to undergo minor oral surgery. Furthermore, osseointegrated oral implants can be maintained with either fixed or removable prostheses, regardless of age. What remains unclear is the extent of diverse patient-mediated concerns among older adults as they relate to the psychosocial (in particular

economic) outcomes of various prosthodontic treatment strategies. Such assessments are necessary if both the dentist and the patient are to make the best informed decision on the prosthodontic options available, whether or not these options include implants. ◆

Le Dr Bryant est professeur adjoint en prosthodontie, département des sciences de la santé buccodentaire, Université de la Colombie-Britannique, Vancouver (Colombie-Britannique).

Le Dr Zarb est professeur et directeur, prosthodontie, au département des sciences cliniques, faculté de médecine dentaire, Université de Toronto (Ontario).

Écrire au : Dr Ross Bryant, Faculté de médecine dentaire, Université de la Colombie-Britannique, 2199, Wesbrook Mall, Vancouver (Colombie-Britannique) V6T 1Z3. Courriel : rbryant@interchange.ubc.ca.

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