Review
Rehabilitation of oral function with removable dentures – still an option?

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SUMMARY Tooth loss is a chronic disability, which makes it difficult for patients to perform essential tasks such as eating, communicating with others and socialising. Numerous studies have revealed and addressed the recent rapid development of various prosthodontic materials and treatment patterns. Oral rehabilitation with dentures exerts a great influence on people's daily life and has tremendous social implications. Dentures help to restore an individual's sense of normality and ability to interact normally. With the introduction and progression of implant technology, many troublesome issues can now be solved simply. Nowadays, more and more attention has been paid to new trends (implant-assisted restoration and fixed prostheses). However, removable dentures may be a more appropriate solution under some circumstances, such as if they are a patient's preferred option, if remaining oral tissues are in poor condition, or if they provide the most cost-effective form of treatment. Thus, removable dentures are still an option for the rehabilitation of oral function. The purpose of this article was to retrospectively review the applications of removable dentures and to emphasise their indispensable status.

KEYWORDS: rehabilitation, removable, dentures, oral function, human

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Introduction
Oral functions consist of masticatory, swallowing, aesthetic, sensory and phonetic components. Oral function pathologies could result from many causes, such as tooth loss (1, 2), muscular parafunction, tumours, trauma and temporomandibular disorders. Patients with these impairments may experience increasing social and psychological difficulties (3–5). Application of various restorations, of which removable dentures have long occupied a place, provides a means to solve those problems. The most frequently demanded characteristics for a denture to restore oral function include masticatory, aesthetic and phonetic properties (6). Patient satisfaction and the cost-effectiveness of treatment with conventional removable dentures versus later developments such as implants are important factors to consider during treatment planning. The purpose of this article was to provide an insight into rehabilitation of oral function with removable dentures.

Literature search
An online database search was performed to identify relevant publications that assessed oral function after rehabilitation with dentures. The search was conducted through PubMed, ScienceDirect Online, SPRINGER and BlackWell, and all were for the period 1960 through 06 February 2014. The keywords used in the search were as follows: oral functions, rehabilitation, removable, denture and human. Articles describing the use and development of removable dentures and rehabilitation of oral functions
review of removable denture were eligible for this review. The
review that follows is not intended as a systematic
review of all past findings. Instead, it focuses on the
advantages and disadvantages of removable dentures
and provides information to readers which will help
them make a proper treatment plan for partially
edentulous subjects under current trends of fixed
dentures and implant prostheses.

Review of traditional removable dentures

Tooth loss has many effects on quality of life, not
only because of its physical and functional conse-
quences, but also the ensuing social and psychological
problems (7). Removable partial dentures (RPD) and
complete dentures are the traditional removable den-
tures that play an important role in restoring oral
functions and systemic health (8), as well as occup-
ying a significant position in prosthodontic history.
Despite the limitations of conventional removable
dentures, satisfactory restorations that can rehabilitate
appropriate oral functions can be fabricated if careful
attention is paid to every step involved (9). Indica-
tions for removable dentures have been described in
several articles (10–12).

Masticatory function

One crucial oral function is chewing, which has sig-
nificant effects on general health status (13). Chewing
problems may be the main reason for impaired oral
health, resulting in demands for treatment (14). Any
problems in the masticatory system, temporomandib-
ular joints, muscles, teeth or motivational control cor-
tex result in masticatory dysfunction.

Tooth loss is one of the most common causes of
reduced chewing ability. Many studies have indicated
that wearing removable dentures to replace the lost
teeth can greatly improve masticatory functions
although without restoring normal chewing ability
compared to complete dentition (15–19). Edentulous
patients showed improvements in terms of overall
patient satisfaction and health-related quality of life
including masticatory function when they received
complete dentures (20). One study demonstrated that
the average efficiency of a removable denture rose
immediately after the restoration was placed, and
reached maximum efficiency gradually in approxi-
mately 1 month (21). Another study also reported
that the masticatory efficiency and the subjective
evaluation of masticatory performance increased sig-
nificantly after the lost teeth were restored with
removable dentures (17, 18). Mastication in patients
with extremely shortened dental arches rehabilitated
with a removable partial denture (RPD) was assessed
in one study (15). Removable partial denture wearers
showed improved masticatory performance and ability
and shorter chewing time than when not wearing the
prostheses or compared to those who had not
received any therapy.

Dietary choices and nutritional intake are affected
by chewing ability and therefore have a critical effect
on general health (22). Some researchers collected
dietary data concerning the food and nutrient intake
of 49 501 male healthy subjects and found that eden-
tulous participants consumed fewer vegetables, less
fibre and carotene, and more cholesterol, saturated fat
and calories than those with 25 or more teeth. Longi-
tudinal analyses suggested that tooth loss may lead to
detrimental changes in diet (23). One study revealed
that a major benefit of wearing an RPD for those who
had lost their posterior teeth was improved mastica-
tory performance (18).

Improvements in masticatory function must be on
the basis of fitting dentures. Garrett (24) reported that
patients with poorly fitting dentures suffered oral dys-
function; however, almost all patients perceived an
improvement in masticatory function after they were
issued with a new, better-fitting removable denture,
in terms of chewing comfort, chewing ability, less dif-
ficulty eating hard foods and eating enjoyment. When
quantifying the security of mandibular dentures in
edentulous patients using a visual analogue scale,
relining ‘loose’ dentures gave higher scores in their
assessments for 21 of 23 patients (25). To maintain
functionally stable dentures, static–dynamic concepts
of framework design that stress the distribution of
vertical and horizontal forces between abutments as
well as abutments and mucosa should be considered
(26). Duplicating favourable features of the previous
denture, especially the polished surface shape, facil-
itated the adaptation process and resulted in better
functional performances (27, 28). Some materials
were used to develop high-quality and innovative
removable dentures with good functional and adapta-
tion properties, including reinforcement of PMMA
denture bases with fibres and thermoplastic materials
One study demonstrated that mean daily nutrient intakes did not differ between subjects with well-fitting dentures and those with natural teeth (32). Studies comparing changes in masticatory function in complete denture wearers before and after relining with a soft liner showed that a soft lining material improved masticatory function with no adverse effects on muscular tasks (33–35). For example, in one clinical study, two sets of complete dentures were fabricated with and without a soft liner for 20 patients (36). They found that masticatory performance in patients wearing complete dentures with soft liners was improved by 5% compared to patients fitted with dentures without soft liners. Soft liners can also be used in removable partial dentures, especially for the distal extension dentures (37). In addition, denture adhesive can also contribute to reducing denture movement and improving chewing function (38–41). Some deleterious effects on dental and supporting tissues are known to be caused by removable dentures, such as caries, periodontal disease and mucosal lesions. However, if a maintenance programme is undertaken, including oral hygiene instruction and motivation as well as regular check-ups by a dentist, all those may be mitigated (42–44). Meanwhile, removable dentures need to be paid periodic attention at least as often as natural teeth.

**Aesthetic function**

Dentures restore a natural appearance and allow patients to regain their confidence to interact with others in our image-conscious society (6). Aesthetic function is mainly determined by the clinical and technical procedure used as well as the choice of patterns and materials (45). Manufacturers correlate the dentures to face contour and tooth form according to the concept developed by Frush and Fisher (46, 47) that integrates tooth selection into an aesthetic system governed by sex, personality and age. Even interim removable dentures can provide aesthetic relief and essential functionality before the final prosthesis (48). For partially edentulous individuals, an RPD replaces the missing teeth, and for edentulous patients, complete dentures also provide them with an appropriate smile and normal appearance, suiting their physical character and image needs. Thus, removable dentures fulfil the aesthetic requirements to some degree, although the satisfaction varies enormously which may be affected by personality type (48), psychological factors (49, 50) and other factors in addition to technical excellence (51).

Restorative technology develops so fast that more and more effort has been expended to improve masticatory function and aesthetics at the same time (52). Improvements in the aesthetics of removable dentures seem to be obvious. When the rotational path is properly designed and fabricated, patients can be pleased aesthetically (53, 54). Various advancements have improved the quality of removable dentures, improving an individual’s quality of life. In framework design, the aesthetic considerations are concerned with keeping parts of the framework out of sight, by minimising the interproximal minor connectors, removing unnecessary clasps, adding indirect retainers distally and so on (26). Ancowitz (55) described six dental categories that assisted dentists in choosing RPD design concepts to avoid unesthetic exposure, in addition to the utilisation of new materials. In addition, communication with patients plays an important role in ensuring satisfactory restorations by following the try-in procedure (56). Improvements in a patient’s aesthetic appearance can be achieved to reach their aims using systematic approaches (57).

For complete dentures, three aesthetic concepts have been recommended: ‘natural’, ‘supernormal’ and ‘denture look’ (58). The dentogenic approach (described as ‘natural’) seeks to match anatomic determinants of sex, age and personality. A patient-centred approach (described as ‘supernormal’) permits changes from patients to achieve what they regard as beautiful. In clinical practice, no one approach is the best for every patient, it depends on each individual. For example, although a denture look is not acceptable for many prosthodontists, patients may be accustomed to this appearance and even prefer it (59–62). Specific decisions about tooth display, proportion, size, shape, arrangement, colour and position should be based on the aesthetic concept the patient and dentist have chosen. Sometimes, duplicating favourable features of a patient’s previous dentures may produce a better aesthetic effect (6).

**Phonetics**

It is well known that the phonetic function is negatively affected by tooth loss and that this impairment
Development of removable dentures

Implant-supported removable dentures show many advantages compared with conventional ones, providing a new concept for restorations. These include implant-assisted and implant-supported overlay dentures, hybrid prostheses and fixed porcelain-fused-to-metal or all-ceramic restorations. The treatment planning process is dictated by the age of the patient, psychological demands, aesthetic needs, requirements for hygiene access, anatomic limitations, degree of ridge resorption, interocclusal space and cost of treatment. For clinicians, the design and maintenance of distal extension partial dentures appears to be challenging as these types of dentures have produced complaints about lack of stability, minimal retention or unaesthetic clasps. Placement of implants in the distal region can convert denture patterns from Kennedy I or II to Kennedy III (72–74). More stable removable dentures with fewer implants may therefore be a cheaper and better choice for those with limited finance than the implant-supported fixed prostheses (75, 76). Another study verified that stable and durable occlusion improved oral function, which could be obtained by placing implants beneath the distal extension denture base of the RPD (77). Analysis of masticatory movements assessed by a tracking device and evaluation of the occlusal force and contact area by a T-scan system were also conducted in this study. The results proved that implant-supported removable dentures had greater force and greater area, and all the patients were satisfied with comfort, chewing, retention and stability. Although the classical treatment plan for edentulous patients is to provide a complete removable denture, choosing implants to support the denture may be one more suitable solution, especially in the mandibular region where the bearing area is relatively insufficient (78, 79). Chen (80) conducted a study comparing the comparative masticatory efficiency of mandibular implant-supported overdentures (ISOs) to tooth-supported overdentures (TSOs) and complete dentures (CDs). The results revealed that the ISO provided the greatest degree of efficiency, followed by the TSO and the CD groups. Awad (81, 82) evaluated the general satisfaction and function (comfort, stability, easing of chewing, speech, aesthetics) of implant-retained overdentures and concluded they were significantly higher among middle-aged or senior edentulous patients.
compared to conventional dentures. Implant-supported prostheses can improve the social and intimate activities in edentulous adults to a greater degree than conventional ones (83), can also reduce psychological distress (84) and can improve nutrition (85). However, a systematic review of 18 articles addressing masticatory performance with implant-supported dentures verified that objective benefits in masticatory performance of implant-supported dentures compared to conventional dentures were limited to implant-supported overdentures with a resorbed mandible and/or difficulty in fitting conventional complete dentures (86). A meta-analysis of randomised controlled trials evaluating implant-supported mandibular overdentures suggested that the magnitude of the effect was still uncertain although implant-supported dentures might be more satisfactory than conventional removable dentures (87). The cost of implant-supported overdentures remains higher than conventional dentures, but if necessary, an implant-retained (using two implants) overdenture seems to be a more cost-effective alternative than implant-supported (four implants) ones (88). Despite these positives, implant-assisted dentures cannot be provided to the entire edentulous population for economic and patient-related reasons (6). A recent study reviewed articles published from 1966 to 2007 and compared the masticatory performance of subjects with implant-supported or retained dentures with that of those with conventional dentures (89). The authors concluded that limited high-level evidence is available supporting advantages in mastication of implant-assistant dentures over conventional dentures.

Special applications of removable dentures

Dental agenesis is a common developmental anomaly and may have significant aesthetic and psychosocial, as well as functional implications. The prevalence of dental agenesis in North America in 2004 reached 3.91% (90), and that in Europe and Australia was even higher (91). Treatment of the adolescent patient requires special considerations among which facial growth is a prominent concern (92). For children with ectodermal dysplasia, periodic removable dentures may be the best choice in contributing to the rehabilitation of all the oral functions, development of normal dietary habits and rapid social integration (93, 94). Fixed prostheses are restricted not only because of the possibility of pulp exposure but also to allow jaw growth (95). Endosseous implants placed in young patients act as ankylosed teeth resulting in infraoclusion of the prostheses or cause jaw growth disturbance (98, 99). The application of implants in the developing maxilla should be avoided until early adulthood (98, 99). Removable dentures should be considered when fixed restorations are inadequate (100). Overdentures are a simple and reversible choice that can provide the means for restoring ideal occlusion, increasing the vertical dimension, improving facial aesthetics, restoring self-image (101) and stimulating the alveolar ridges (102). It is recommended that prosthetic rehabilitation must be performed as early as possible to overcome the handicap and allow the patient to integrate into society (103). Clinical observations reveal that overdentures do not impede growth of the jaws or eruption of the permanent dentition (104). Further, a long-term study of paediatric patients treated with overdentures verified that no TMJ-related complications occurred (105). Patients with oligodontia or other development defects treated with conventional or modified overdentures illustrated the value of removable prostheses as one approach to fulfilling the requirements of aesthetic rehabilitation (106).

Removable dentures play important roles in the procedure of occlusal rehabilitation. Occlusal reconstruction is one of the most demanding tasks and therefore needs to be considered carefully as the stakes are high and failure is costly (107). During the procedure of increasing the occlusal space, splint therapy, usually used for a trial period (109), reduces activity and relieves symptoms of muscle dysfunction (108). Thus, a right centric position can be recorded by de-programming and jaw manipulation procedures (110). For some complex patients, removable dentures make sense as a temporary prosthesis when restoring teeth in bad condition (111). In addition, removable dentures can be used as provisional restorations which are a good diagnostic instrument in full-arch oral rehabilitations in the process of achieving ideal results (112). Overlay removable partial dentures can be used instead of an occlusal splint to efficiently evaluate the vertical dimension of a patient’s occlusion (113) and provide a reversible choice before transferring to a final restoration (114, 115). For financial reasons or general medical conditions, overlay removable partial dentures have some
advantages and provide a simpler and cheaper substitute compared to fixed prostheses (116, 117).

**Conclusion**

Although removable dentures are usually less appreciated due to concerns regarding their comfort, aesthetics, masticatory function, occlusal stability and maintenance of oral hygiene, more modified strategies are being developed and put into use, perfecting the application of removable dentures so that they are competitive as well as being non-invasive and cost-effective. With the geriatric population growing, there will be increase in the percentage of patients having edentulous or partially edentulous jaws. Our analysis shows that the use of removable dentures remains a viable and predictable treatment choice in clinical dentistry. An obvious shortcoming of this review is that it is not a systematic study, so that many facets cannot be addressed sufficiently and the results may not be considered as robust.

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