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Clinical use of duplicate complete dentures: A narrative review

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ABSTRACT

Most reports on duplicate dentures are introduction to fabrication methods or clinical case reports. Only a few studies have verified their clinical effectiveness; hence, evidence to construct useful clinical guidelines for duplicate denture use is lacking. This review aimed to comprehensively investigate reports on duplicate dentures to accumulate evidences that will contribute to the formulation of clinical practice guidelines. Duplicate dentures are effectively used for impression making and bite registration when fabricating new dentures, thereby reducing the number of clinic visits and treatment time. Duplicate denture can also be used as temporary or new dentures. Older people in whom various adaptive abilities have declined, may find it difficult to adjust to new dentures and experience stress, even if the shape is appropriate. Duplicate dentures, which reproduces the shape of old dentures that they are used to, have the advantage of being more familiar to older people and less stressful. When manufacturing duplicate dentures, digital methods such as milling and three-dimensional printing are superior to conventional methods regarding working time and cost. A notable advantage of the digital method is that the denture shape can be saved as digital data, and the denture can be easily duplicated if lost.

1. Introduction

Treatment dentures are used before complete denture fabrication in cases where occlusal or mucosal treatment is required for mouth preparation. Dentures that are currently in use are modified and often used as treatment dentures. However, modifying dentures can be difficult if the denture in use has a metal base or if the resin base has deteriorated significantly owing to frequent repairs. In such cases, the fabrication of duplicate dentures is effective and can also be used as new dentures [1–4]. Especially in older people, since the ability to adapt physically and sensually decreases with age, they often face difficulty wearing the new denture if its shape is significantly different from that of the previous denture. Thus, duplicate dentures with the same shape as previous ones are considered useful [5–8]. Moreover, the procedure for fabricating duplicate dentures is more straightforward than that for conventional dentures; hence, it can be used in cases with a limited number of treatments, such as in older people who use home-visit treatment or patients with mild dementia [9]. Furthermore, duplicate dentures can be used for impression-making and bite registration when fabricating new dentures, making artificial tooth alignment easier than with conventional methods [10,11]. Recently, various digital technologies have been developed to manufacture duplicate dentures [4,12–21]. Digital technology is extremely useful in the production of duplicate dentures, not only simplifying the production procedure, but also quickly reproducing dentures in the case of denture loss using the saved three-dimensional (3D) data of the denture shape [22,23]. Although there have been many reports on duplicate dentures, most introduction to fabrication methods or clinical case reports [1–3,10,11,24,25]. As only a few studies have verified their clinical effectiveness, there is a lack of evidence to construct useful clinical guidelines for duplicate denture use. Therefore, this study aimed to comprehensively investigate the previous reports on duplicate dentures to accumulate evidence that could contribute to the formulation of clinical practice guidelines.

2. Materials and methods

English literature published until April 2023 related to duplicate complete dentures were comprehensively searched using the National Library of Medicine (MEDLINE) database, accessed through PubMed and Scopus. The following search strategy was employed: “Duplicate denture” OR “Copy denture” OR “Denture replica”.

The inclusion criteria for selection of articles in this narrative review

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were those articles written in English that studied clinically related performances of duplicate dentures, such as manufacturing method, dimensional accuracy, working time, cost, purpose of use, and clinical evaluation. In vitro studies and case reports were also included. Exclusion criteria included articles that focused on duplicate techniques for fixed partial dentures, fixed implant-supported prostheses, and replica dentures for implant surgical guides. Articles that used duplicate dentures of removable partial dentures were also excluded. Studies without abstract were excluded. The titles and abstracts of all identified articles were screened to eliminate those that clearly failed to meet the inclusion and exclusion criteria by two reviewers. After the first screening phase, complete text of the articles were comprehensively assessed for eligibility. The final decision regarding the inclusion of articles was reached after full-text analysis by mutual consensus between the reviewers. An investigation regarding the above-mentioned items, including the references of the retrieved articles, was conducted.

3. Results and discussion

A total of 531 and 586 articles were confirmed in PubMed and Scopus, respectively. After eliminating 288 duplicate articles, 829 articles were finally confirmed. Based on the titles and abstracts of the identified papers, the manufacturing method, dimensional accuracy, working time, cost, purpose of use, and clinical evaluation of duplicate dentures were summarized after removing articles that did not meet the criteria. Regarding the main topic of this literature review, five articles that conducted clinical evaluations of duplicate dentures were found.

3.1. Fabrication of a duplicate denture

3.1.1. Conventional method for manufacturing duplicate dentures

Various methods have been proposed for manufacturing duplicate dentures. The conventional method for fabricating duplicate dentures is as follows: a negative mold of the denture is created by embedding the denture in use in an impression material with a special duplicate flask, and then a specific resin material is filled in the mold to create a duplicate denture. The mold materials used in conventional methods include those that emphasize the reproducibility of the denture shape, such as metals [3] and ceramics [1,24], and the simplicity of the procedures that use ready-made impression trays [25] or wax materials [6]. Moreover, the impression materials used for embedding the denture include alginate [1,24] or silicone-based impression materials [10,11, 25], or plaster [2,3,6] for higher reproducibility. Furthermore, when filling resin materials, most reports generally involve replicating the entire denture as one material; however, a method of filling the artificial tooth and denture base separately has also been introduced [1].

3.1.2. Replicated denture production method using digital technology

Recently, the number of reports on the methods for manufacturing duplicate dentures using digital technology (digital methods) has increased. The procedure for manufacturing duplicate dentures using the digital method is as follows: the external shape of the denture in use is converted into 3D data—stereolithography (STL) format. Based on the STL data, a duplicate denture shape is designed using computer-aided design (CAD) software, and based on that CAD design, the duplicate denture is processed using computer-controlled digital processing equipment that is computer-aided manufacturing (CAM), which is called CAD-CAM technology. CAM methods include milling methods that cut out resin block materials, and 3D additive manufacturing methods that use 3D printers (3DP methods).

To establish a method for manufacturing duplicate dentures using the CAD-CAM method, Maeda et al. introduced the use of digital technology for manufacturing digital dentures in 1994 [26]. Kawahata et al. manufactured a denture form by cutting out modeling wax and analyzed the dimensional accuracy using existing dentures as a reference [27]. Thereafter, Goodacre et al. summarized the manufacturing flow of resin-made duplicate dentures using digital technology [22]. Since then, many researchers have reported various methods for manufacturing duplicate dentures using digital technology. Digital technology can simplify the production of duplicate dentures, and is also beneficial in duplicating maxillofacial prostheses with complex shapes that are usually difficult to duplicate through conventional methods [28].

Methods using dental cone-beam CT (CBCT) imaging [4,12,13] and optical laboratory scanners [14] for converting the external shape of dentures into 3D geometric data have been reported. Duplication technique using CT, in terms of obturator, was first reported in 2016 [29]. When scanning denture shapes using an optical laboratory scanner, it is necessary to scan the mucosal and polished surfaces separately and reconstruct both images on a computer [14]. However, recent portable optical scanners [15] or an intraoral scanner [16,17] have been used to obtain 3D data of the external shape of dentures in a single scan. Regarding CAM, methods have been reported in which a trial denture form is duplicated from a monolithic wax block [18], or a duplicate denture is directly cut from a resin block [19]. Furthermore, reports on the production of duplicate dentures using the 3DP method have recently increased [4,13,14,16,17,19–21].

The monolithic resin blocks used in the milling method are mainly composed of polymethyl methacrylate (PMMA) resin or polycarbonate. In contrast, the resin powder material used in the 3DP method is composed of methacrylic acid esters. The 3DP method, as an additive manufacturing method, includes the Stereo Lithography Apparatus (SLA) and Digital Light Processing (DLP) methods; the DLP method is mainly used to manufacture duplicate dentures [30–32].

With both digital methods, there are patterns in which the denture base and artificial teeth are manufactured as a single unit, or the denture base and artificial teeth are manufactured separately and later bonded together. Several methods exist for bonding the denture base and artificial teeth, such as using a special adhesive or self-curing polymerization resin [33]. The problem in manufacturing the artificial tooth and denture base as a single unit is that the artificial tooth and denture base parts will have the same color tone, which makes it impossible to provide aesthetics. Recently, a method has been introduced in which duplicate dentures are fabricated using crown-colored resin using the 3DP method, and esthetics are imparted by characterizing the denture base and gingival area [4]. Notably, an innovative digital method to duplicate and replace only the artificial tooth part of the denture that is currently in use has been introduced [34].

3.2. Dimensional accuracy, work time, and manufacturing cost of duplicate dentures

Few studies have discussed the dimensional accuracy of duplicate dentures. As duplicate dentures are often intended for relining or used in impression-making or bite-registration for the production of new dentures, strict dimensional accuracy might not necessarily be required. Regarding conventional replication methods, some studies have examined the effects of differences in replicas and impression materials on the dimensional accuracy of replicated dentures [35]. Recently, the number of reports comparing the traditional and digital methods has increased. Duplicate dentures manufactured using the milling method had the same accuracy as those manufactured using the conventional method and were well-tolerated for clinical use [36]. Additionally, a systematic review of in vitro studies revealed that monolithic PMMA resin blocks used in milling methods have superior mechanical properties compared with conventional heat-polymerized PMMA resins [37]. However, when the thickness of the denture base is thin, the risk of fracture of PMMA resin blocks is higher than that of conventional denture base resins [38].

A study comparing the accuracy of duplicate dentures among various digital methods reported that denture bases manufactured by the milling method had significantly better trueness than those manufactured using the 3DP method (DLP method); however, no significant difference was observed in the fitness of the denture base mucosal surface [32]. Other

studies have also reported that denture bases fabricated using the milling method have superior mucosal surface accuracy compared with those manufactured using the 3DP method (DLP method) [30,39]. Additionally, in a study comparing the scan method between CBCT imaging and a lab scanner for 3DP methods and between DLP and SLA as manufacturing methods, it was found that the accuracy was within the clinically acceptable range for all combinations, but the accuracy of the combination of lab scanner and SLA was significantly better than that of the combination of CBCT and SLA [31]. The conventional method was reported to require a longer lab time and to be less efficient than the digital method [31]. Although the material costs were higher for the digital method, the total cost may be higher for the conventional method [40]. It is predicted that digital devices will evolve in the future, and further improvements can be expected regarding work time and cost using digital methods.

3.3. Purpose of using duplicate dentures

3.3.1. Duplicate dentures as new or temporary dentures

Many reports exist on the usefulness of duplicate dentures not only as new dentures but also as temporary dentures, such as treatment and immediate dentures [1–4]. Patients with sleep apnea syndrome used duplicate dentures that is worn while sleeping called night dentures [21]. Duplicate dentures can also be used as spares for normally used dentures [3,9] and are useful when dentures are lost owing to accidents or disasters. The main advantage of using digital methods to create duplicate dentures is that denture form data can be saved, and dentures can be easily replicated multiple times.

As the manufacturing procedure for duplicate dentures is simpler and less frequent than the general denture manufacturing procedure, it is effective when manufacturing new dentures for patients with mild dementia or during home visits [1]. Furthermore, older people often have difficulty adapting to new dentures owing to a decline in various functions [5–7,25,35]. Taji et al. reported that the mean Mini Mental Status Examination (MMSE) score for institutionalized patients who did not accept denture delivery (11.7 +/−7.0) was significantly lower than that of those who accepted and wore their dentures (16.0 +/−6.8) [41]. Therefore, the cognitive status of older persons with dementia should be a criterion in clinical decision making relating to new denture fabrication. According to the dental treatment guideline for dementia people, although it is written in Japanese, the fabrication of new dentures cannot be recommended depending on the level of dementia [42]. A duplicate denture that reproduces the shape of the denture that the patient is currently using, even if its shape is not clinically adequate, is easy to get used to at an early stage, and is effective in maintaining mental stability in the older adults [9].

3.3.2. Duplicate dentures used for impressions and bite registration

Duplicate dentures are used for impression-making (occlusal impression, occlusal pressure impression, and dynamic impression) and bite registration during new denture production [6,10,11,13,15,17,19,20,24]. Using the 3D data obtained by scanning the denture in use with an intraoral scanner, a duplicate denture was manufactured by digital methods and used as a denture for try-in [11]. A specific tray made by duplicating the previous denture for impression making and bite registration to fabricate a new maxillary denture was reported to reduce chair time and the number of visits, owing to the simple process, and produce a clinically satisfactory denture quality [43].

According to a report on the use of duplicate dentures for bite registration, the reproducibility of the occlusal vertical dimension of the denture was better than that of the conventional method [44]. An innovative method for bite registration of a mandibular complete denture was reported; the duplicate denture was divided in the midline, the bite position was recorded using an intraoral scanner with the separated duplicate denture inserted on one side, and images of both sides were superimposed on the computer [20].

3.4. Clinical evaluation of duplicate dentures manufactured using conventional methods

Various clinical evaluations of duplicate dentures have been performed. Although the evidence level for the research method is not high, duplicate dentures have been clinically evaluated as being better than dentures manufactured using conventional methods in many aspects (Table 1).

Davis et al. conducted a retrospective study of the medical records of 100 patients who underwent complete denture treatment at a university hospital. They compared 50 patients who received conventionally manufactured complete dentures and 50 patients who received duplicate dentures. Although methodological bias cannot be ruled out because the participants were not randomly assigned; they reported no significant difference between the two groups regarding denture fit accuracy and patient adaptation [45].

Scott et al. non-randomly assigned 65 edentulous patients to a group wearing a duplicate denture (33 people) and a group wearing dentures made using a conventional method (32 people) and evaluated oral-related quality of life (QOL) (OHIP-14) before and after wearing dentures. In both groups, the dental students made all the dentures under the supervision of their instructors. There was no significant difference between the two groups regarding the changes in the OHIP scores before and after treatment. Furthermore, the group wearing dentures made using the conventional method showed significant improvement in five of the seven OHIP subscales, whereas the group wearing duplicate dentures showed significant improvement in all seven subscales [46].

Ellis et al. divided 40 edentulous patients into a group wearing a duplicate denture (20 patients) and a group wearing dentures made using a conventional method (20 patients) in a non-random manner so that they were equal in age and sex. They evaluated their satisfaction using the Visual Analog Scale (VAS) and oral health-related QOL (OHIP-20) before and 1 month after wearing the dentures. There were no significant differences in the evaluation values between the two groups before and after treatment. Regarding OHIP-20, the “handicap’’ subscale significantly improved in the group wearing conventionally manufactured dentures, and the ”pain” and “psychological discomfort” subscales significantly improved in the group wearing duplicate dentures. Furthermore, although patient satisfaction improved significantly in both groups, aesthetic satisfaction was lower in the duplicate denture-wearing group [47].

Kamalakidis et al. randomly assigned 20 edentulous patients to a group wearing conventionally manufactured complete dentures or a group wearing duplicate dentures. They compared the level of denture satisfaction, OHIP-20 score, number and areas of pain during the initial denture adjustment, before treatment, 3 and 6 months after treatment. No significant differences in satisfaction or OHIP-20 scores for the new dentures were observed between the two groups. In the group wearing dentures fabricated using conventional methods, denture satisfaction and OHIP-20 scores significantly improved after treatment. Whereas, in the duplicate denture wearing group, there was no significant increase in denture satisfaction; however, the OHIP-20 scores had improved. The total number of denture-related pain points was approximately twice as high in the group wearing conventional dentures as that in the group wearing duplicate dentures. There was no significant difference between the two groups in the number of visits required to feel comfortable [48].

3.5. Clinical comparison of fabricating duplicate denture between digital and conventional methods

Although reports regarding the duplicate denture manufacturing through digital method has increased, research comparing digital and conventional methods of fabricating duplicate dentures is limited (Table 2).

Liu et al. randomly assigned 30 edentulous patients to a group wearing dentures manufactured using a conventional method and a

Table 1
Clinical evaluation of duplicate dentures manufactured using conventional methods.

Reference	Study design	Total number of patients	Classification of patients		Randomized (Y/N)	Denture fabrication			Evaluation items	Foliow-up duration	Results
			Conventional denture	Duplicate denture		Denture manufacturer	Conventional denture	Duplicate denture			
[46]	Retrospective study	100 (65 years or older)	50	50	N	Undergraduate clinic	Conventional technique	Duplication technique	Number of visits required for construction and insertion of the dentureNumber of post-insertion visits needed to make the denture comfortable A questionaire (Are you wearing the denture we provided? How is the new dentures compared with the one they were replaced? Better or same or worse?)	No description	Duplication group required fewer visits for the delivery of the dentures, but there was no statistical difference between the number of post-insertion visits.No significant difference between the two groups regarding denture fit accuracy and patient adaptation. More patients in the duplication group continued to wear their new dentures compared with the conventional group
[47]	Comparative study	65	32 (15 males and 17 females, 71 ± 9.6 years)	33 (14 males and 19 females, 71 ± 8.0 years)	N	Dental students fabricated all the dentures under the supervision of their instructors	Technique involved making primary and secondary impressions, recording jaw relationship using occlusal rims, trial insertion and fitting of the complete dentures	Replica dentures were used as a basis for recording the impressions and jaw relationships; the design features were modified as required e.g. creating further base extension or increasing the vertical dimension, where there had been tooth wear on the original dentures	Oral-related quality of life (QOL) (OHIP-14)	Before wearing dentures and at least 3 months after using new complete dentures	There was no significant difference between the two groups regarding the changes in the OHIP scores before and after treatment. The conventional denture group showed significant improvement in five of the seven OHIP subscales, whereas the duplicate detnure group showed significant improvement in all seven subscales
[48]	Comparative study	40	20 (74.2 ± 7.29 years)	20(73.1 ± 8.61 years)	N	Predoctoral student	Conventional dentures were provided using standard hospital protocols	Duplication dentures were provided using standard hospital protocols	Satisfaction using the Visual Analog Scale (VAS) and oral health-related QOL (OHIP-20)	Before and 1 month after wearing the dentures	There were no significant differences in the evaluation values between the two groups before and after treatment. Regarding OHIP-20, the “handicap’’ subscale significantly improved in the conventional denture group, and the ”pain”

(*continued on next page*)

Table 1 (*continued*)

Reference	Study design	Total number of patients	Classification of patients		Randomized (Y/N)	Denture fabrication			Evaluation items	Foliow-up duration	Results
			Conventional denture	Duplicate denture		Denture manufacturer	Conventional denture	Duplicate denture			
											and "psychological discomfort" subscales significantly improved in the duplicate denture group. Although patient satisfaction improved significantly in both groups, aesthetic satisfaction was lower in the duplicate denture group
[49]	Randomized Controlled Trial	20	10 (7 males and 3 females, 71.5 ± 5.3 years)	10 (6 males and 4 females, 74.2 ± 7.4 years)	Y	Senior-year undergraduate students, whowere supervised by one experienced clinical instructor	Traditional construction protocol with a bilateral balanced occlusal scheme	Duplication construction protocol with a bilateral balanced occlusal scheme	The level of denture satisfaction (McGill denture satisfactioninstrument,) OHIP-20 score, number and areas of pain during the initial denture adjustment	Before treatment, 3 and 6 months after treatment	No significant differences in satisfaction or OHIP-20 scores for the new dentures were observed between the two groups. In the conventional denture group, denture satisfaction and OHIP-20 scores significantly improved after treatment. Whereas, in the duplicate denture group, there was no significant increase in denture satisfaction; however, the OHIP-20 scores had improved. The total number of denture-related pain points in the conventional denture group was approximately twice as high as that in the duplicate denture group. There was no significant difference between the two groups in the number of visits required to feel comfortable

Table 2
Clinical comparison of fabricating duplicate denture between digital and conventional methods.

Reference	Study design	Total number of patients	Number of patients		Randomized (Y/N)	Denture fabrication			Evaluation items	Follow-up duration	Results
			Conventional denture	Duplicate denture		Denture manufacturer	Conventional denture	Duplicate denture			
[50]	Randomized controlled trial	30 (17 males and 13 females, 68 ± 3.2 years)	15	15	Y	NA	Traditional method was employed.Five visits were required over the course of treatment and the treatment cycle was approximately 5–8 weeks.	Traditonal impressions were scanned using the three-dimensional (3D) scanner, digital impression was designed and printed by using the 3D printer. The record bases and wax occlusal rims were fabricated on 3D-printed models, and the maxillomandibular relationship was recorded. Then, a facebow tranfer was used to mount the master casts on the articulator. The base plate and dentition were designed and the 3D printer was used to print the base plate and dentition with the base resin and artificial tooth resin materials.	Patient satisfaction was measured with a 0-10 visual analog scale (VAS)A questionaire (including esthetics, ability to speak, ability to chew, stability, and comfort) was used	Immediately, and 1, 3, and 6 months after denture delivery	The ability to speak, ability to chew, and comfort in the two groups gradually improved at the first three time-points. The esthetics and stability of the two groups were scored high after the initial delivery. The VAS scores of the two groups regarding esthetics, ability to speak, ability to chew, stability, and comfort were not significantly different at any time point. The number of visits in the duplicate denture group were significantly decreased compared with that of the traditional group.

group wearing replicated dentures manufactured using a 3DP method and evaluated satisfaction using a VAS in a single-blinded randomized controlled trial. The VAS evaluation was performed four times: immediately after denture placement and after 1, 3, and 6 months. VAS values for speaking, chewing, and comfort in both groups gradually improved in the first three sessions, and after 3 months, they reached a clinically good level. There were no significant differences between the two groups in the VAS scores for speaking, chewing, stability, or comfort at any evaluation time. The number of visits for 3DP replicated dentures was significantly lower than that for the conventional method group [49].

The following two studies compared two different methods, although they were not clinical comparisons. Satin et al. compared the reproducibility of bite registration for complete denture production between the conventional method and the use of duplicate dentures made using the digital method. Their results showed that although both methods were within the clinically acceptable range, the deviation of the digital method was smaller [43]. Tanaka et al. compared the 3D shape accuracy of duplicate dentures fabricated by a digital method using an intraoral scanner and duplicate dentures fabricated using a conventional method. Statistically significant differences were observed between the reference denture form and dentures replicated using the intraoral scanner, and between the dentures replicated using the intraoral scanner and the conventional dentures. However, there were no significant differences between maxillary and mandibular dentures. They concluded that replicating dentures using an intraoral scanner was more accurate than replicating dentures using conventional methods [50].

Although conventional methods can produce clinically acceptable duplicate dentures, digital methods offer several advantages. Considering improvements in reproducibility and operability owing to future technological innovations, digital methods will become the standard method for manufacturing duplicate dentures and are expected to further improve accuracy and shorten work time [23].

4. Conclusion

Duplicate dentures are useful as temporary dentures such as treatment dentures, and are also effectively used for making impressions and bite registration when making new dentures, thereby reducing the number of clinic visits and treatment time. Furthermore, it is possible to use the duplicate denture as a new denture, which has been rated equivalent to dentures manufactured using conventional methods regarding patient satisfaction and oral health-related QOL. Older people in whom various adaptive abilities have declined, may find it difficult to adjust to new dentures, even if the shape is appropriate, and may feel stressed. Duplicate dentures, which reproduce the shape of previous dentures that they are used to, have the advantage of being more familiar to older people and less stressful. Duplicate dentures are also feasible and practical in cases of maxillofacial prostheses that involve difficulties in fabrication and adjustment. Duplication technique can shorten the chair time and save the cost, which offer great advantages for not only the patients but also the patients' families, and general dentists. However, challenges exist in the use of digital technique, especially in local dental clinics, owing to the high cost of the 3D machines and lack of expertise of the dental technicians in using digital technique.

When manufacturing duplicate dentures, digital methods such as milling and 3DP are superior to conventional methods regarding working time and cost. Considering the rapid development in digital technology recently, digital methods are expected to become the standard for manufacturing duplicate dentures. A notable advantage of the digital method is that the denture shape can be saved as digital data, and the denture can be easily duplicated if lost. Therefore, in a society where lifespans are increasing and the population is aging, opportunities to use duplicate dentures are expected to increase. However, challenges exist in the use of digital technique, especially in local dental clinics, owing to

the high cost of the 3D machines and lack of expertise of the dental technicians in using digital technique.

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Not applicable.

Scientific field of dental Science

Prosthodontic Dentistry.

Conflict of interest

All authors declare that they have no conflicts of interest in regard to this work.

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