Research Report

Rapid Fabrication Process of Digital Dentures in Disaster Situations and a Feasibility Study on Production Time

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This study evaluated the feasibility of rapid digital denture fabrication under disaster-simulated conditions using an intraoral scanner and 3D printer, involving three healthy adult males with single posterior tooth loss scanned with TRIOS 5 in a simulated evacuation shelter where denture design by a technician required 9–14 minutes and intraoral scanning 9–13 minutes, followed by 15 minutes for 3D printing, 32 minutes for washing and polymerization, and 46 minutes for polishing, adjustment, and fitting, with the entire workflow from entry of the first participant to delivery of the final denture completed in 3 hours and 41 minutes, thereby demonstrating that on-site digital dentures can be provided within a few hours, a dramatic reduction compared with conventional 1–2 month fabrication, and suggesting that mobile dental units equipped with scanning and printing technology (medical MaaS) could offer a practical solution for rapid oral rehabilitation in disaster response and remote healthcare settings.

1. Introduction

In disaster situations, it has been reported that a certain proportion of elderly people lose their dentures or fail to bring them during evacuation. For example, following the Great East Japan Earthquake, approximately one-fifth of denture wearers either lost their dentures or did not carry them during evacuation[1]. The absence of dentures is a serious problem, as it directly leads to impaired masticatory function, malnutrition, aspiration pneumonia, and reduced quality of life (QOL). In recent years, advances in digital denture fabrication using intraoral scanners and 3D printers have made immediate denture production feasible[2]. With internet connectivity, scan data obtained in evacuation shelters can be transmitted to remote dental laboratories for design and fabrication, while 3D printing of the denture can be performed on-site[2]. This has the potential to revolutionize the provision of dentures in disaster scenarios[3]. Furthermore, the use of mobile dental units equipped with scanners and 3D printers (so-called medical MaaS) enables direct provision of denture fabrication and delivery at disaster sites and in medically underserved areas. This approach not only contributes to disaster response but may also improve access to routine dental care.

2. Objective

The purpose of this study was to measure the actual fabrication time of digital dentures using intraoral scanners and 3D printers under conditions simulating a disaster, and to establish a rapid and practical workflow for denture provision.

3. Methods

Three healthy adult males (aged 50, 51, and 51 years) participated in the study. Their missing teeth were as follows: mandibular right first molar, mandibular left second premolar, and mandibular right first molar. The experiment was conducted in a Japanese-style room with simple mats and pillows, simulating an evacuation shelter environment. An intraoral scanner (TRIOS 5, 3Shape) connected to a laptop PC was used. Each participant underwent scanning sequentially, and the required time was recorded. The scan data were sent to a dental laboratory, where a dental technician performed digital denture design. The final design data were transferred to a 3D printer installed at the shelter, and the entire workflow—printing, washing, polymerization, polishing, adjustment, and fitting—was documented.

4. Results

The scanning times for each participant were as follows: Participant 1: 13 min 29 sec (from room entry to scan completion; 3 min 40 sec from entry to scan start) Participant 2: 10 min 34 sec (1 min 26 sec) Participant 3: 9 min 40 sec (2 min 22 sec) The times required for denture design at the dental laboratory were: Participant 1: 14 min 10 sec Participant 2: 12 min 32 sec Participant 3: 8 min 57 sec Following nesting, 3D printing required 15 min 14 sec, washing and polymerization required 32 min 23 sec, and polishing, adjustment, and fitting required 45 min 40 sec. Overall, the total time from the first participant's room entry to the final denture fitting for the third participant was 3 hours 41 min 36 sec.

5. Discussion

This study demonstrated that a single-tooth denture can be fabricated and delivered within approximately 3 hours 40 minutes under disaster-simulated conditions. Compared with the conventional denture fabrication process, which often requires 1–2 months, this workflow achieved significant time reduction and may contribute to rapid restoration of oral function in disaster settings[4]. Of the total fabrication time, dental procedures (scanning, fitting, and adjustment) required about 20 minutes, while denture design by the dental technician required approximately 10 minutes. The majority of time was consumed by 3D printing and polymerization.

Therefore, during these waiting periods, dental professionals could attend to other evacuees, conduct examinations, or provide oral care, highlighting the high practicality of this workflow in disaster situations. The use of mobile dental units equipped with scanners and 3D printers enables immediate on-site denture provision at evacuation shelters or temporary housing. This has the potential to fundamentally transform dental care delivery in disaster-stricken or resource-limited areas and represents a practical application of medical MaaS. Nevertheless, while 3D-printed dentures offer reduced polymerization shrinkage and superior fit, the study also revealed the necessity of fine adjustments[5]. Careful design of undercuts and the presence of skilled dental technicians capable of making chairside adjustments are crucial. This study examined relatively simple single-tooth cases. Future research should expand to multiple-tooth loss and edentulous cases[2]. In disaster situations where postal infrastructure is available, the fabrication of high-precision milled dentures at dental laboratories, followed by delivery to the site, also warrants consideration[5].

6. Conclusion

This study confirmed that digital dentures fabricated with intraoral scanners and 3D printers can be completed within approximately 3 hours 40 minutes under disaster conditions. Compared with conventional denture production timelines, this represents a major reduction in time, offering an effective means to mitigate health risks associated with denture loss during disasters. Moreover, mobile dental units equipped with scanners and 3D printers allow for immediate on-site response, expanding the possibilities of medical MaaS in disaster care, home care, and underserved regions. Future challenges include validating the workflow for edentulous and multi-tooth loss cases, evaluating long-term durability and comfort of the dentures, and establishing standardized protocols for integration of mobile dental units into disaster medical systems. In parallel, strengthening digital technology training for dental professionals will be essential. The integration of mobile dentistry and digital denture technology holds the potential to reshape not only disaster response but also everyday dental practice.

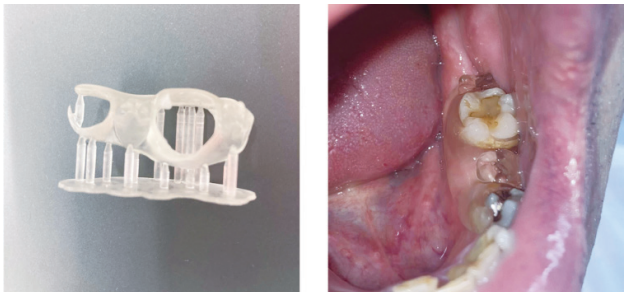

Figure 1: Fabricated digital denture and intraoral view at delivery

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