

# SEMI-DIGITAL WORKFLOW OF REMOVABLE PARTIAL DENTURE FABRICATION FOR SCLERODERMA-INDUCED MICROSTOMIA PATIENTS: TWO CLINICAL REPORTS

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## ABSTRACT

Scleroderma is a chronic connective tissue disease characterized by collagenous fibrosis resulting in the hardening and contracture of the skin and mucosa. Most of the scleroderma patients develop Raynaud's phenomenon that the fingers and toes feel numb, prickly and frigid in response to cold temperatures or stress. Due to fibrosis of the skin and soft tissues, scleroderma induces microstomia that clinically represents limited mouth opening which results in difficulty both for the patients and the dentists. Limitation of lip and tongue movements, xerostomia, gastroesophageal reflux disease, myofascial pain, dysgeusia, and periodontal problems are the most common oral health issues in scleroderma patients. Prosthetic rehabilitation of patients with a small oral orifice, such as scleroderma-induced microstomia may present difficulties. Patients with microstomia often complain of an inability to insert or remove dentures. This clinical report describes the semi-digital workflow of prosthetic rehabilitation of two partially edentulous patients with scleroderma-induced microstomia. Intraoral scanning was used for impression making and models were printed using a 3D printer. Both patients received a conventional removable partial denture. Intraoral scanning can be an alternative to conventional impression-making techniques and can be used safely in patients with microstomia for impression making.

**Key words:** Scleroderma, Microstomia, Removable partial denture, Intraoral scan, 3d print.

## Introduction

Scleroderma is a chronic connective tissue disease characterized by collagenous fibrosis resulting in the hardening and contracture of the skin and mucosa. Most of the scleroderma patients develop Raynaud's phenomenon that the fingers and toes feel numb, prickly and frigid in response to cold temperatures or stress. Due to fibrosis of the skin and soft tissues, scleroderma induces microstomia that clinically represents limited mouth opening which results in difficulty both for the patients and the dentists. Limitation of lip and tongue movements, xerostomia, gastroesophageal reflux disease, myofascial pain, dysgeusia, and periodontal problems are the most common oral health issues in scleroderma patients. Most scleroderma patients develop Raynaud's phenomenon that the fingers and toes feel numb, prickly, and frigid in response to cold temperatures or stress. Due to fibrosis of the skin and soft tissues, scleroderma induces microstomia that clinically represents limited mouth opening which results in difficulty both for the patients and the dentists [1-8].

Prosthetic rehabilitation of individuals that have limited oral cavity, such as scleroderma-induced microstomia may present difficulties [1, 9-11]. Individuals suffering from microstomia presents a complaint of an inability to or reo located or to remove dentures [1-10, 12, 13]. All prosthetic procedures can challenge especially impression making in

microstomia patients. Therefore, the techniques used in taking impression requires modification considering it's not possible to employ the use of any stock impression trays [1-10, 12, 13]. Previously, many impression making techniques using sectional impression trays have been successfully applied [6-10, 12, 13], the most suitable technique of providing a preliminary impression for a the individual that have microstomia is not yet clear [9, 10, 12-15]. The choice of more practical method is up to the dentist;s skills and preferences [9, 10].

Recently, the use of analog impression-taking methods trends shifted towards digital technologies in daily routine prosthetic dental practice. Today, impression making, design, and fabrication of dental restorations using computer-aided technologies are easily accessible [1]. Computer-aided digital technology provides not only less time but also accurate, repeatable, and easily feasible fabrication on chairside and laboratory procedures [16]. In this digital revolution, the involvement of intraoral scanners plays an enormous role in denture fabrication with the elimination of tray selection and/or adaptation, cross-infection, and laboratory transfer of the impressions as well as the necessity of high-quality working models [17]. Computer-aided design and computer-aided manufacturing (CAD/CAM) in tooth- or implant-supported fixed prosthodontics are well studied [17-22] through the use of digital techniques on partial or complete denture production

has been limited [11, 23]. The dynamic movements of soft edentulous tissues and dispersed reflection of saliva on soft tissues lead to unpredictable results for digital impressions to consider them successful [15].

In patients with scleroderma-induced microstomia, the use of CAD/CAM technologies might be clinically easier to record the denture seating area rather than the use of conventional analog methods with sectional resin trays.

This clinical report presents the semi-digital workflow of removable partial denture (RPD) treatment of two cases with microstomia.

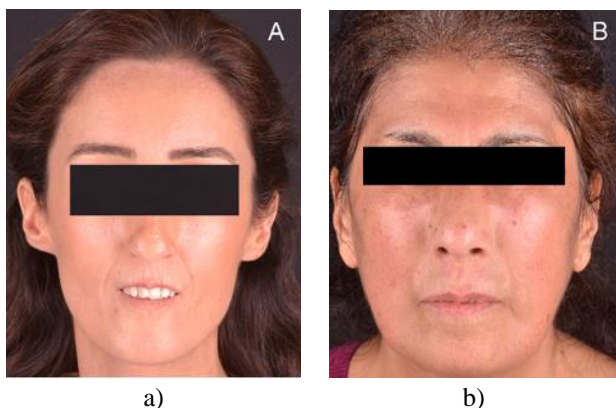
*Clinical reports*

*Case 1*

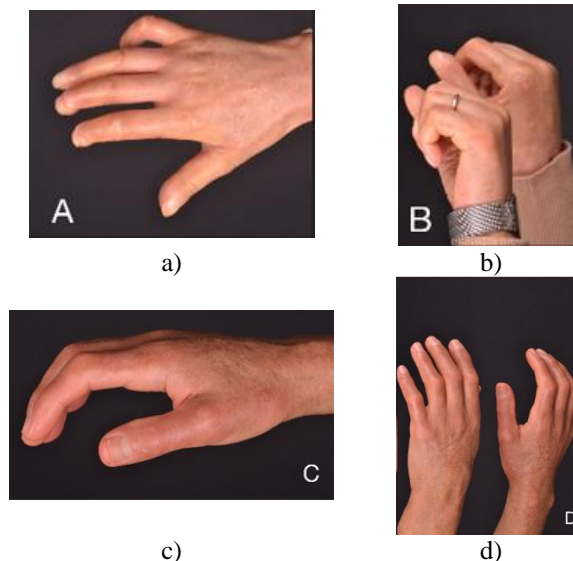
A 37-year old female patient was referred to the Department of Prosthodontics, Faculty of Dentistry of Istanbul University for RPD fabrication. The patient's chief complaints were reduced function and inability in chewing due to missing teeth.

The patient's medical history revealed that she was diagnosed with scleroderma when she was 29 years old. Scleroderma was not diagnosed in her family.

Extra-oral examination revealed changes in the facial skin. The skin present on the facial was smooth and tight, and a lack of normal animation lines leading to a mask-like appearance (Figure 1). The patient's hands had sclerodactyly (Figures 2a and 2b) that is specific to scleroderma. Intra-oral examination revealed that the patient had bilateral posterior missing teeth in the mandible (Kennedy Class II, modification 1). Soft tissue examination indicated extremely thin alveolar mucosa and fibrotic lips.

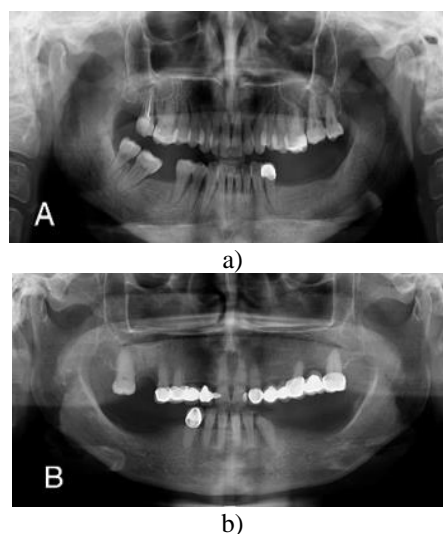


**Figure 1.** Smooth and tight facial skin resulting in a mask-like appearance. a) Case 1. b) Case 2

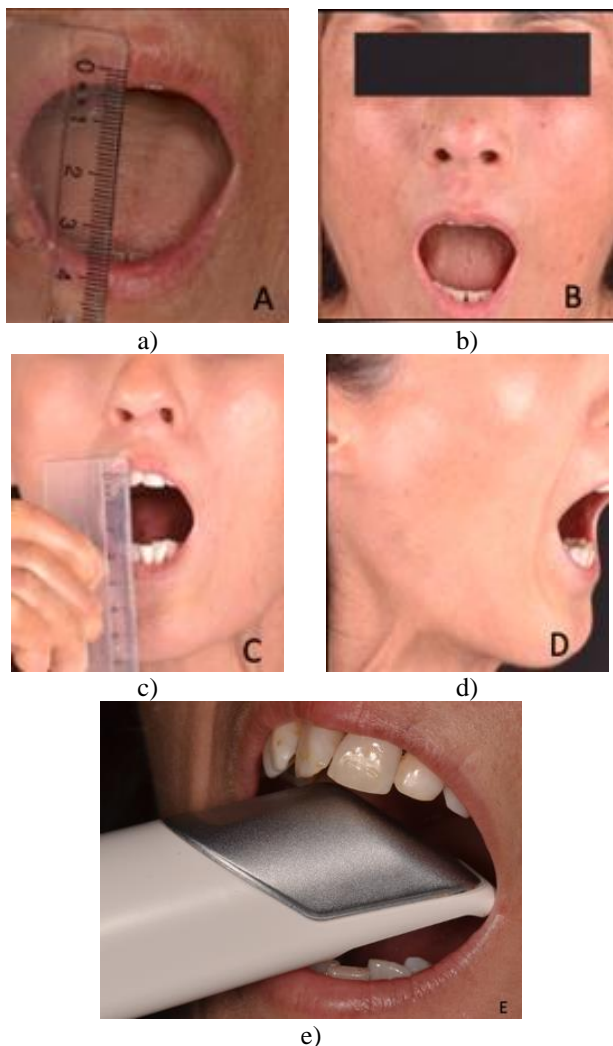


**Figure 2.** Sclerodactyly. a, b) Case 1. c, d) Case 2

A panoramic radiograph (Figure 3) revealed only periodontal ligament widening in most of the teeth with no significant periapical pathology. The vertical dimension of occlusion seemed appropriate. The patient had a diminished mouth opening of around 25 mm (Figures 4a and 4b) (Severe microstomia (maximal mouth opening  $\leq$  30 mm) was identified based on the criteria provided by Naylor *et al.* [24]. The salivary flow seemed to be reduced. The oral health status was good, and before impression processes, oral cavity was examined to check for the need of any tooth recontouring. The remaining teeth, which were planned to receive retainers, had naturally occurring undercuts and guide planes on the enamel surface.



**Figure 3.** Panoramic radiographs of a) Case-1. b) Case 2



**Figure 4.** a) Limited mouth opening around 25 mm. b) Lateral view of tight mouth opening. c) Limited mouth opening around 30 mm. d) Tight mouth opening and fibrotic lips. e) Difficulty in placing the intra-oral tip of the scanner in limited mouth opening.

*Case 2*

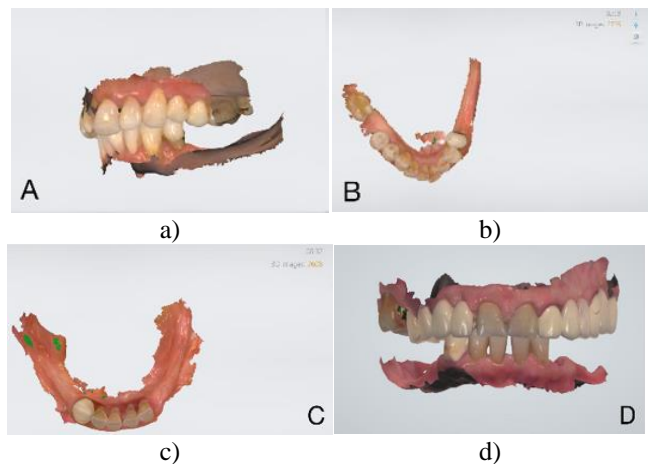
A 51-year-old female patient was referred to the Department of Prosthodontics, Faculty of Dentistry of Istanbul University for RPD fabrication. The patient's chief complaints were reduced function and inability in chewing due to missing teeth.

The patient had complained of scleroderma symptoms since she was 22 years old. Extra-oral examination revealed no specific facial symptom related to scleroderma (**Figure 1b**). The patient had also the symptoms of scleroderma in her hands with pale fingers and difficulty in moving (Raynaud's phenomenon) (**Figures 2c and 2d**).

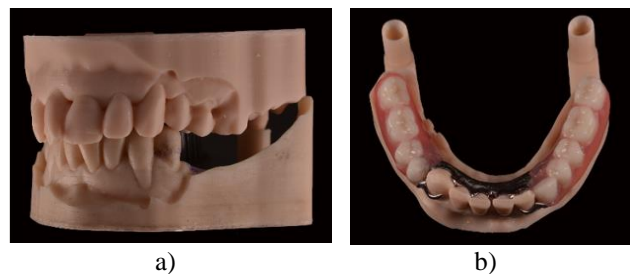
Intra-oral examination revealed bilaterally missing mandibular teeth (Kennedy Class I) and tongue rigidity. Edentulous tissues showed optimal mucosal resiliency. Lips were stretched and showed no flexibility at all. Salivary

quantity and flowability seemed to be reduced. Despite the hand deformity and limited oral opening, her oral hygiene seemed to be appropriate. The periodontal examination revealed no periodontal pocket and tooth mobility. A panoramic radiograph (**Figure 3**) revealed crestal bone loss with no significant periapical pathology in the remaining natural teeth. Severe microstomia (maximal mouth opening  $\leq 30$  mm) was also diagnosed according to Naylor *et al.* [24] (**Figure 4**).

Implant retained fixed partial denture or conventional RPD construction were presented as prosthetic treatment options for their missing posterior teeth and both patients accepted the treatment of conventional RPD.



**Figure 5.** Intra-oral images. a,b) Case 1, c,d) Case 2



**Figure 6.** Simple hinge on the mandibular printed cast to easily fix to the maxillary cast

*Treatment procedures*

*Impression-making*

The smallest stock tray no:1 (Medesy, Maniago, Italy) was tried intra-orally for conventional preliminary impression taking. The use of a dental mirror for retraction of the cheeks and the intra-oral positioning of the stock trays were not possible due to the fibrotic, non-elastic structure of the soft tissues that resulted in microstomia and limited mouth opening. At this step, conventional impression making procedures were canceled and the use of an intra-oral scanner was decided for both cases.

An intraoral scanner (3Shape Trios3, Copenhagen, Denmark) was used to obtain 3D intraoral scans and

generate digital models of both arches. In digital impression making, sufficient care was taken in the intra-oral positioning and strolling of the intra-oral scanner (**Figure 4e**). To obtain a continuous digital image, patients were instructed to stay at rest so that the edentulous areas were tried to be kept with no displacement. The recording of the intraoral images of the first patient lasted 8 minutes with 4225 views while recording the intraoral images of the second patient lasted 12 minutes with 3969 views (**Figures 5a-5d**). After scanning the occlusal to import to the supporting software for stereolithography (SLA) 3D printer (Formlabs 2; Formlabs, Somerville, USA). Working casts were printed with a  $\pm 25 \mu\text{m}$  accuracy model using model resin (Formlabs model resin; Formlabs, Somerville, USA). A simple digital hinge data was also integrated into STL models so that working casts can be easily fixed together (**Figure 6**).

Casts were surveyed using a dental surveyor (Bego Paraflex Surveyor, Lincoln, USA) and the RPD design was completed. Both RPD frameworks were cast with chrome cobalt molybdenum dental alloy (Wironit LA; BEGO, Bremen, Germany) (**Figure 7**). After the frameworks were tried intraorally, the artificial teeth (Ivoclar Vivadent AG, Schaan, Liechtenstein) were arranged, and the try-in dentures were evaluated. Dentures were processed using heat-polymerized polymethyl methacrylate denture base resin (Meliodent; Bayer UK Ltd, Newbury, UK) and delivered to the patients.

Relining was not required after one year of patients' check-ups. Both patients had no difficulties using the dentures, and satisfactory results were obtained during a 1-year follow-up period. Due to COVID-19 Pandemic, patients were called for a control appointment, however, they refused to visit the hospital and were notified they have no problems with their removable partial dentures.



**Figure 7.** Conventional RPD frameworks fitting on the printed cast.

## Results and Discussion

Semi-digital workflow of RPD construction using an intraoral scanner used to make impressions were presented for two cases.

Intra-oral scanners are not suggested on a toothless jaw due to its lack of ability to register displaceable soft tissues

surrounded with saliva [1, 18]. In edentulous cases with normal peripheral tissues with sufficient elasticity, digital capturing is not always easy to record due to the inevitable displacement of the peripheral tissue during the movement of the intra-oral scanner in the oral cavity. Digital recording of partially edentulousness is more favorable than complete edentulousness because present teeth provide digital reference points for the scanner when capturing [1]. The difficulty of digital impression recording of the mobile peripheral tissues is not still resolved that limiting the use of digital impression making in removable denture construction [1]. Kim *et al.* [15] reported the difficulty of digital recording mobile tissues and overcame this problem by stretching the tissues with the help of the tip of the scanner which might lead to misrecording. Contrary to expectations, most of the peripheral tissues especially vestibular sulcus areas in present microstomia-induced scleroderma cases were easily captured because these tissues were not displaced due to the sclerotic and fibrotic structural changes.

The time spent on the scanning and capturing step is too long for any digital capturing (around 8 min). To obtain digital data, only the tip of the scanner could be moved inside the oral cavity due to the limited mouth opening. The intraoral scanner was also used to retract the tongue that was how the scanning was performed. In a setting of predoctoral students, Kattadiyil *et al.* [22] reported significant differences in clinical treatment times of conventional fabrication over digital fabrication that required 3.5 hours more. Additional to this finding, the time spent was relatively too short when the use of sectional impression resin trays for these cases was considered.

Software showed some setbacks, however by deleting certain and rescanning options allows to create a satisfactory STL file to yield a 3D-printed model. It should be noted that deleting and rescanning procedure is not limitless therefore experience in using intraoral scanners is of importance in the successful manipulation of the equipment. As a result of the present patients' firm soft tissues and decreased flow of the saliva, the 3D-printed working casts were quite well to design the end products.

Similar semi-digital methods were described in the literature. Kim *et al.* [15] utilized an intraoral scanner for a definitive impression in an individual that have an extremely tight reconstructed lip trial denture bases and recommended continuing to follow steps conventionally. Saygılı *et al.* [13] also presented a case report for preliminary impressions using an intraoral scanner for a patient with microstomia. Oh, *et al.* [25] used an intraoral scanner and 3D printed occlusal rims for an immediate denture and finished the denture using conventional methods following the next appointment.

In present cases, the digital manufacturing methods are not preferred because both patients can adjust the RPDs into the mouth by rotating it at  $90^\circ$ , the framework of removable

dentures was designed monolithic and cast conventionally thus decreasing the complexity related with the use of sectional dentures [1, 12]. Digital framework production in the present cases is not a necessity at this time, instead, it would only cause increased costs. Today, conventional RPD framework production results in better clinical adaptation, better accuracy and fit over digital manufacturing [6, 16, 17]. Wu *et al.* [11] looked forward to the combined use of an intraoral scanner and 3D printing technology and commented on the potential to design and fabricate a conventional RPD framework in complicated patients.

CAD/CAM tech in prosthodontics provides patient with comfort and a lesser clinical appointments. The use of digital technologies in toothless arches does not necessarily ease the processes involved in the fabrication of a complete denture [19]. Relining can be required after digital manufacturing [6, 23]. However, RPD fabrication is quite easier and feasible with intraoral scanning, in cases where you can record jaw relations and patients who have an existing vertical dimension relationship with opposite jaws. In those who have somewhat firm soft tissues and limited mouth opening use of intraoral scanners for impression, making may be an alternative with better utility and relative comfort for the patient [1].

### Conclusion

When CAD/CAM technology permits accurate registering movable soft tissues for final impressions of toothless areas, the state of art in prosthodontics will get to a place where a fully digital workflow for any patient. According to the clinical observations driven from both microstomia patients, it is suggested for manufacturers to fabricate alternatively smaller intra-oral scanner tips for patients with limited mouth opening, microstomia, etc.

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