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Time-study research on maxillofacial prosthetic treatment

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ABSTRACT

Unreasonable medical fees can cause problems such as increased medical costs, greater medical disparities, decreased medical standards, and physician shortages. To prevent such problems, it is important to set appropriate medical fees, ensure their proper use, and improve the efficiency of medical care. The treatment of patients with maxillofacial defects is generally more expensive compared with general prosthodontic treatment because it involves more materials and requires more frequently follow-ups for longer period. However, the actual time required for maxillofacial prosthetic treatment is unclear. Therefore, in this study, we aimed to clarify the amount of time spent treating maxillofacial prosthetic patients. We analyzed clinical data from patients undergoing routine maxillofacial prosthetic treatment, irrespective of difficulty level, at 8 university hospitals and 2 dental clinics. We also collected data from maxillofacial prosthodontists on the treatment time required for various Japanese health insurance items, including the fabrication of maxillofacial prostheses. The results revealed that some aspects of maxillofacial prosthetic treatment may take longer to perform and are more costly to perform than previously thought, suggesting the need for some adjustments to the health insurance reimbursement system. Maintaining an appropriate balance between expenditures and fees will greatly benefit patients and physicians, ensuring positive health outcomes and a healthy society.

1. Introduction

Head and neck cancer accounts for 5% of all cancers in the Japanese population, with around 15,000 to 20,000 people affected each year and increasing numbers of cases being reported [1,2]. Cases of oral and/or pharyngeal cancer are increasing especially. Oral cancer is the most common type of head and neck cancer, accounting for 26.9% of all head and neck cancers, about half of which are tongue cancer. The 5-year relative survival rate for oral cancer is 71% [3]. The head and neck region includes organs necessary for basic life functions such as breathing and swallowing, organs that are needed for communication such as speaking and listening, and organs that control balance and the senses, such as taste and smell [4,5]. Damage to these organs can therefore hinder daily living and reduce quality of life [6]. Therefore, maxillofacial prosthetics treatment is important in the rehabilitation of patients following treatment for oral cancer.

Although Japan implemented universal health coverage in 1961, which, alongside other health care policies, has helped to establish a

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healthy population over many decades, the nation still faces many challenges. The main issues with Japan's social insurance system are the fiscal challenges posed by a super-aging population and the increasing cost of medical care. The Dental and Oral Health Promotion Law, enacted in 2011, positioned oral health care as an essential element for improving the health and longevity of the nation's population and has substantially changed the role of oral health care under the overall national health care policy [7]. The law stipulates that dentistry needs to contribute to the maintenance of general health by closely collaborating with the medical field, especially in the prevention and treatment of cancer.

The mission of the Council of Japan Dental Science of Societies (CJDSS) is to improve the operation of the social insurance system in the field of dental care, to collect and disseminate information related to dental care, and to cultivate and train dental professionals such as dentists and dental hygienists to develop and improve dental care [8,9]. Misuse of the medical reimbursement system may lead to issues such as increased medical expenses, greater medical disparities, decreased medical standards, and physician shortages. To prevent such issues, it is important to establish an appropriate medical reimbursement system, ensure its proper use, and increase medical efficiency.

Conducting time-study research to measure the time required for each treatment item in a dental practice can reveal the key factors that contribute to medical reimbursements [10,11]. A national survey conducted by the CJDSS collected data mainly from facilities that provide general prosthetic services, and thus the number of maxillofacial prosthetic cases included in the survey was limited [12].

Successful maxillofacial prosthetic treatment for patients with head and neck cancer requires multidisciplinary knowledge and an interprofessional team approach, including expertize in surgical and reconstructive procedures, medical and radiation oncology, dental implant prosthetics, general prosthodontics, and perioperative oral care [11]. Unlike general dental treatment, maxillofacial prosthetic treatment involves specialized knowledge and skills in areas such as examination, diagnosis, preoperative treatment, postoperative treatment and prosthesis fabrication. Thus, it is hypothesized that the treatment of patients with maxillofacial defects will require more chair time to complete all the steps in prosthetic treatment. Moreover, the total cost of maxillofacial prosthetic treatment is generally higher than that of general prosthetic treatment because it involves more volume of materials and requires more follow-up visits.

Several studies have been conducted [13–15] to estimate the treatment time and cost for general prosthodontic treatment. However, no studies have examined the economic burden that maxillofacial prosthetic treatment poses. In other words, there are no reports comparing the cost and time required for maxillofacial prosthetic treatment with those of general prosthetic treatment and thus the appropriate balance between medical income and expenditure for maxillofacial prosthetic treatment, which is a critical factor for both patients and clinicians to know, remains unclear. Without achieving an appropriate balance, the number of clinicians performing such treatment is expected to decrease. Therefore, understanding the current status and carefully setting the treatment cost may greatly benefit patients with oral dysfunction and esthetic concerns. We conducted this study to elucidate the actual time required to perform various aspects of maxillofacial prosthetic treatment.

2. Materials and methods

In this observational study, clinical data were collected for patients who were undergoing maxillofacial prosthetic treatment during regular medical care, regardless of the treatment difficulty, between November 1, 2022 to January 31, 2023 at 8 university hospitals and 2 dental clinics in Japan: Tokyo Medical and Dental University, Nihon University, Tohoku University, Showa University, Tsurumi University, Ohu University, Aichi Gakuin University, Tokushima University, Usui Dental

Table 1
Classification by dental procedure.

Dental procedures		
Primary Item	Secondary Item	Insurance Definitions
Impression making for missing teeth	(1) Complex Impression: 230 points	Combination impression or impression using custom try
	(2) Special Impression: 272 points	Bite-seating impression using resin impression material or rubber impression material.impression using flange technique or myo-monitor Rubber impression using custom try and making border molding with compound
Impression making for bone defects	(1) Difficult: 222 points	Maxillofacial prosthesis for bone defects due to tumors,cysts, etc. Occlusal lamp.Speech aid. Palatal Lift Prosthesis. Hotz plate. That are easier than the following four situation(A-D).
	(2) Extremely difficult: 402 points	A. When the range of defects in the hard palate and alveolar process exceeds the other side. B. When defects included the soft palate. C. When there is an extensive defect of the mandible, which requires reconstruction such as flap coverage. D. When the patient open his mouth, the distance between the central incisors or the distance between the alveolar ridges in the midline is less than 30 mm.
Bite Registration	(1) Minority tooth loss: 57 points	One to eight missing teeth
	(2) Multiple tooth loss: 187 points	Nine to fourteen missing teeth
	(3) Complete denture 283 points	Edentulus
Denture trial fitting	(1) Minority tooth loss: 40 points	One to eight missing teeth
	(2) Multiple tooth loss: 100 points	Nine to fourteen missing teeth
	(3) Complete denture 190 points	Edentulus
Denture repair	(1) Minority tooth loss: 290 points	One to eight missing teeth
	(2) Multiple tooth loss: 320 points	Nine to fourteen missing teeth
	(3) Complete denture 375 points	Edentulus
Delivery of Maxillofacial Prosthesis	(1) Difficult: 1650 points	Maxillofacial prosthesis for bone defects due to tumors,cysts, etc. Occlusal lamp.Speech aid. Palatal Lift Prosthesis. Hotz plate. That are easier than the following four situation(A-D).
	(2) Extremely difficult: 4300 points	A. When the range of defects in the hard palate and alveolar process exceeds the other side. B. When defects included the soft palate. C. When there is an extensive defect of the mandible, which requires reconstruction such as flap coverage. D. When the patient open his mouth, the distance between the central incisors or the distance between the alveolar ridges in the midline is less than 30 mm.
Denture adjustment	189 points	

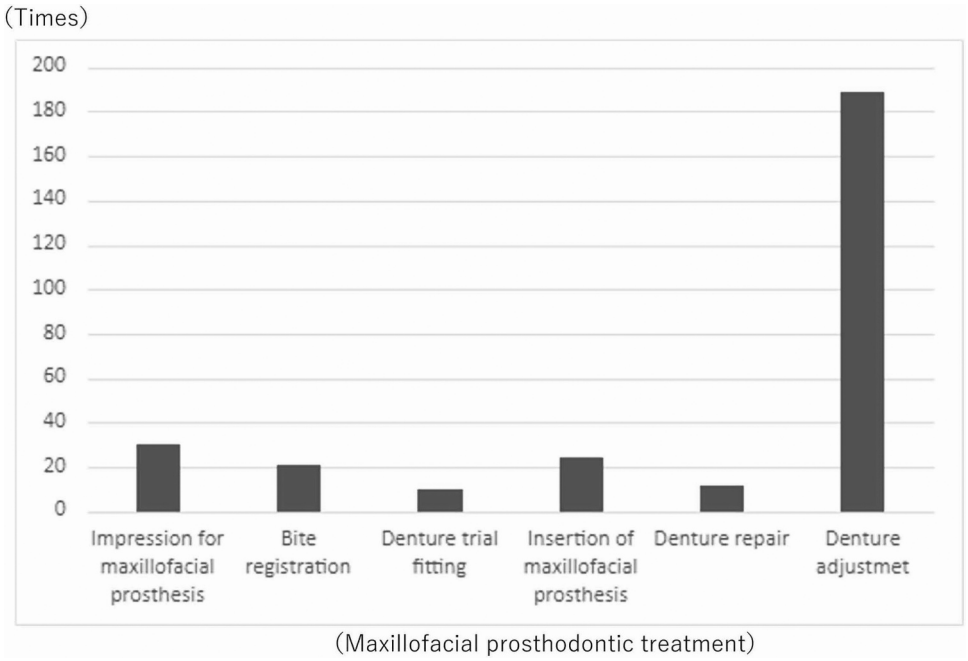

Fig. 1. Number of times each procedure was performed.

Clinic, and Sado Dental Clinic. These facilities were identified through the Japanese Academy of Maxillofacial Prosthetics of Dentistry's Medical Problem Review Committee and agreed to participate in the study. The research protocol was approved by the ethics committees of Tokyo Medical and Dental University (approval number: D2021–103) and all participating institutions. This study was conducted in accordance with the principles of the Declaration of Helsinki and its later amendments. Consent from patients was obtained via the opt-out route, whereby information about the research was presented in poster form in the treatment locations. In addition, data were collected on the time required for treatment, including the fabrication of maxillofacial prostheses, for 7 primary and 15 secondary insurance items evaluated. The primary items were as follows: impression making for missing teeth, impression making for maxillofacial defects, registration of maxillomandibular relation, denture trial fitting, denture repair, delivery of the maxillofacial prosthesis, and denture adjustment. Impressions of missing teeth to fabricate maxillofacial prostheses were divided into two secondary items, based on the difficulty and impression method: i.

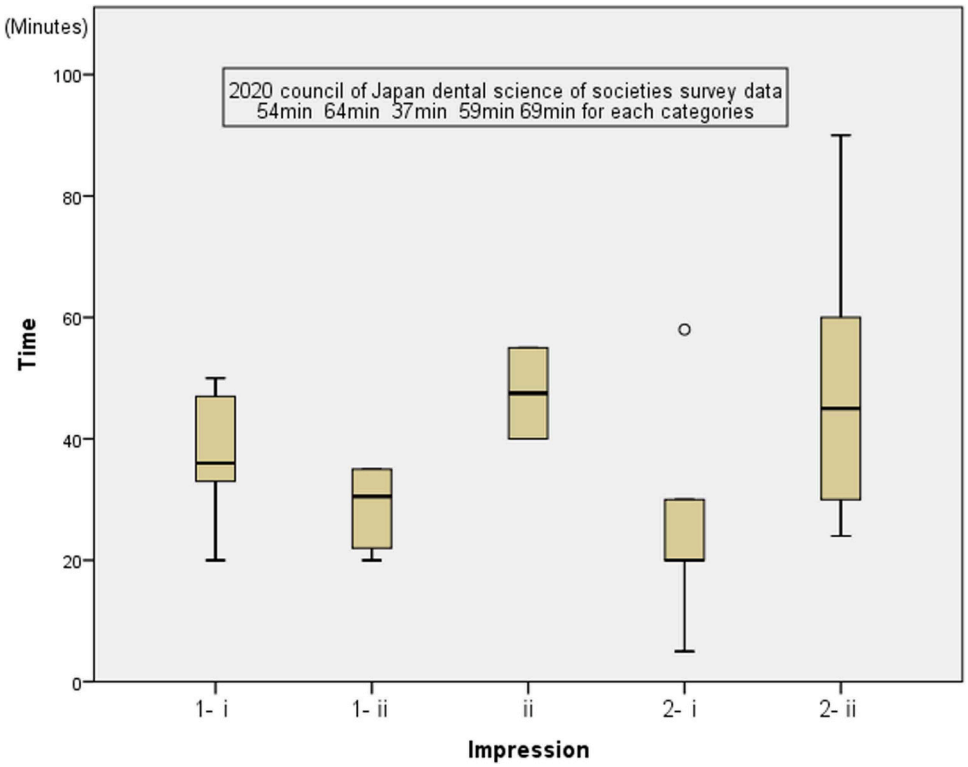

Fig. 2. Time spent taking impressions.

complex impressions and ii. special impressions. Impressions making for maxillofacial defects was also divided into two secondary items, based on the level of difficulty: i. difficult and ii. extremely difficult. Additionally, when fabricating a maxillofacial prosthesis, impressions of missing teeth and impressions of maxillofacial defects were classified according to their combination.

Bite registration, denture trial fitting, and denture repair were classified into three secondary items: i. 1 to 8 missing teeth, ii. 9 to 14 missing teeth, and iii. completely edentulous. Delivery of the maxillofacial prosthesis was divided into two secondary items: i. difficult and ii. extremely difficult. There was only one category of denture adjustment items for maxillofacial prosthesis, in line with the insurance score (Table 1).

We evaluated descriptive statistics using the mean and standard deviation (SD). The data collected in this study were also compared against survey data collected by the CJDSS in 2020. All statistical analyses were performed using IBM SPSS Statistics for Windows, Version 21.0. (IBM Corp, Armonk, NY).

3. Results

3.1. Number of cases

During the study period, data on 248 cases were collected from Tokyo Medical and Dental University Hospital, while data on 47 cases were collected from the other 7 hospitals and 2 clinics. To ensure the accuracy and reliability of the analysis, incomplete records were removed, typographical errors were corrected, and inconsistent data formats were standardized. Finally, 286 of the 295 cases were included in the analysis.

3.2. Number of performed procedures

This study examined the frequency of various procedures related to dental prosthetics, particularly maxillofacial prosthetics. Impressions for maxillofacial prosthetics were taken 30 times, bite registration was performed 21 times, denture trial fitting was performed 10 times, and maxillofacial prosthetic delivery was performed 24 times. Denture repairs were made 12 times and denture adjustments were performed 189 times. Overall, a total of 286 procedures were performed during the study period (Fig. 1).

3.3. Time spent taking impressions

Five combinations of impression taking were recorded in this study: complex and difficult (1-i), special and difficult (1-ii), extremely difficult (ii), complex and extremely difficult (2-i), and special and extremely difficult (2-ii). There were 5 cases in category 1-i, with a mean time of 37.20 min (SD 11.99); 8 cases in category 1-ii, with a mean time of 28.75 min (SD 6.48); 2 cases in category ii, with a mean time of 47.50 min (SD 10.61); 5 cases in category 2-i, with a mean time of 26.60 min (SD 19.69); and 10 cases in category 2-ii, with a mean time of 48.50 min (SD 18.30) (Fig. 2).

The mean time of the five categories was 54, 64, 37, 59, and 69 min, respectively, in the CJDSS survey. Comparing the average time for each category with the CJDSS survey, only category ii has a longer time, but the other categories are shorter.

3.4. Time spent on bite registration, denture trial fitting, denture repair, and delivery of maxillofacial prostheses

There were 10 cases of bite registration for minority tooth loss, with a mean time of 30.40 min (SD 17.60); 6 cases of bite registration for multiple tooth loss, with a mean time of 27.33 min (SD 16.46); and 5 cases of bite registration for complete denture, with a mean time of 23.40 min (SD 14.95). The mean time of the three categories was 23, 23, and 30 min, respectively, comparing the average time for each category to the CJDSS survey, bite registration for minority tooth loss and multiple tooth loss had a longer time, bite registration for complete denture had shorter times. (Fig. 3).

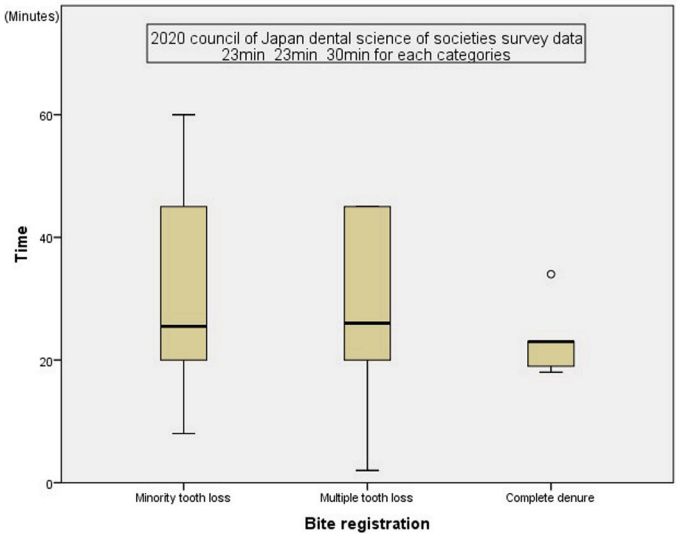

Fig. 3. Time spent for bite registration.

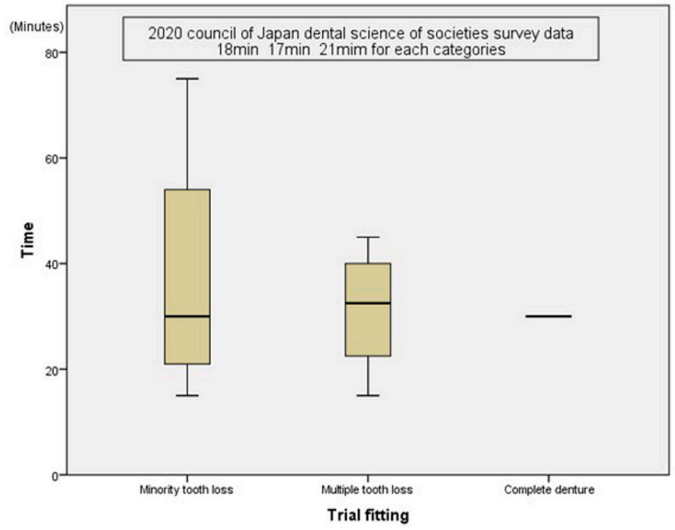

Fig. 4. Time spent for denture trial fitting.

There were 5 cases of denture trial fitting for minority tooth loss, with a mean time of 39.00 min (SD 25.01); 4 cases of denture trial fitting for multiple tooth loss, with a mean time of 31.25 min (SD 12.50); and 1 case of complete trial fitting, which took 30.0 min. The mean time of the three categories was 18, 17, and 21 min, respectively, comparing the average time for each category to the CJDSS survey, all categories had a longer time. (Fig. 4).

There were 7 cases of denture repair for minority tooth loss, with a mean time of 46.14 min (SD 25.01); 1 case of denture repair for multiple tooth loss, which took 25.0 min; and 4 cases of denture repair of complete denture, with a mean time of 41.25 min (SD 6.24). The mean time for denture repair ended to be longer at 30 min in the CJDSS survey (Fig. 5).

In the category of delivering maxillofacial prostheses, there were 13 difficult cases, with a mean time of 35.08 min (SD 13.66), and 11 extremely difficult cases, with a mean time of 44.73 min (SD 13.80). The mean time for the two categories was comparable, at 34 and 46 min,

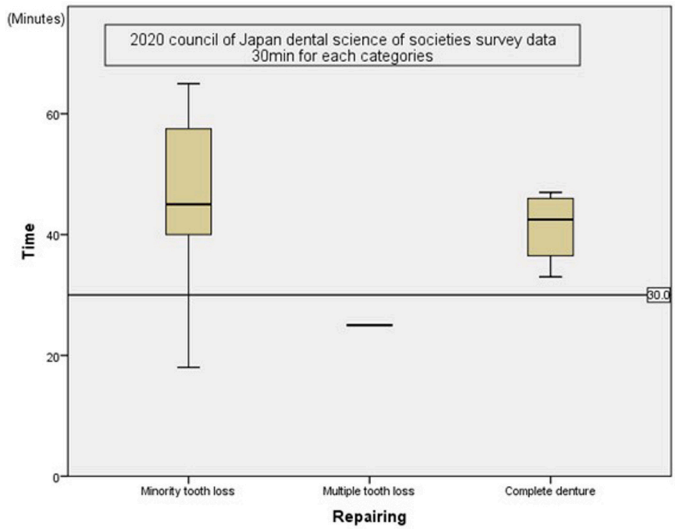

Fig. 5. Time spent repairing maxillofacial prostheses.

respectively, comparing the average time in each category to the CJDSS survey, the time is longer in the difficult category and slightly shorter in the extremely difficult category in the CJDSS survey (Fig. 6).

3.5. Time spent adjusting dentures according to defect classification

In the CJDSS survey, the mean time spent adjusting dentures was 29 min. Our study revealed differences in the adjustment time needed according to the classification of defects.

Mandibular defects were divided into marginal resection, segmental resection, and hemimandible resection, according to severity (Fig. 7). There were 26 cases of denture adjustment for marginal resection, with a mean time of 30.35 min (SD 12.69); 27 cases of denture adjustment for segmental resection, with a mean time of 24.63 min (SD 8.49); and 12 cases of denture adjustment for hemimandible resection, with a mean time of 30.00 min (SD 11.67) (Fig. 8).

Maxillary defects were divided into 6 categories of adjustment time based on the Aramany classification [16]. There were 24 cases of denture adjustment for Aramany I defects, with a mean time of 30.79 min (SD 9.99); 50 cases for Aramany II defects, with a mean time of 25.28 min (SD 13.23); 4 cases of Aramany III defects, with a mean time of 21.25 min (SD 4.79); 17 cases of Aramany IV defects, with a mean time of 32.18 min (SD 16.04); 2 cases of Aramany V defects, with a mean time of 39.00 min (SD8.49) in Aramany V; and 7 cases of Aramany VI defects, with a mean time of 39.71 min (SD 20.55) (Fig. 9).

4. Discussion

4. .1. Large number of adjustments required

The number of denture adjustments accounted for 65.0% of the total data collected. The high number of adjustments is a reflection of the reality of daily clinical practice. Patients with head and neck defects may have severe functional impairments of speech, mastication, and/or swallowing. These functions are essential for activities of daily living, making the fit of dentures an important consideration for patients. After surgery, the intraoral condition may undergo many changes. Sensitive

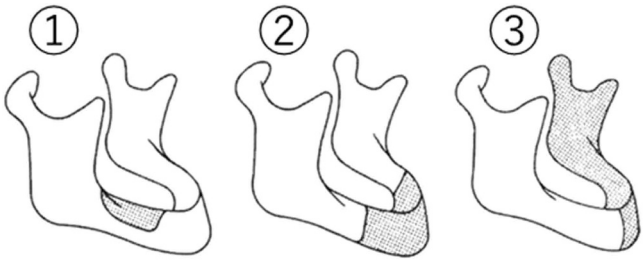

Fig. 7. Classification of mandibular resection.

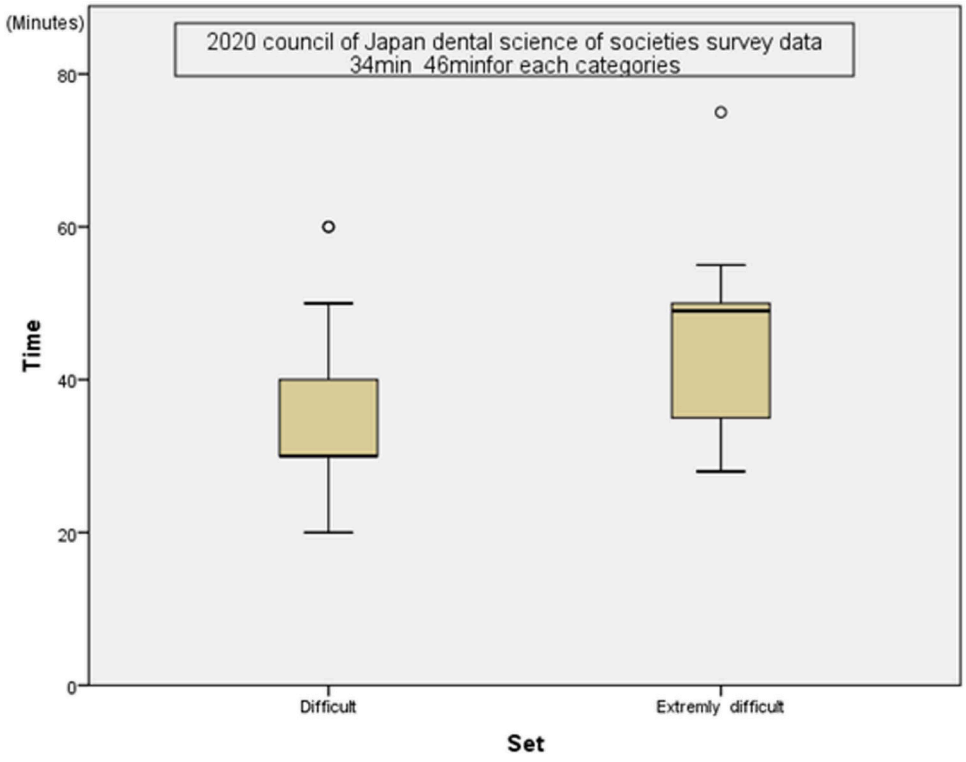

Fig. 6. Time spent for maxillofacial prosthesis delivery.

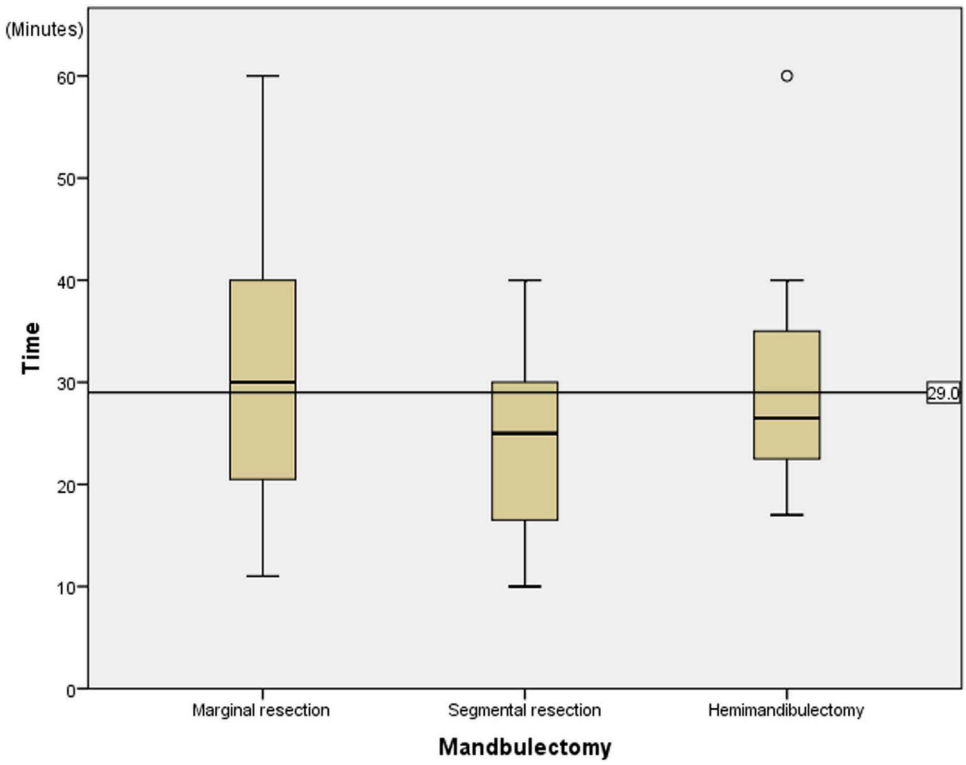

Fig. 8. Time spent adjusting dentures in mandibulectomy cases.

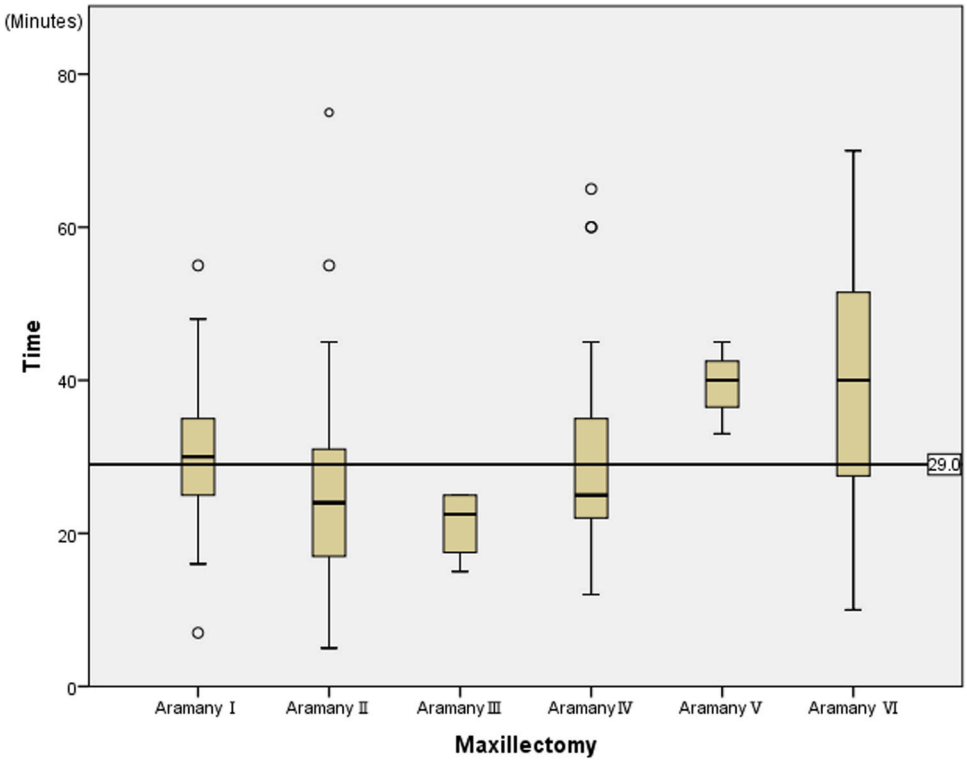

Fig. 9. Time spent adjusting dentures in maxillectomy cases.

areas may be prone to bleeding and pain due to the presence of defects, including in the nasal cavity. Maxillofacial prostheses with complicated structures may be difficult to wear and patients may require specialized instruction [17]. It is also clear that fabricating new maxillofacial prostheses is a greater burden to the patient and the dentists compared with normal dentures. In addition, the patient may experience chronic stress because of a tumor, various dysfunctions, and esthetic problem that require supportive care. Frequent denture adjustments may be required because the maxillofacial prosthesis is more mobile compared with normal dentures and may cause more stress on the abutment teeth.

In addition, there is an increased risk of caries in the remaining teeth after radiation therapy.

Frequent adjustments are reasonable to expect and often necessary in patients with head and neck defects. Therefore, the present insurance system in which the number of adjustments per month is limited is considered to be detrimental to the patient.

4.2. Large variability in time data collected

Even though the data collected on clinical practice was obtained from maxillofacial prosthodontists in this study, the range of time spent on the calculated items within the current insurance framework varied widely. There are several likely reasons for this wide variation in the time-study data collected. First, maxillofacial prosthodontists encounter many variations in the types of defects as well as in the severity of defects that they must treat. Moreover, the location of intraoral pain as well as the tolerance for pain and discomfort varies from patient to patient, which naturally affects treatment. The dentures used in maxillofacial prosthetic treatment tend to be larger and more complex compared with normal dentures. These prostheses are often placed on mucous membranes and other areas prone to bleeding, so they must be inserted and removed with care. In many cases, the patient needs time to become accustomed to the maxillofacial prosthesis. This suggests the need to include some other factors in the insurance system. The number of teeth is just one factor to be considered.

4.3. Comparison of the present data with that of the CJDSS survey

The impression items in our study cover the insurance points for the number of teeth and maxillofacial defects, respectively. Therefore, it is likely that the time needed to take impressions will be within the current estimated time. However, the times spent performing bite registration, trial fitting, denture repair, and denture adjustment were much longer than those in the CJDSS survey. The reason for this is that the CJDSS survey assumed a normal denture and did not consider maxillofacial defects. Due to the presence of defects, which can be quite large in some maxillofacial patients, and the need for more frequent follow-up visits, typically more materials are needed compared with conventional prosthetic treatments. Thus, the treatment costs of the steps for bite registration, fitting, denture repair, and denture adjustment must be reconsidered.

These findings also show that maxillofacial prosthetic treatment varies widely and does not fit easily within the current insurance framework. It is therefore necessary to consider not only the presence of jaw defects and the number of remaining teeth but also the presence or absence of soft tissue morphological defects, soft tissue dysfunction, limitations in mouth opening, and the additional presence of a facial defect.

While transitioning to a digital workflow can potentially reduce material consumption and improve chair time, this option may not be feasible for all facilities because it requires expensive equipment and software. Furthermore, the current insurance system in Japan does not cover digital workflows, which may discourage some patients from opting for it due to the associated costs. As a result, the conventional workflow remains the preferred choice for most patients [18,19,20].

4.4. Comparison with previous studies

In the literature, the mean chair time for prosthodontists to fabricate a complete denture ranged from 268 to 308 min from the time of the first examination to the second review appointment after delivery. The mean chair time for each clinical procedure in complete denture construction has also been reported. For implant-retained mandibular overdentures, the mean chair time was 327 min from delivery to the time of the second review appointment. Furthermore, the mean clinical working time was reported to be 3.1 h for a fixed implant–supported prosthesis. The treatment cost for a complete denture was estimated to be 43,904 yen, including a material cost of 8,641 yen, and a labor cost of 35,534 yen [21]. In this study, the total time for all steps in the maxillofacial prosthesis fabrication process was calculated to be with the shortest and longest steps averaging 42 and 300 mins, respectively. The cost of the easiest maxillofacial prosthesis fabrication process was 27,930 yen, while that of the most difficult was 76,310 yen.

4.5. Limitations and future work

This study did not take into account soft tissue morphology or dysfunction because only items within the present insurance framework were examined. It is very difficult to collect data for a large number of cases of maxillofacial defects that all satisfy the same criteria, so the number of cases per procedure varied greatly due to the lack of cases. To address a further limitation, we believe that it is necessary to assign additional points to each step of the treatment procedure according to conditions that include not only the presence of a maxillofacial defect and the number of remaining teeth but also the presence or absence of soft tissue morphological defects and soft tissue dysfunction. Although this study was a cross-sectional study, further longitudinal studies will be necessary to reveal the clinical situation. Future studies should also evaluate the cost of materials for maxillofacial prosthesis fabrication. The year of experience the dentists, the influence of maxillofacial prosthodontists' treatment, and the cost of dentists' salaries should also be carefully considered in the future. It will also be important to clarify the actual situation by comparing the time spent in each case with the time spent on actual on average in cases with the same level of treatment.

Further research is needed to provide a uniform level of maxillofacial prosthetic rehabilitation for head and neck cancer patients all over Japan.

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Conflict of interest

None.

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