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ORIGINAL ARTICLE

Use of digital technologies in maxillofacial prosthetics in Japan

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ABSTRACT

Purpose: This study investigated the use of digital technology in maxillofacial prosthetics among practitioners involved in maxillofacial prosthetic rehabilitation in Japan.

Materials and Methods: A self-administered survey questionnaire with 24 closed-ended and multiple choice questions was used. A total of 300 questionnaires were distributed at the 32nd meeting of the Japanese Academy of Maxillofacial Prosthetics that was held in Tokyo, Japan in June 2015. The survey questionnaire was distributed in a pack that included an introduction letter explaining the research aims, objectives, and informed consent. The data obtained were analyzed by descriptive statistical methods and reported as frequency and range.

Results: In total, 105 respondents (77 men (73.4%), 28 women (26.6%); median age, 40 years; age range 21-66 years) completed the questionnaire (response rate, 35%). The majority of respondents were dentists (75.2%), followed by dental technicians (21.9%). The median duration of work experience for the respondents in their specialty was 14 years, and 97% of respondents had interested and adopted digital technologies in maxillofacial prosthetics. Digital technologies were used significantly in patient and practice management, diagnostic, and patient's defect visualization ($p < 0.001$) but insignificant in treatment planning ($p = 0.917$). In contrast, there were significant increases in non-use of digital technologies in prosthesis design, prosthesis manufacturing, and patient and prosthesis evaluation ($p < 0.001$).

Conclusion: Japanese dental practitioners are interested and willing to use digital technology in maxillofacial prosthetics. Most respondents use some or a substantial number of digital technologies in clinical practice. (*Int J Maxillofac Prosthetics 2021;4:25-36*)

Keywords

Digital technology, maxillofacial prosthetics, use, Japan.

INTRODUCTION

The maxillofacial prostheses used in treatment replace defects in the oro-facial area and serve to restore oral functions such as swallowing, speech, and mastication.[1] The complicated structure of maxillofacial defects necessitates highly specialized procedures to fabricate the prostheses. Digital technology is one of the promising modalities that can be used to simplify the procedures of maxillofacial prosthetic rehabilitation.[2-5]

In maxillofacial prosthetic rehabilitation, digital technology has been used more often for digitization, design, and rapid prototyping purposes than for evaluation prostheses and patients.[2] Since computer aided design and computer aided manufacturing (CAD/CAM) applications were introduced in dentistry, the technology has greatly evolved. The clinical application of CAD/CAM now allows clinicians to directly obtain high-resolution data on head and neck defects and provide prosthetic rehabilitation based on those data, which would not have been available before.[6] Recent studies have revealed that the use of digital technologies can be extended beyond conventional and partially digital workflow to fully digitized workflow include defect digitization, prosthesis design, fabrication, and evaluation in patients with maxillofacial defects.[6-10]

Globally, the use of digital technologies differ considerably among individuals and institutions.[11-16] Studies show that the use of innovative digital technologies is often based on the assumption that, despite their great benefits, many innovations are not used to their full potential. Several studies in dentistry have measured the extent that dental professionals use digitalized dental practice[17-21] and digitalized information seeking processes[22] and advocate the use of specific technologies.[23-25] Although these studies provide important evidence on the use of dental digital technologies, they do not provide an overall picture of current use. However, limited studies in maxillofacial prosthetics have surveyed maxillofacial

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prosthetic practitioners about their engagement and use of digital technologies in the United Kingdom and North America,[5, 26] while it has not yet been studied in Japan. In this study, no hypotheses were tested as this survey was an exploratory study. Thus, the aim of this study was to determine the use of digital technologies in maxillofacial prosthetics among Japanese dental practitioners.

MATERIALS AND METHODS

A self-administered survey questionnaire was developed that comprised 24 closed-ended and multiple-choice questions (Appendix 1) in four categories (Table 1): demographics (sex, age, profession, specialty, and work experience); interest to use digital technology; use of digital technology (administrative, diagnostic, and therapeutic applications); and advantages and disadvantages of these technologies. This study was approved by the Ethics Committee of the Faculty of Dentistry, Tokyo Medical and Dental University (TMDU), approval number 1082.

A total of 300 questionnaires were distributed at the 32nd meeting of the Japanese Academy of Maxillofacial Prosthetics (JAMP) that was held at TMDU from 18 to 20 June 2015. JAMP was established in 1984 to improve research and clinical treatment in maxillofacial prosthetics in Japan, and the society currently has about 600 members. There are around 300 prosthodontists, 200 oral surgeons, and 50 dental technicians, dental hygienists, and speech therapists. JAMP also has a system for certifying specialists in maxillofacial prosthetics, and 141 accredited specialists have been certified. The survey questionnaire was distributed along with an introduction letter that explained the research aims and objectives and also sought informed consent.

Completed questionnaires were coded, and spreadsheets were created for data entry. Survey results were manually entered into a personal computer by two authors separately. Data entries were checked by a third party to identify errors, and necessary corrections were made after manually rechecking the questionnaires. For further data analysis, the respondents were divided into two groups based on their profession: dentists and dental technicians. Descriptive statistics were assessed for each variable and reported as frequency and range. For all statistical tests, a p value of less than 0.05 was considered statistically significant. Associations between technology use and the other variables were tested using chi-square tests.

RESULTS

Among 300 distributed questionnaires, 105 questionnaires were returned (a response rate, 35%). The main characteristics of the questionnaire sample are detailed in Table 2. The results showed that respondents who interested to use digital technology are significantly higher than those who are not (Fig 1). Most of respondents (97%) had interested to use digital technologies in maxillofacial prosthetics. Among the respondents, 86% believed that digital technology will be useful tool in maxillofacial prosthetics, while 69% believed it would be necessary. Also, 82% believed that digital technology will become the ultimate tool in the future of maxillofacial prosthetics. In regard to the use of digital technologies in future routine practice, 68% of participants agreed with the statement that digital technology will be used for selected maxillofacial prosthetic applications, while 24% believed that it will be used in all aspects of maxillofacial prosthetics (Fig 1).

Ninety-two percent of respondents were willing to use digital technologies in the future. About 70% of respondents believed in the need for continued dental education and workshops that use digital technology in maxillofacial prosthetics, and 77% of respondents were willing to attend such workshops (Fig 1). Regarding the type of cases in they would like to use digital technology in the future, 74% of respondents indicated cases of facial defect, followed by 71% for maxillectomy cases, 63% for mandibulectomy cases, and about 45% for cleft lip and palate cases. The respondents predicted less use in radiation therapy and glossectomy (Fig 2).

Digital technologies were used significantly in patient and practice management, diagnostic, and patient's defect visualization ($p < 0.001$) but insignificant

Table 1. Four categories considered in questionnaire.

Category	Related questions
Demographics	1 to 5
Interest to use digital technology	6 to 14
Use of digital technology	15 to 22
Advantages and disadvantages	23 and 24

Table 2. Main characteristics of participants.

Characteristics	%	n
Gender		
Male	73.4	77
Female	26.6	28
Age, years		
20-29	20.0	21
30-39	28.6	30
40-49	26.6	28
50-59	19.0	20
≥ 60	5.8	6
Profession		
Dentist	75.2	79
Dental technologist	21.9	23
Medical doctor	1.9	2
Dental hygienist	1.0	1
Specialty		
Prosthodontist	25.8	27
Maxillofacial prosthodontist	12.4	13
Prosthodontist and maxillofacial prosthodontist	21.0	22
Oral and maxillofacial surgeon	16.1	17
Plastic surgeon	1.9	2
Others	22.8	24
Work experience, years		
< 5	23.8	25
5-9	12.4	13
10-19	23.8	25
20-29	24.8	26
≥ 30	15.2	16

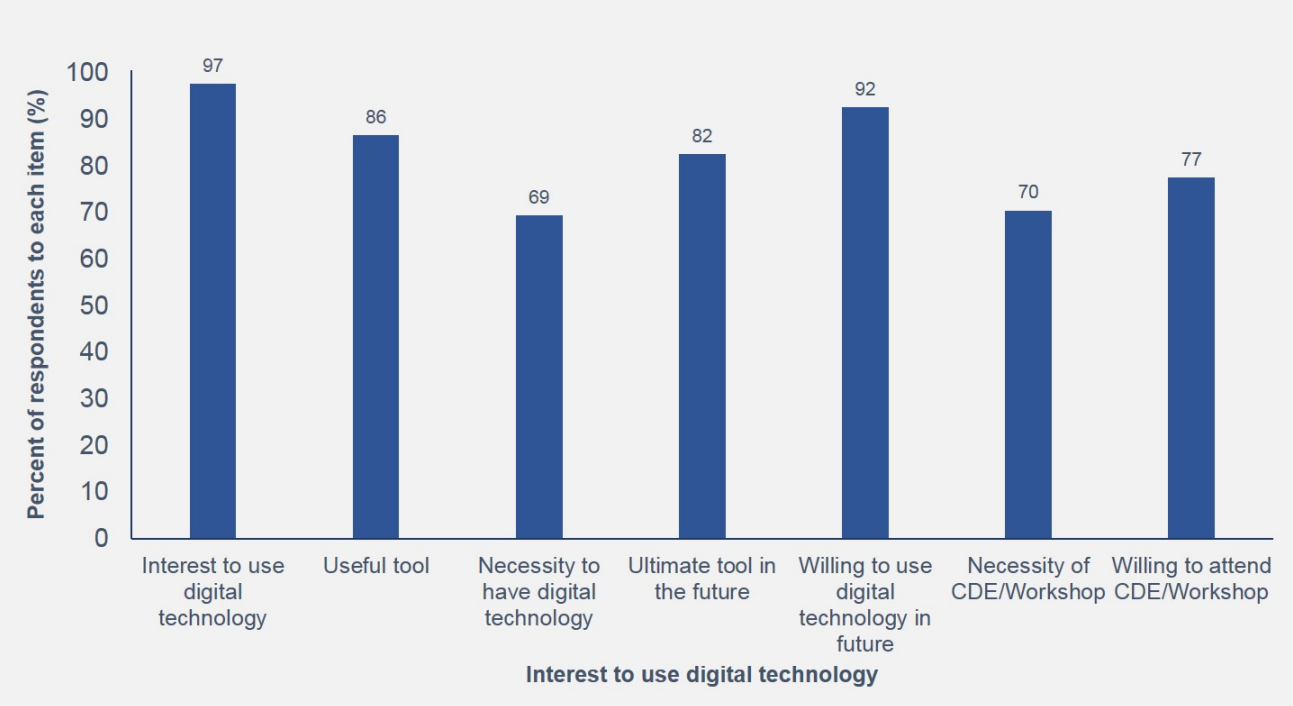


Fig 1. Interest to use of digital technologies in maxillofacial prosthetics in Japan.

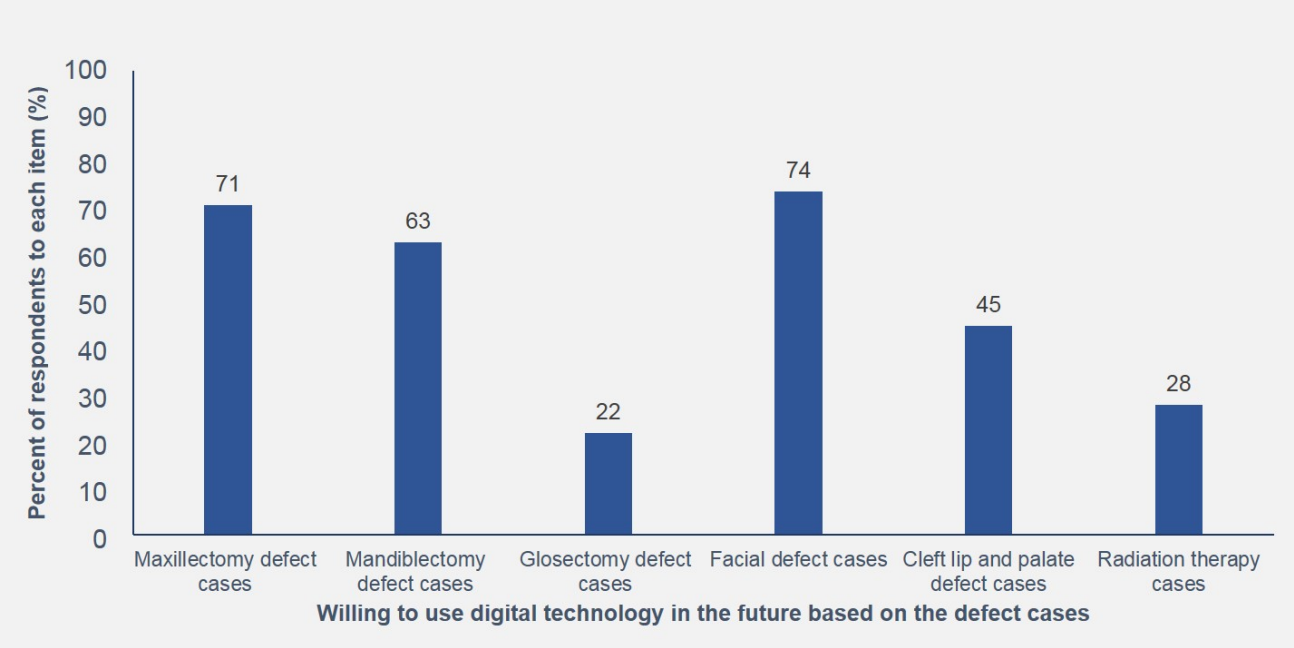


Fig 2. Willing to use digital technologies in in the future based on defect cases.

in treatment planning (p = 0.917). In contrast, there were significantly increases in non-use of digital technologies in prosthesis design, prosthesis manufacturing, and patient and prosthesis evaluation (p < 0.001) (Table 3). For patient and practice management, the most frequently used technologies involved digital appointments and reminders (59%) and digital patient information (57%) (Fig 3). In the use of digital diagnostic technologies, 71% of respondents used digital orthopantomography (OPG), 70% used digital intraoral radiography, and 63% used intraoral digital photography (Fig 4). For defect visualization, digital OPG was used by 48% of respondents, digital three-dimensional (3D) CT by (44%), and intraoral

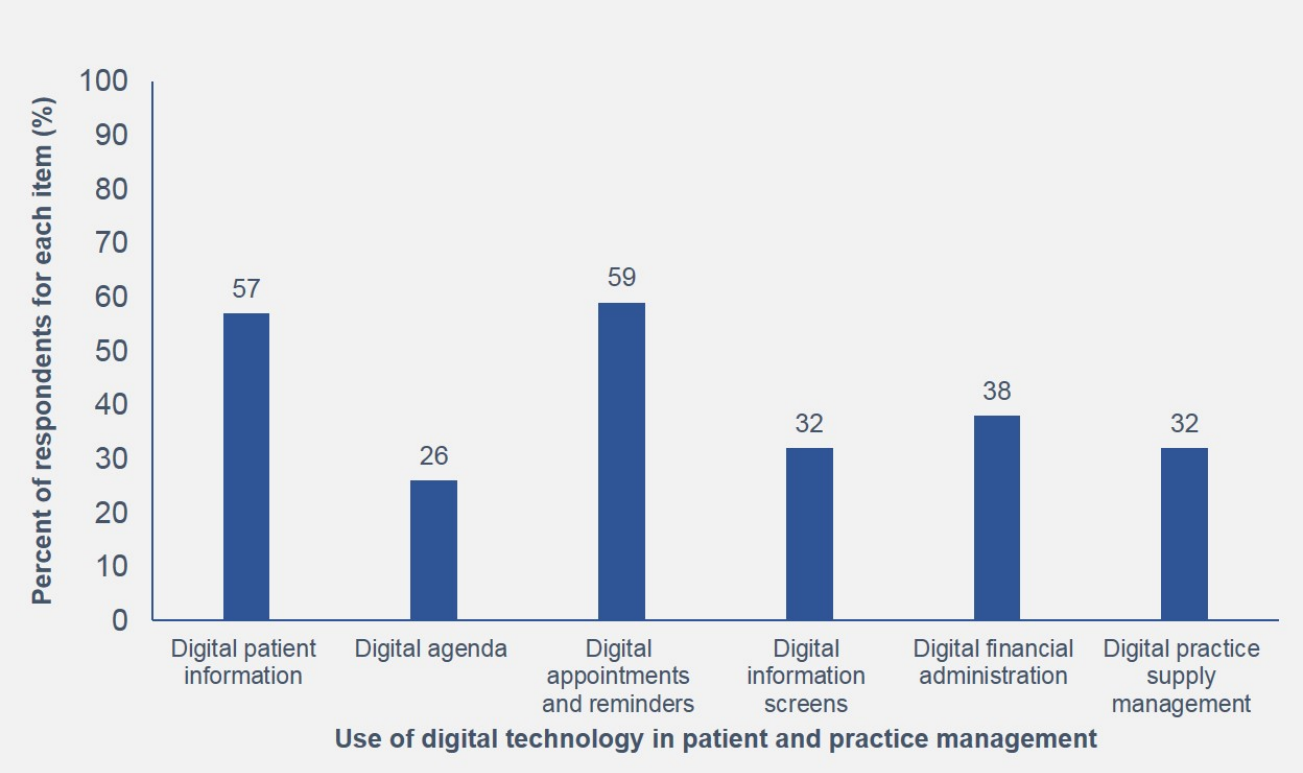


Fig 3. Digital technologies used in patient and practice management. As more than 1 category could be selected, each item percentage score for that item.

Table 3. Usage of digital technologies in maxillofacial prosthetics.

Usage of digital technology	n	%	P
Patient and practice management			
Yes	72	68.5	< .001
No	24	22.8	
Diagnosis			
Yes	86	81.9	< .001
No	11	10.4	
Patient's defect visualization			
Yes	65	61.9	< .001
No	28	26.6	
Treatment planning			
Yes	45	42.8	0.917
No	46	43.8	
Prosthesis design			
Yes	31	29.5	< .001
No	56	53.3	
Prosthesis manufacturing			
Yes	28	26.6	< .001
No	62	59.0	
Patient and prosthesis evaluation			
Yes	11	10.4	< .001
No	78	74.2	

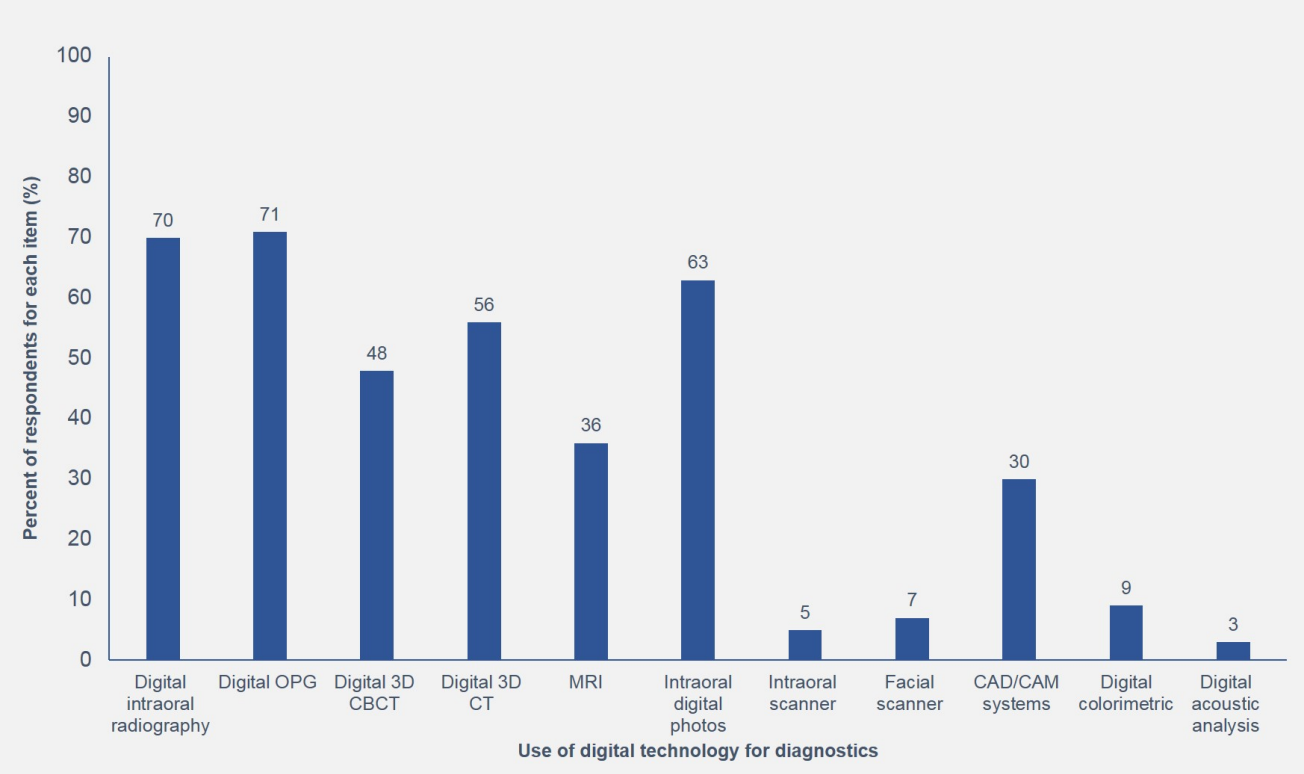


Fig 4. Digital technologies used in diagnosis. As more than 1 category could be selected, each item percentage score for that item.

digital photography by 43% (Fig 5). The most popular digital technology used for treatment planning was digital photography (30%), followed by digital 3D models (23%) and CAD/CAM systems (11%) (Fig 6). For digital technologies used in prosthesis design, manufacturing, and patient-prosthesis evaluation, the frequency of use varied, but mainly CAD/CAM systems were used for designing and manufacturing. For evaluation, the only digital technology used was a facial scanner to evaluate esthetics.

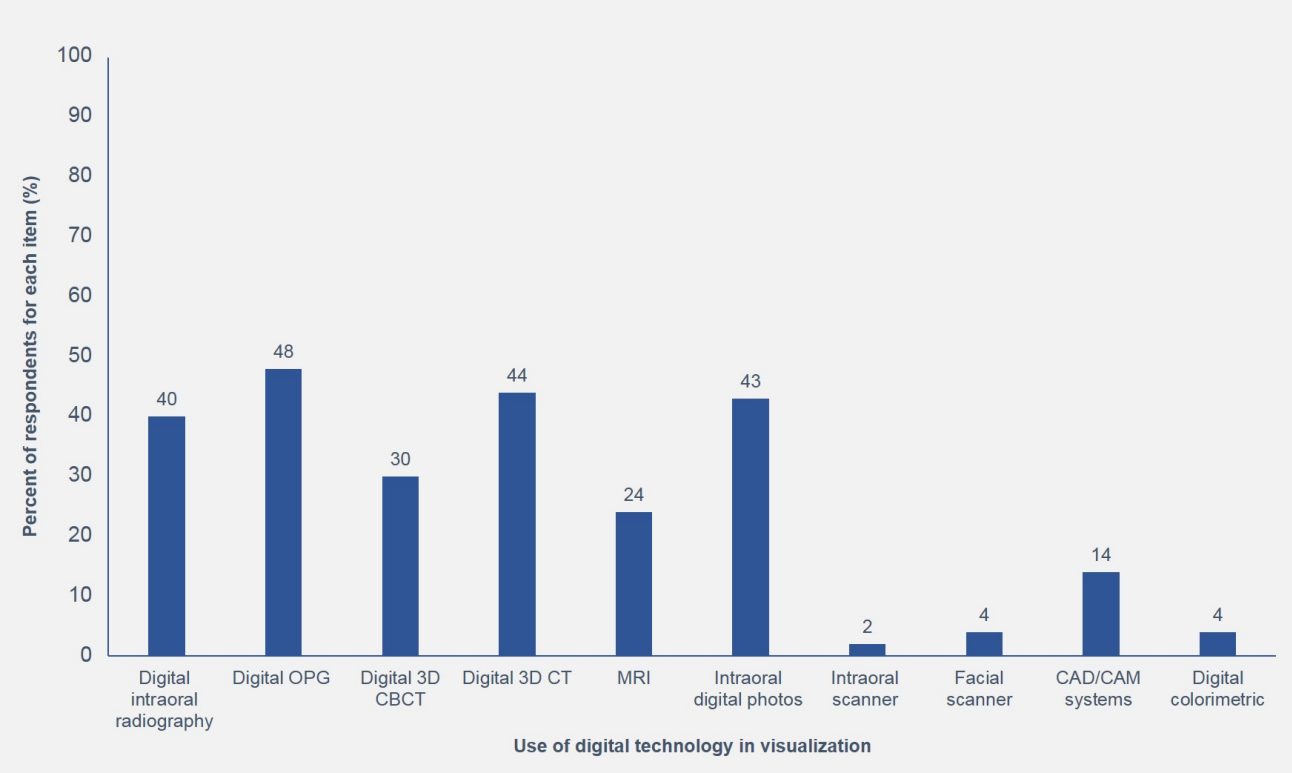


Fig 5. Digital technologies used in defect visualization. As more than 1 category could be selected, each item percentage score for that item.

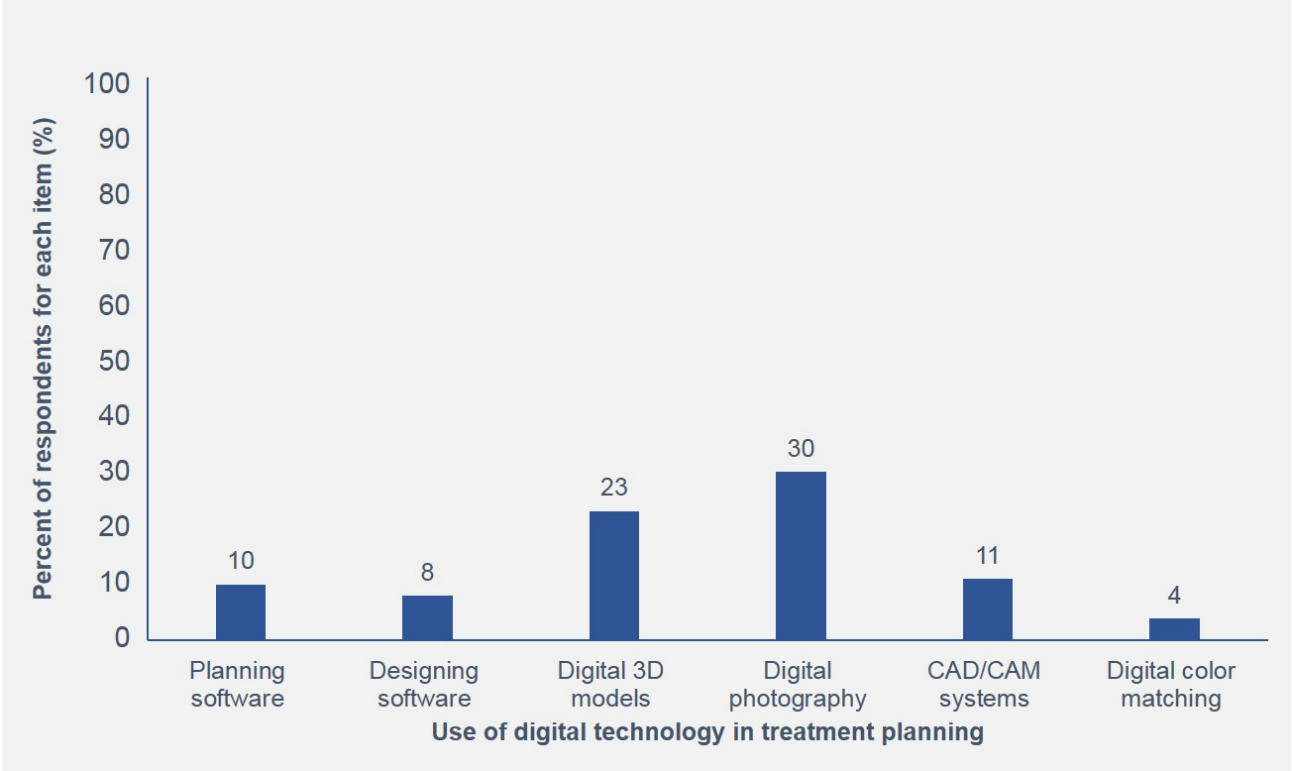


Fig 6. Digital technologies used in treatment planning. As more than 1 category could be selected, each item percentage score for that item.

The specified reasons that the respondents had for using digital technologies in maxillofacial prosthetics were: ease of storing data (64%), reducing treatment time (57%), taking measurements (33%), ease of communication (26%), and cost reduction (20%) (Fig 7). In contrast, the specified reasons for not using digital technology were: need for more equipment (55%), expense (54%), and difficulty with manipulation (25%) (Fig 8).

The comparison between respondent groups showed that the use of digital technologies in prostheses design and manufacturing was significantly higher among dental technicians than among dentists ($P < 0.001$) (Fig 9).

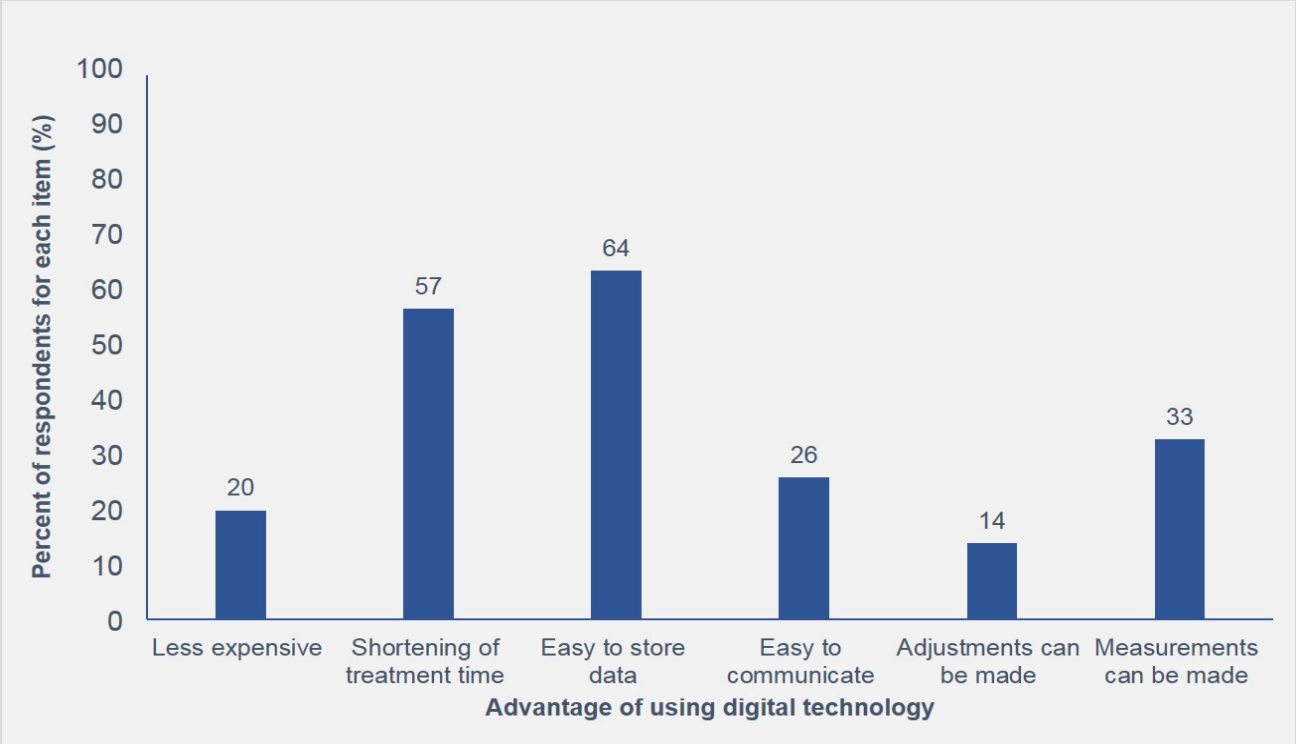


Fig 7. Advantages of using digital technologies in maxillofacial prosthetics. As more than 1 category could be selected, each item percentage score for that item.

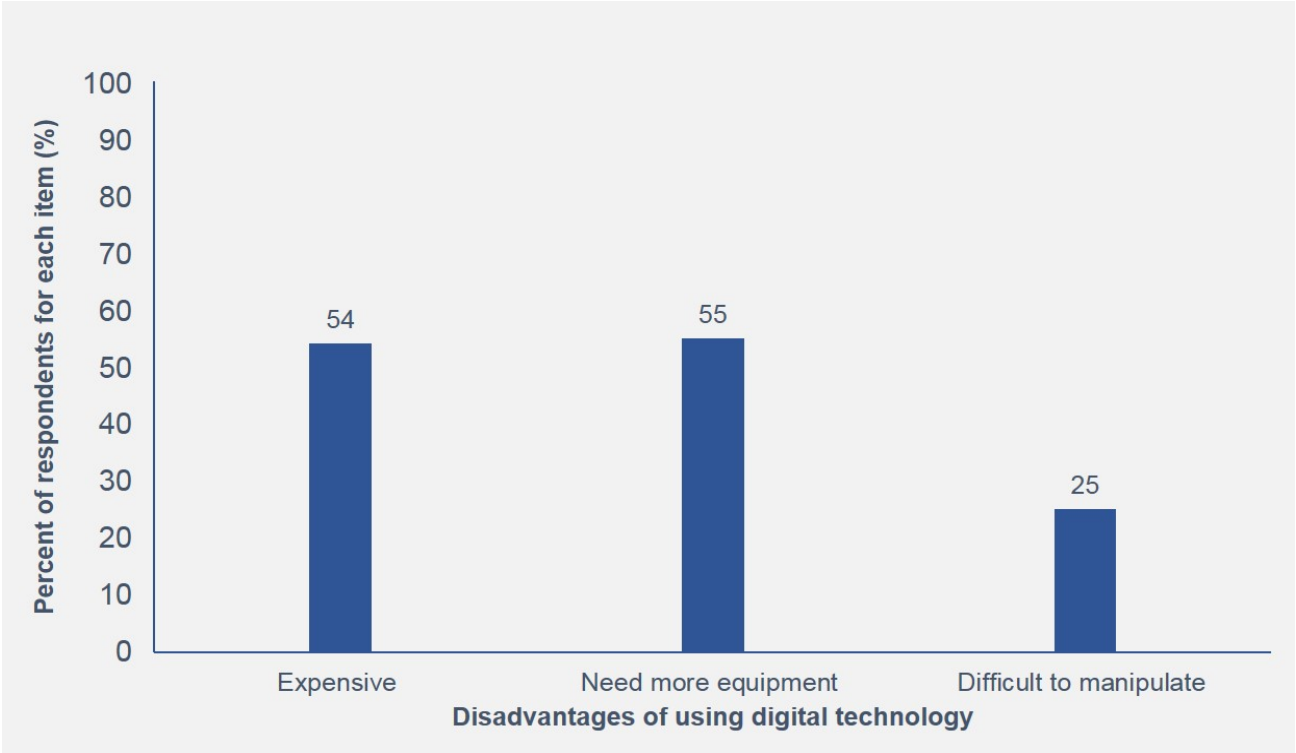


Fig 8. Disadvantages of using digital technologies in maxillofacial prosthetics. As more than 1 category could be selected, each item percentage score for that item.

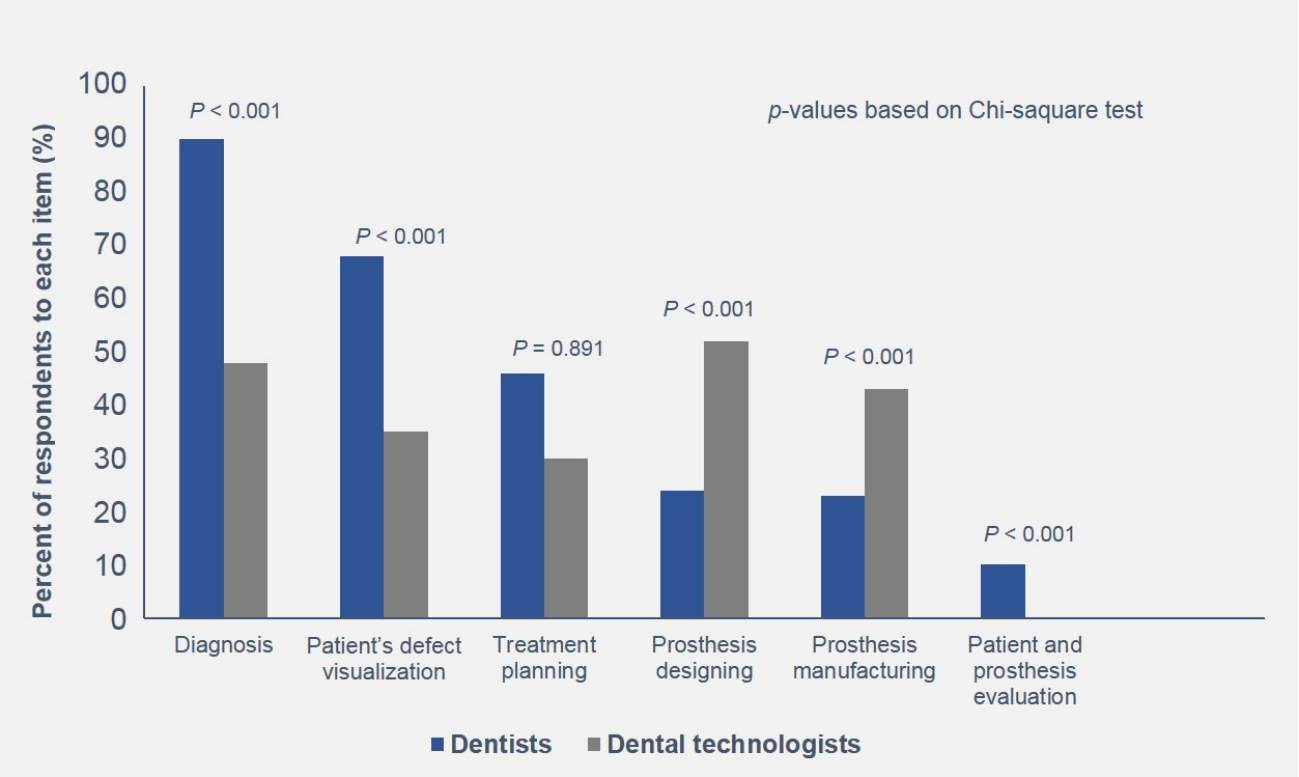


Fig 9. Comparison of digital technologies used between dentists and dental technologists.

DISCUSSION

As a research tool, questionnaires provide information about opinions, attitudes, and behavior of the respondents. Questionnaires should have carefully planned and prepared set of questions and, reminders to elicit responses, as well as have suitable response rates.[27] To our knowledge, there are no published studies that assess the use of digital technologies in maxillofacial prosthetic practice in Japan or elsewhere. To develop a suitable set of questions specifically suited for investigating the use of technologies, we based the questionnaire on previous questionnaires reported in the dental and social scientific literature. In addition, a pilot questionnaire was used to provide valuable feedback, improve the layout and format of the questions, and ensure that they were easily understood. The response rate of 35% in this study is comparable with that of similar studies performed in the UK and Netherlands.[26, 28]

The findings of this study suggest that a high proportion of Japanese dental practitioners have interested and are willing to use digital technology in maxillofacial prosthetics. This interest and willingness are positive indicators for future applications. The present study also showed that the average digital technology use was fairly widespread among practitioners with some contrast in the degree of use, especially for prosthesis design, manufacturing, and evaluation. Overall, administrative and diagnostic technologies were used more often than clinical applications. As no previous studies have been done in the field of maxillofacial prosthetics, for comparison, we examined studies on computer and internet usage among dentists in the United States,[20] United Kingdom,[19] and Canada[17] and the use of dental technologies in New Zealand.[29] These studies showed that patient and practice management systems as well as diagnostic technologies were used more than digital technologies for clinical applications, which is compatible with the results of the present study.

The present results showed that digital OPG, digital intraoral radiography, intraoral digital photography, and digital 3D CBCT technologies were often used in diagnosis and defect visualization. The use of these digital technologies seems higher among Japanese dental practitioners in this study than among dentists surveyed in the above mentioned studies. The reason for this discrepancy may be that digital technology is a rapidly changing field and has therefore changed in the years since the earlier studies were published. For treatment planning, digital photography was the most common technology used, in large part because this technology is easy to manipulate and inexpensive to maintain. As to the routine use of digital technologies in maxillofacial prosthetics in the future, most participants agreed with the statement that it will be used for selected maxillofacial prosthetic applications. This response is

likely due to the complexity of some maxillofacial defects that would not be managed by the application of digital technology. This selectivity was reflected by the fact that most respondents would like to use digital technology in the future for cases involving facial defects, maxillectomy, and mandibulectomy, which are all less complicated than cases of glossectomy, for example.

In dental studies,[18, 24] the factors primarily influencing technology use are perceptions of its relative advantages and financial aspects. The results of this study showed that more usage of digital technologies for clinical applications is desired. However, the major factors limiting their use in the field of maxillofacial prosthetics are their expense, the multiple technologies needed, and difficulties in manipulation. Although it is a limitation that this survey was carried out six years ago and within these last few years the digital technology was rapidly advanced, these data could not be considered as representative of presence status. As the digital workflow is rapidly advancing, it is necessary to perform this survey again and compare the results of the last five years to know the presence status taking in the account the fast developing of the technology.

CONCLUSIONS

The findings of this study provide insight into the use of digital technology in maxillofacial prosthetics in Japan. Most respondents use some or a substantial number of digital technologies in clinical practice. However, the expense of the technologies, the multiple technologies needed, and the difficulty in manipulating the technologies are the major factors limiting their expanded use in maxillofacial prosthetics.

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Appendix 1. Questionnaire on use of digital technology in maxillofacial prosthetics.

Demographics		
Q1	Gender	Male ❑ Female ❑
Q2	Age	( ) Years old
Q3	Profession	Dentist ❑ Dental technologist ❑ Dental hygienist ❑ Speech therapist ❑ Others ❑, please specify ( )
Q4	Specialty	Prosthodontist ❑ Maxillofacial Prosthodontist ❑ Oral and Maxillofacial Surgeon ❑ Maxillofacial technologist ❑ Dental Digital Technologist ❑ Others ❑, please specify ( )
Q5	Work experience	( ) Years
Interest to use of digital technology		
Q6	Do you interest to use digital technology in your practice?	
	Yes ❑ No ❑	
Q7	Do you feel digital technology is a useful tool in maxillofacial prosthetics?	
	Yes ❑ No ❑	
Q8	Do you think the necessity of having digital technology facilities?	
	Yes ❑ No ❑	
Q9	Do you think digital technology will be the ultimate tool in the future of maxillofacial prosthetics and research?	
	Yes ❑ No ❑	
Q10	To what extent do you believe digital technology will be used in routine maxillofacial prosthetics practice in the future?	
	It will not be used ❑ In all aspects of maxillofacial prosthetics ❑ Limited use ❑ Selected maxillofacial prosthetic applications only ❑ No idea ❑	
Q11	Would you like to use digital technology in your future professional career?	
	Yes ❑ No ❑ Maybe ❑	
Q12	For what cases would you like to use digital technology in your future professional career?	
	Acquired maxillofacial defect cases ❑ Congenital maxillofacial defect cases ❑ Intra oral prostheses ❑ Extra oral prostheses ❑ Radiotherapy appliances ❑ Others ❑, please specify ( )	
Q13	Do you think frequent Continued Dental Education CDE/workshops should be conducted to acquire more knowledge on digital technology?	
	Yes ❑ No ❑ Maybe ❑	
Q14	Are you willing to attend CDE/workshops pertaining to digital technology in maxillofacial prosthetics?	
	Yes ❑ No ❑	
Use of digital technology		
Q15	Do you use digital technology to manage your practice?	
	Yes ❑ No ❑	
	If yes, what kind of digital technologies that you use? *Multiple answers are allowed*	
	Digital patient information ❑ Digital agenda ❑ Digital appointments and reminders ❑ Digital information screens ❑ Digital financial administration ❑ Digital practice supply management ❑ Others ❑, please specify ( )	
Q16	Do you use digital technology in diagnostic applications?	
	Yes ❑ No ❑	
	If yes, what kind of digital technologies that you use in diagnostic applications? *Multiple answers are allowed*	
	Digital intra oral radiography ❑ Digital orthopantomogram ❑ Cone Beam Computer Tomography (CBCT) ❑ Computer Tomography (CT) ❑ Magnetic Resonance Imaging (MRI) ❑ Intra oral digital camera ❑ Intra oral digital scanner ❑ External laser scanner ❑ Digital 3D models ❑ Digital photography ❑ CAD/CAM system ❑ Digital color determination ❑ Digital acoustic analysis ❑ Others ❑, please specify ( ) External laser scanner ❑ Digital 3D models ❑ Digital photography ❑ CAD/CAM system ❑ Others ❑, please specify ( )	

Appendix 1. Continued...

Q17	Do you use digital technology in patient's defect visualization? Yes ❑ No ❑ If yes, what kind of digital technologies that you use in visualization? Multiple answers are allowed 3D visualization software ❑ 3D Cone Beam Computer Tomography (CBCT) ❑ 3D Computer Tomography (CT) ❑ 3D Magnetic Resonance Imaging (MRI) ❑ Intra oral digital camera ❑ Intra oral digital scanner ❑ External laser scanner ❑ Digital 3D models ❑ Digital photography ❑ CAD/CAM system ❑ Others ❑, please specify ( )
Q18	Do you use digital technology in treatment planning? Yes ❑ No ❑ If yes, what kind of digital technologies that you use in treatment planning? Multiple answers are allowed Treatment planning software ❑ 3D designing software ❑ Digital 3D models ❑ Digital photography ❑ CAD/CAM system ❑ Digital color matching ❑ Digital acoustic simulation ❑ Others ❑, please specify ( )
Q19	Do you use digital technology in prostheses designing? Yes ❑ No ❑ If yes, what kind of digital technologies that you use in designing? Multiple answers are allowed 3D designing software ❑ Computer Aided Design CAD system ❑ Digital 3D models ❑ Digital photography ❑ Others ❑, please specify ( )
Q20	Do you use digital technology in prostheses manufacturing? Yes ❑ No ❑ If yes, what kind of digital technologies that you use in manufacturing? Multiple answers are allowed 3D printing technologies ❑ Additive manufacturing technologies ❑ Rapid prototyping technologies ❑ Milling technologies ❑ Others ❑, please specify ( )
Q21	Do you use digital technology in patients and prostheses evaluation? Yes ❑ No ❑ If yes, what kind of digital technologies that you use in evaluation? Multiple answers are allowed Digital based questionnaire ❑ Digital function analysis ❑ Digital photography ❑ Digital color analysis ❑ Digital acoustic analysis ❑ Others ❑, please specify ( )
Q22	Have you attended any courses related to digital technology in maxillofacial prosthetics? Yes ❑ No ❑
Advantages and disadvantages	
Q23	Please specify what are your reasons to use digital technology in your practice? Multiple answers are allowed Less expensive ❑ Short time ❑ Easy to store data ❑ Easy to communicate ❑ Adjustments and measurements can be made ❑ Improve case diagnosis and treatment planning ❑ Improve the final treatment outcome ❑ Improve the patient quality of life ❑ Others ❑, please specify ( )
Q24	Please specify what are your reasons of not using digital technology in your practice? Multiple answers are allowed Expensive ❑ Need more equipment ❑ Difficult to manipulate ❑ Hard to Perform ❑ No Idea ❑ Others ❑, please specify ( )