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Use and Efficacy of Intra Oral Scanning in the Fabrication of Removable Prosthesis: A Narrative Review

Abdulaziz Saud Aldayel[I*], Jawaher Abdullah F Albarakati[II]

I. Department of Maxillofacial Surgery and Rehabilitation, King Fahad Medical City, Riyadh, KSA.
(Corresponding Author) *
II. Department of Prosthodontics, King Saud University Hospital, Riyadh, KSA.

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ABSTRACT

Intra oral scanning or IOS is a relatively new method of fabricating the removable prosthetic that promises to make the conventional impression obsolete. This narrative review will be an attempt to compare and describe the existing reported applications of IOS in fabrication of different types of removable prostheses in prosthodontics and its effectiveness. An electronic database search was carried out in PubMed, MEDLINE, Scopus, and Embase with emphasis on articles from January 2013 to March 2024. The review looked at in vitro studies and clinical reports on DI, CDI and various forms of DDs and DP. Thus, patients expressed a significantly higher level of preference for the digital scanning technique over conventional impression taking methods in terms of discomfort, nausea, and breathing problems. It has been most beneficial in the fabrication of RPD's, and implant supported prostheses with better fit of the prosthesis. Nevertheless, the usage of IOS in complete dentures remains somewhat limited and weakens through the difficulties in capturing edentulous arches properly. Thus, even if IOS technology has high initial costs and initial difficulties, in the long run, it can be a useful instrument to improve the work of a contemporary dental practice. Thus, it can be concluded that further investigations are required to fill the existing gap and introduce the intraoral scanner for additional applications in removable prosthodontics. This review will also extend IOS's applicability of supporting prosthodontic practice to increase patient benefits and enhance the fabrication process.

Key words: Intra oral scanning, Removable prosthodontics, Digital impressions, Case-control study

INTRODUCTION

Intraoral scanning is one of the recent developments when it comes to tools that have gained popularity in the contemporary practice of dentistry, especially prosthodontics. In the past, impression making for the production of complete and partial removable prosthetic appliances involved the use of conventional techniques. Such traditional approaches may present difficulties such as, patients' discomfort, low reliability because of material deformation, and time-consuming treatment. Thus, the applicability of IOS relates to introducing an innovative digital solution that is supposed to increase the accuracy of diagnosing and treating diseases, simplify various operations, and provide better experiences to patients [1]. IOS technology uses the most modern opto-electronics to obtain a highly detailed stereoscopic image of the oral cavity. These digital impressions are then used to design and sculpt functional prosthetic devices using Computer aided design /Computer-aided manufacturing CAD/CAM systems. The use of IOS in fabrication of removable prostheses has relatively more importance as the rate of edentulism continues to rise in the growing elderly population and there is high need in accurate and efficient dental solutions. Thus, the objective of this narrative review is to systematically identify and summarise existing peer-reviewed literature concerning the contemporary application and effectiveness of IOS in the construction of removable prostheses [2]. This review will come in different sections to focus on areas such as patients' preference, clinical efficacy, and techniques in IOS technology. However, through reviewing the recent published studies and clinical reports of iOS application, this paper seeks to stress on the opportunities and persisting hardships of implementing iOS into prosthodontic practice. The present literature is reviewed to

identify the articles and papers published between January 2013 and March 2021. The specific areas of discussion are: IOS vs traditional impression methods, IOS's reproducibility and precision and IOS applications in fabrication of complete dentures, removable partial dentures (RPDs) and implant supported prostheses [3]. Also discussed in the course of reviewing the research, are the patient outcomes with respect to perception of comfort and satisfaction, gag reflex, nausea, and hassles related to impression taking.

However, the said development in particular aires a challenges that come with the application of IOS system in removable prosthodontics [4]. First, costs of purchasing and installing of IOS technology and its impact on the new methods of learning by the dental professionals and some technical issues in acquiring the detailed patient's body contours are the main challenges. Also, the review will consider the future clinical trials, which are imperative to define the standard of practice and demonstrate the prospects of IOS regarding the conventional approach [5]. Therefore, this is a narrative review of the transformative effect of intraoral scanning in the construction of removable prostheses that will be useful to the dental practitioners and researchers focusing on digital dentistry tomorrow. The review therefore emphasizes the various possibilities through which IOS could improve or develop the prosthodontic outcomes in favor of both the clinician and the patient [6].

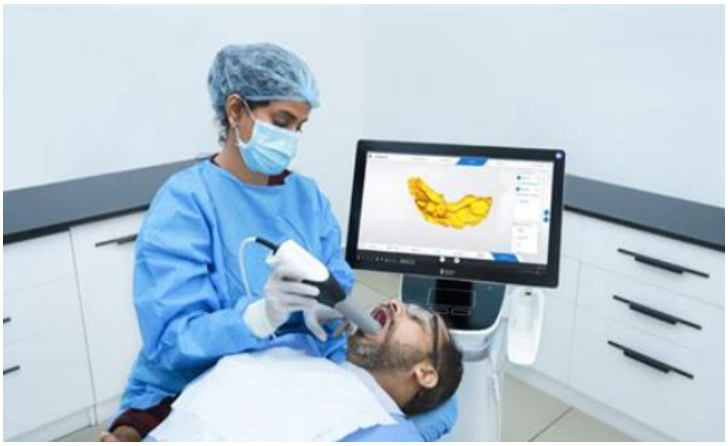

Figure 1. Prosthodonic Scan

Historical background

Advanced previous studies showed that the field of prosthodontics has underwent through various techniques and materials to enhance fabrication of the removable prostheses. Previously, the fabrication processes of the complete and the partial dentures mostly utilized the analog impression procedures that have been in use since the period of around a century [7]. These methods include the use of impression materials like alginate or polyvinyl siloxane to make a negative cast that reflects the correct dimensions of a patient's oral cavity. While these material types were utilised as a therapy option to provide patients with comfortable and non-irritating appliances, some of the associated issues encountered included discomfort among the patient; and inaccuracies such as when the material used shrunk or expanded; not forgetting the time-consuming nature of the therapy process [8]. The very first major step towards the contemporary approaches of denture fabrication was facilitated by the CAD/CAM technology at the end of the 20th century. The initial inspiration of CAD/CAM systems involved the fabrication of fixed prostheses for example crowns and bridges but no major application was presented in removable prosthodontics because the procedures involved and the need to achieve intimate tissue contact. The attempts to apply the use of digital technology in the fabrication of dentures started gaining the 1990s [9]. The introduction of digital impression systems was the first moment towards integrating's cooperation. These early systems, nevertheless, had problems in perceiving the numerous particulars of soft tissue required for the fabrication of removable prostheses. There was specific progress with the introduction of IOS as they could provide very accurate digital impression without the use of the impression materials. The first intraoral scanners came into use in the early 1980's and the first applications were mainly for fixed prosthetics. Technological advancement characterized the development of these devices and saw a steady improvement in the scanning accuracy, scanning speed as well as the scan ease [10]. By the year 2000, the technology had been enhanced to make it fit to be used when doing removable department

prosthodontics. During this period; advanced models of IOS were created capable of yielding all the arch scans with maximum precision [3].

Later in 2012, researchers describe the application and possibility of constructing a denture through digital method which opens the door for the acceptance and practice of IOS in the removable Prosthodontics [9]. The subsequent years recorded a steep growth in the accessibility and effectiveness of IOS systems since developments in image digitalization and software computations augmented its systems constantly. These new IOS technologies have been in parallel with extensive developments in computer aided design & computer aided manufacturing, which enabled dentists to design and fabricate the final functional complete dentures, RPDs and implant retained prosthetics. Digital treatment workflows have proved to have multiple benefits such as higher accuracy, less operating time on a dentist's chair and increased patient comfort [6]. Presently, the intraoral scanning is termed as one of the revolutionary techniques in dentistry as it is the digital method that has number of advantages over the traditional impressions. It can therefore be seen that there is continual advancement in terms of new bio-materials, better scanning technologies and syncronised digital workflows which have steadily brought in new possibilities for removable prosthodontics and paved the way for the digital dentures to evolve into the standard of care in the future [1].

Intraoral scanning

IOS has emerged as a core component of the current dental practice, more so in the specialty of prosthodontics. This technology employs complex optical systems to generate highly precise and accurate, three-dimensional images of a patients' mouth eliminating the process of using trays filled with impression materials. The various IOSs are picked by carefully by the operator and only leaves a digital impression that is accurate and can be used in execution of CAD/CAM systems to manufacture the various prosthetic appliances. The key advantages of using IOS include: Patients' comfort has increased since the method does not create discomfort that comes with traditional impression materials [5]. Owing to the same, it speeds up the overall work flow of an operator by shortening the time taken in taking impressions and has real-time flexibility. IOS is especially used in designing removable partial dentures, complete dentures, and implant retained prosthetic appliances where the fit and function are excellent. Nonetheless, it is crucial to acknowledge that the considerable expenses and the time spent on adaptation to the IOS application make it an efficient tool in modern dentistry [11].

Figure 2. Scanning procedure

Materials and Methods

Search strategy

The present narrative review followed the bias free data extraction. An extensive approach regarding the search guidelines was used in the current review in order to provide information on intra oral scanning in the fabrication of removable prosthesis. The search was performed across three major databases: Some of the databases included in the search were PubMed, Medline, and the Cochrane Database of Systematic Reviews. These databases were selected due to the coverage of the highest quality peer-reviewed articles and clinical researches in the field of dentistry and the related disciplines. The search involved the use of

keyword and Boolean operators so as to make more refined search that would enable the inclusion of studies that were core to the research question.

Results and Discussion

Use and efficacy of intraoral scanning

Removable partial dentures (RPDs)

IOT has been found useful in the fabrication of removable partial dentures as highlighted in this paper. Thus, digital impressions give a more accurate fit as compared to the other traditional methods. Because of the high precision of IOS, the framework is more easily adapted to oral structures, so few changes are required and patients can be more comfortable and satisfied [9].

Complete dentures

It is implicitly demonstrated that the way in which IOS is used to fabricate complete dentures is changing. Nevertheless, scanning edentulous arches has its problems, but as the scanner technology and the software have developed, these challenges are being solved. Telescopic complete dentures can also be created additive manufacturing to improve the fit and potentially also the fabrication time in comparison to conventional fabrication technologies [6].

Implant-supported prostheses

IOS technology is most suitable in the fabrication of implant supported prostheses. Among its advantages are fine matching of positions of implantation, and of surrounding tissues, which is particularly important in using the prostheses. Digital impressions prove most useful when the case is intricate and necessitates accuracy [12].

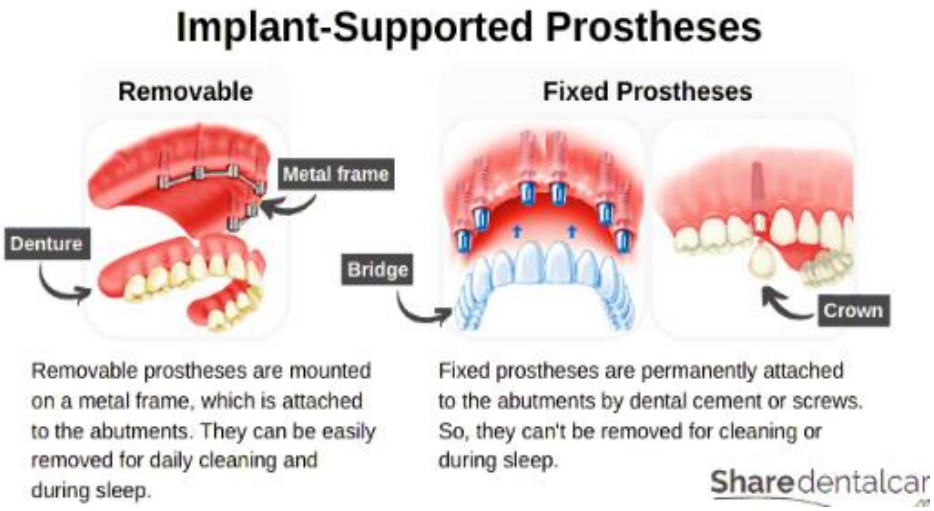

Figure 3. Implant supported prostheses

Digital immediate complete dentures

Prosthetics that are inserted directly after the extraction of teeth, are benefited by IOS technology. Pre-operative Scans assists in the fabrication of immediate dentures since after completion of the extraction procedures, the candidate can be fitted with the fabricated dentures [13].

Digital interim complete dentures

Temporary dentures are used by individuals who have undergoing a dental treatment while waiting to get the final dentures. This can be made better through the application of IOS technology in that production is faster, and the fit is better meaning that the patient will not feel uncomfortable during the waiting period [14].

Digital obturators

An obturator is a prosthesis that is intended to seal the anatomical, congenital or acquired tissue opening for example in a patient who has had a cleft palate. It must be noted that intraoral scanning and digital impressions enhance the fit of such obturators and therefore better closure and functionality for the patient [12]. This eliminates any sort of movement or slippage, and guarantees a better fit for the patient hence higher preference from the patients. This also simplifies the fabrication, cutting down measures and corrections that are usually required to make new items. The adoption of digital impressions in the production of obturators is a significant improvement in prosthetic dentistry since it increases the chances of a better prognosis for the patient as well as enhances the patient satisfaction [15].

Accuracy and precision

They also pointed out that digital impressions utilizing the intraoral scanners are precise most of the times than the traditional impressions. However, research studies have indicated that there is a decrease in the gap in the fitting of the prosthesis made using IOS. IOS also reduces what are characteristic to the basic kinds of impressions: flaw and air bubble. IOTs are accurate and highly precise when it comes to acquiring the digital impression of the teeth. Investigations have revealed that the fit and function of RPDs produced through computer aided design and manufacturing are better than the traditional techniques [16]. Nevertheless, IOS has only recently found application in the fabrication of complete dentures, and some issues still exist regarding the crafting of a precise picture of edentulous arches. Technology and even software in scanners continue to improve and the development of algorithms of the software helps in facing the challenges hence the improved outcomes [14].

Applications in removable partial dentures (RPDs)

Though, the present study revealed that IOS technology has been used efficiently in the fabrication of RPDs. This increases the precision of the framework and its better placement on the oral structures during its construction. Research shows that computer produced RPD's demonstrate better fit and function that the conventional techniques [17].

Applications in complete dentures

To the authors' knowledge, iOS applications have not been used extensively in traditional complete denture fabrication processes, including when it comes to acquiring accurate records of the edentulous arch. Earlier, the shortcomings presented by the scanner technology and the systems used in analyzing the data used to present serious problems in the discipline. However, over the recent past, some improvements are progressively transforming this situation. Advanced scanners allow scanning of edentulous arches with a higher precision and a better depiction than before as the scanners are able to define details of this anatomy [18].

At the same time, the progress in the advancement of data analysis and interpreting algorithms has improved the scanned data elaboration and comprehension. These development have make it possible to have accurate records that are very crucial in production of proper fitting and functional dentures. Therefore, operating iOS applications in their daily work, dental professionals can start perceiving the possibility of using these options. It can be expected that this shift will expand as more progression in technology occurs, though more so in the future most likely [9].

Applications in implant-supported prostheses

Intraoral scanning is very efficient in the design of implant prostheses as well as the precise capturing of implant location and surrounding tissues. CBI is more desirable in intricate cases as it offers higher levels of accuracy [6].

Figure 4. Supported view

Clinical performance and patient satisfaction

Literature on digital dentures has revealed that the short-term clinical performance of the dentures is good, patients' responses are positive, and the cost is fairly beneficial. Intraoral scanning technology offers critical development in generation of removable prostheses [19]. It improves some of the parameters of treatment quality and organizational effectiveness, the level of patients' comfort, and the efficiency of interpersonal and interdisciplinary cooperation. Thus, in the light of the present study, one can conclude that even if it requires initial expenses and the additional time for mastering the IOS technology, its usage in the process of treatment becomes the valuable tool for practicing modern dentistry [2].

Limitations and challenges

Technical and financial challenges

However, although IOS technology used in the fabrication of removable prostheses is beneficial in many ways, the following drawbacks cannot be overlooked. A major issue is the act of change in relation to the IOS technology. This is the rate at which subordinates understand the differences and accept to work under the new technology. Professionals who work in the dental field need suitable training to incorporate the technology in their procedures which may take some time and may during this time negatively change the speed that clinical processes take [11]. To fully embrace the IOS there is a need to master the scanning technique and gain deep insight on the details of the digital impressions together with mastering the various software's that come with the IOS [8]. Due to the initial costs of purchasing intraoral scanners and the related CAD/CAM software, which may be rather high? In a way, this is a sizeable capital investment in many dental practices' business models. Despite these advantages being laudable and providing significant improvements in the long run and efficiencies the costs might be prohibitive particularly to small practices and other small organizations with a constrained budget. Technical restraints are also applicable to some intraoral scanners, some of which include the following. Some sites within the oral cavity are more complex to image and include areas that are undercuts or areas that reflect light. These difficulties can cause obtaining of less detailed or less accurate digital impressions and that, in turn, can influence the fit and functional requirements of the final prosthesis. While innovations are being made to the scanners consistently to overcome such drawbacks, some of them exist and are even more evident especially for the complicated scans [16].

Moreover, application of the IOS technology into the already existing workplace naturally triggers the need for sound IT support systems. Functionality also has to ensure that it has the adequate equipment, in terms of hard ware and software, to handle digital records. This encompasses exemplary safety measures related to storage of patients' records that can prevent the leakage of sensitive data [3]. Conclusively, based on the application of IOS technology as depicted in this paper, the following shortcomings were identifiable; First, the high costs in acquiring the necessary technology, secondly the difficulty in achieving accurate impressions, thirdly the challenges faced in training the team on the new technology and finally the requirement of contending IT infrastructure. These include factors that are necessary to be solved with a purpose of enhancing the utilization of IOS technology within the existing dental practice [11].

Clinical and procedural limitations

Although IOS has evolved with many advantages added to its list, several clinical and procedural limitations of the technique should be considered. Another disadvantage is related to the natural outlook and stability of 3D printed dentures. Today's common 3D printing technologies for dentures may produce restoration with less life-like esthetics, and equal or slightly lower retention than traditional techniques [7]. The primary problem of obtaining balanced occlusion in protrusive and lateral movements has not yet been solved with digital dentures. Significant negative impacts could entail compromised denture stability or increased bone resorption in the future which call for more advancement in the property of the material and printer settings [17].

Another major drawback of this study is that there are no well-established protocols relating to the application of IOS in removable prosthodontics. This is a clear advantage of digital workflows Since there are no standard laws that mandate the usage of certain practices in dental practices, such practices have to be initiated and this can lead to gaps in the results produced. It is necessary to perform additional clinical trials in order to develop and identify standard procedures that can be safely used as guidelines in various research centers and laboratories, thus providing effective and accurate results [6]. The issue of heavy dependence on digital technology is followed by such concerns as data regulation and protection. As virtual

impressions and patients' records are created and used, issues of patient identity/privacy arise; therefore, digital dentistry relies on adequate IT support. Thus, dental practices need to have sufficient measures taken to secure themselves from hackers and protect patient information. However, based on the reported outcomes, the IOS technology do long-term clinical trials remain primarily inconclusive nonetheless? When it comes to the existing databases, the majority of the information can be traced to short-term results, and it is crucial to extend the timeframe of investigations related to the long-standing stability of digitally fabricated removable prostheses. Knowing how these prostheses operate in the long run is very important in establishing the validity of the prostheses [18].

It is also noteworthy that, due to the restrictions of IOS technology, the clinical workflow can be impacted. For instance, getting precise recordings of edentulous arches is difficult, and this may affect the ability of complete dentures to fit and work correctly [15]. Further, there are usually some patients could be presented with various challenges in terms of anatomy that could be hardly scanned due to the presence of such features as deep undercuts and highly reflective surfaces. These challenges can be manifested leading to less clear scanning and causing some regions of the oral cavity not to be scanned properly or areas to be scanned but not accurately enough to create an accurate final onlay or complete prosthesis [4]. Moreover, although IOS technology is intended to minimize chair time, the application of a new technology has he primary stage can be rather time-consuming as dentists adapt to the new system. This may cause initial delay in clinical processes to adapt to the new technological advancement among the occupational staff. Meeting the requirement is critical in the effort to get dental professionals the extensive training they need to overcome this challenge [10].

In conclusion, the prospect for scanning technology in intraoral situation has many advantages The conventions and procedures however do present sig clinical limitations. That includes aesthetics andstadiness of 3D printed dentures, absence of protocol, storage and data privacy issues, scarcity of techniques' clinical use, and disruption in the initial stages. Resolution of these limitations would be important in order to attain the optimum results for IOS technology in the removable prosthodontic specialty [13].

Conclusion

This paper concludes that intraoral scanning technology has more possibilities for the future endorsement of the prosthodontic procedure and the enhancement of the outcome for both the clinician and the patient. For this reason it becomes useful for improving on precision, rate of work and the comfort of the patient as it is applied in construction of removable prostheses. Nonetheless, the enhancement of its advantages is still limited by several issues under the conditions of present-day facilities, including high initial costs, staff training, technical constraints, or the lack of protocol guidelines. Elimination or reduction of these challenges will consequently be a lifelong process of research and development. Consequently, the dental discipline can use these barriers as an incentive to fund research that will improve this technology's application. In this regard, it is expected that as the bottlenecks highlighted before are accomplished, the true benefits of intraoral scanning technology will be further enhanced, therefore, enhancing patient satisfaction and clinical efficacy. Finally, all these technologies will determine the future of the prosthodontic treatment and will contribute to the intraracial scanning technology for the standard of care in the dental practice. More proof that it works and reduction in costs should enable the intraoral scanning to progress from being a boutique service to routine. This will also help the dental professionals reduce their workloads and increase their performance while on the other hand assisting the patients to get better dental services and experiences.

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