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Digital Impression and Conventional Impressions in Fixed Partial Denture-A Systematic Review

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Abstract:
Clinicians use CAD-CAM systems to obtain a digital scan of the oral tissues followed by chairside fabrication, to transmit the digital scan to the laboratory for prosthesis fabrication , or to digitally scan a stone model fabricated from a conventional impression followed by laboratory fabrication . Potential advantages of using CAD-CAM technology over conventional methods include speed , ease of use , and the quality of restoration.The aim of this systematic review was to analyse critically marginal and internal fit of the crowns fabricated by conventional impression technique and CAD CAM systems.For identification of studies included or considered for this review , detailed search strategies were developed for the database searched . The search methodology applied was a combination of MESH terms and suitable key words . The MEDLINE search used the combination of controlled vocabulary as well as free text terms . The key words employed in this search were broadly classified into four categories describing population , intervention , outcome and the type of study. Key words within each group were combined using Boolean operator OR and the searches of individual groups were combined using Boolean operator AND to retrieve articles electronically Out of the 18 studies obtained from electronic search 4 studies were excluded after examination of title and abstract and 8 were excluded after examination of core data and a total of 6 studies were reviewed .Research is lacking to draw robust conclusions about the relative benefits of Digital impressions in terms of restoration survival . The marginal fit and internal fit analysis suggested similar performance in both techniques . The quality of evidence of interproximal contacts and occlusal contacts were very low to draw any conclusions regarding how the impression techniques compared . With regard to the patient acceptance , the overall patients' acceptance of digital impression techniques was significantly higher than that of conventional impression techniques.

Keywords*: Impressions,digital,conventional, marginal fit.*

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BACKGROUND:

The use of intraoral scanners for study models has increased in recent times . Digital scanners can obtain high quality impressions and can reduce several problems like the gag reflex , patient discomfort , time , accuracy. In the 1980's Intraoral scanning systems were introduced. Computer-aided design and computer-aided manufacturing (CAD-CAM) systems have been tested since the early 1970s as an alternative to the conventional methods for fabrication of indirect restorations. Since then, CAD-CAM systems have undergone substantial development and have become increasingly popular in dental offices. The common applications of CAD-CAM technology for replacement of missing teeth or tooth structure include fabrication of inlays , onlays , single crowns , fixed dental prostheses , implant crowns , and partial and complete dentures(Boeddinghaus et al., 2015; Seelbach et al., 2013)

Clinicians use CAD-CAM systems to obtain a digital scan of the oral tissues followed by chairside fabrication, to transmit the digital scan to the laboratory for prosthesis fabrication , or to digitally scan a stone model fabricated from a conventional impression followed by laboratory fabrication . Potential advantages of using CAD-CAM technology over conventional methods include speed , ease of use , and the quality of restorations . Reduction in patient discomfort , time efficient treatment , and ability of capturing highly accurate information and storing highly accurate information without pouring stone casts are some of the benefits of digital impression technique .

Digital impression techniques can save space and time in the clinic by eliminating the need to pour stone cast . Other advantages of the digital impressions and scanning systems are the easy transfer of digital data to the dental technician through email , avoiding shipping of impression and models to the laboratory . This results in a better communication with the laboratory (Menini et al., 2018). The dental technician can immediately visualize tooth preparations (or the position of implant scan bodies) , and this guarantees a better communication .

Digital dentistry is can improve and transform the relationship between dentist and dental laboratory . As a part of this trend , intraoral scanners are playing a pivotal role to this changing relationship . In the last few years, several studies have dealt with IOS and their use in different fields of dentistry .However , only a few studies have compared the patient preference and comfort with digital and conventional impressions in particular among young patients .

The primary objective of this systematic review was to analyse critically marginal and internal fit of the crowns fabricated by conventional impression technique and CAD CAM systems . We also compared secondary outcomes of Time efficiency accuracy and operator perception.

MATERIALS AND METHODS :

Review of literature on studies evaluating the accuracy of conventional and CAD CAM impressions that have been published was carried out without any filter on publication dates and all articles of the past were retrieved .

SOURCES USED :

For identification of studies included or considered for this review , detailed search strategies were developed for the database searched . The search methodology applied was a combination of MESH terms and suitable key words . The MEDLINE search used the combination of controlled vocabulary as well as free text terms . The key words employed in this search were broadly classified into four categories describing population , intervention , outcome and the type of study. Key words within each group were combined using Boolean operator OR and the searches of individual

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groups were combined using Boolean operator AND to retrieve articles electronically .

LANGUAGE :

Articles in other languages than English were not included.

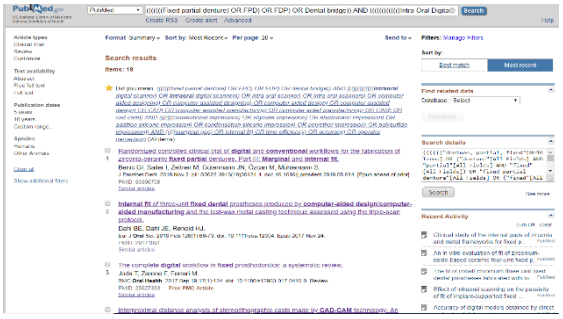
SEARCHED DATABASES :

- PubMed
- PubMed Advanced Search
- MEDLINE
- Google Scholar

SEARCH STRATEGY:

((((((Fixed partial denture) OR FPD) OR FDP) OR Dental bridge)) AND ((((((((((((Intra Oral Digital Scanner) OR Intra oral digital scanners) OR Intra oral scanner) OR Intra oral scanners) OR Computer Aided designing) OR Computer assisted designing) OR Computer aided design) OR Computer assisted design) OR CAD) OR Computer assisted manufacturing) OR Computer aided manufacturing) OR CAM) OR CAD-CAM)) AND (((((((Conventional Impression) OR Alginate impression) OR Elastomeric impression) OR Addition silicone impression) OR condensation silicone impression) OR polyether impression) OR polysulfide impression)) AND (((((Marginal gap) OR Internal fit) OR Time efficiency) OR Accuracy) OR Operator perception)

SEARCH METHODOLOGY :



INCLUSION CRITERIA :

CRITERIA FOR CONSIDERING STUDIES FOR THIS REVIEW

Types of studies :

1. Clinical studies , case control studies and randomized control trials

Types of Population :

1. Conventional Impression

2. CAD CAM impression

Types of outcome measures :

- Internal fit
- Marginal Fit
- Accuracy

EXCLUSION CRITERIA :

The following studies were excluded

- Case reports/case series
- In vitro studies
- Review articles

RESULTS :

Out of the 18 studies obtained from electronic search 4 studies were excluded after examination of title and abstract and 8 were excluded after examination of core data and a total of 6 studies were reviewed as depicted in the flow chart.(Fig 1),The variables of interest of the study,characteristics of the included studies and reasons for excluding the studies were stated(Tables 1,2,3)

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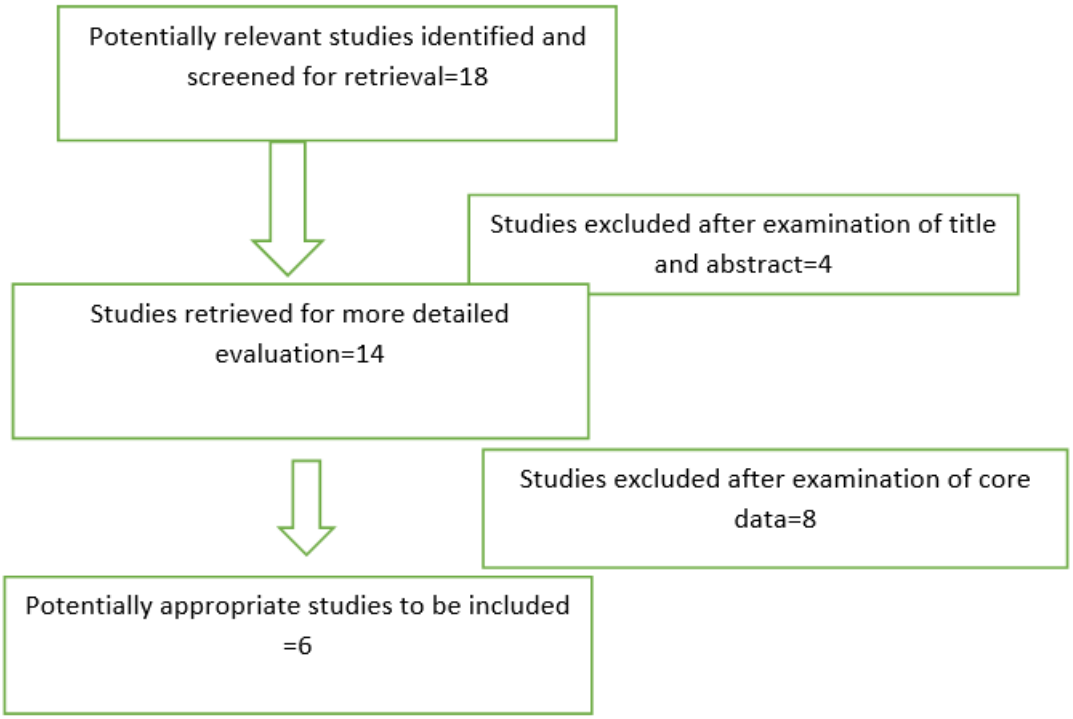

Fig 1: Flow chart for search methodology

Table 1:VARIABLES OF INTEREST

S . No	Variables of Interest
1)	Marginal Fit
2)	Internal fit

Table 2:GENERAL INFORMATION OF INCLUDED STUDIES IN THE REVIEW :

S. No	**Article**	**Sample size**	**Impression compared**	**Outcome**
1)	Janfredreick et al 2012	5	Polyether Lava scan	Direct digitalisation less error
2)	Gonzaga et al(2014)	12	Polyether Lava cos	Polyether impressions less accurate
3)	Danush et al(2015)	25(invivo)	Polyether Lava Cos	Direct digitalisation better
4)	Benic et al(2018)	10(invivo)	Polyether	iTero better in direct

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			Lava, iTero,Cerec	digitalisation
5)	Seokhwan et al(2015)	10	Polyether, Lava	No difference in marginal fit
6)	Paolo et al (2008)	45	Polyether,lava,procera,eververest	Lava better marginal fit

TABLE 3: EXCLUDED STUDIES WITH THE REASON FOR EXCLUSION :

S. No	Article	Reason for exclusion
1)	Anders otorp et al (2011)	Impression techniques not compared
2)	Dubal R K et al (2015)	Difference in population Digital impressions not compared
3)	Karl M et al (2012)	Different Population (Implant impressions)
4)	Dahl et al (2017)	Impression techniques not compared
5)	Hoffman et al (2017)	Impression techniques not compared
6)	Joda et al (2017)	Review Article
7)	Keul et al (2014)	Different Outcome measure
8)	Shembesh et al (2016)	Conventional impression not compared
9)	Ting Shu et al (2016)	Different outcome measure
10)	Ueda et al (2015)	Different population
11)	Vandeweghe et al (2016)	Different Population (Implant Crowns)
12)	Wettstein et al (2008)	Different outcome measure

RISK OF BIAS IN INCLUDED STUDIES:

The assessments for the four main methodological quality items are shown in table. The study was assessed to have a "High risk" of bias if it did not record a "Yes" in three or more of the four main categories, "Moderate" if two out of four categories did not record a "Yes" and "Low" if randomisation assessor binder and completeness of follow-up were considered adequate and CEBM levels of evidence assessed(Tables 4,5,6).

Table 4: RISK OF BIAS- MAJOR CRITERIA

Author and year	Randomisation	Allocation concealed	Assessor blinding	Dropouts described	Risk of Bias
JanFrederick et al (2012)	No	No	No	No	High
Gonzaga et	Yes	No	No	No	High

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al(2014)					
Danush et al(2015)	Yes	No	No	Yes	Moderate
Benic et al(2018)	Yes	No	No	No	High
Seokhwan et al(2015)	Yes	No	No	No	High
Paolo et al (2008)	Yes	Yes	Yes	Yes	Low

Table 5 :RISK OF BIAS –MINOR CRITERIA

Author and Year	Sample justified	Baseline Comparison	I/E criteria	Method error
JanFrederick et al (2012)	yes	yes	yes	no
Gonzaga et al(2014)	no	yes	yes	yes
Danush et al(2015)	yes	yes	yes	no
Benic et al(2018)	yes	yes	yes	no
Seokhwan et al(2015)	No	no	no	no
Paolo et al (2008)	Yes	no	yes	no

Table 6:CEBM LEVEL OF EVIDENCE OF INCLUDED STUDIES

S.NO	STUDY	STUDY DESIGN	CEBM LEVEL OF EVIDENCE
1	Janfredreick et al 2012	In vivo	Level 4
2	Gonzaga et al(2014)	In vivo	Level 4
3	Danush et al(2015)	In vivo	Level 4
4	Benic et al(2018)	In vivo	Level 4
5	Seokhwan et al(2015)	In vivo	Level 4
6	Paolo et al (2008)	Invivo	Level 1 b

DISCUSSION:

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To compare the marginal and internal fit of fixed prosthetic denture restorations fabricated with digital and conventional impression techniques is the aim of this review. The secondary outcomes included determining the effect on the accuracy outcome as well as patient and operator perception . Dental restorations fabricated with the digital impression technique presented with comparitively smaller but not statistically significant marginal and internal discrepancies than those fabricated with the conventional impression technique . Digital dies led to restorations with smaller marginal discrepancies and significantly smaller internal spaces than SLA / polyurethane dies .((Bosniac et al., 2019; Menini et al., 2018)

All reported marginal gaps of crowns fabricated using digital impressions included in this review resulted in clinically acceptable marginal gaps . All marginal gaps were less than 120 μm, which is the clinical acceptable limit (Güth et al., 2013, 2017) . With digital impressions indirect digitalization results are clinically acceptable when concerning crowns . For fabrication of implant - supported crowns and FDPs digital impression accuracy is clinically acceptable . Trueness and precision differs significantly between the digital impression systems and impression methods . Local deviations over 100 μm can lead to inaccurate fitting , thus causing problems in large prosthetic restorations(Stimmelmayr et al., 2012) . Impression accuracy and the fit of the definitive prosthesis depend on every phase of the process . In conventional techniques every step , including impression , stone casts , wax patterns , investment , and casting , must be carried out precisely to achieve the best fit . Instead , dental CAD / CAM systems usually need fewer steps (i.e. , digital impression , design , and milling) , where the number of error sources is less than in the conventional method (Ueda et al., 2016) .

Additionally , the milling method is also standardized . In fabrication of full - arch FDPs , digital impressions showed higher local deviations than conventional impressions did . As clinical implications of this study , it concluded that the accuracy of CAD / CAM systems and digital impressions is compatible with conventional impressions . The time efficiency of digital impression systems is better than for conventional techniques (Ahrberg et al., 2016; Berrendero et al., 2016) . As to operator's perception , digital impressions are easier for inexperienced clinicians . On the other hand , distal targets are challenging to impress with intraoral cameras . The size of digital intraoral cameras is still bigger than traditional impression trays . Some digital systems , for example CEREC Bluecam, also require use of titanium oxide to improve the contrast . In dental digital impression systems , the number of error sources is smaller than in traditional impression methods . The digital impression is monitored on the hardware display screen , thus enabling poorly scanned objects to be reproduced smoothly without losing the complete impression data (Kohorst et al., 2011; Vlahova, 2016).

The intraoral camera is often a more comfortable and less invasive option for patients with sensitive gag reflex or profuse salivation , and the data transmission is cheap and fast . Digital impression data is also easier to store . Digitalization has already become common place in dentistry in other specialized areas such as radiology . On the other hand, high investment costs are a barrier to uptake of technologies (Benli, 2018) . Many of these studies measured the accuracy of the final restoration , and consequently the results may be influenced by each step of the ceramic manufacturing phase , not only the impression . The fit of the final restoration is measured from the gap between the restoration and the clinical preparation . In these studies , there was variation on how the fit of the final restoration was evaluated . Although all studies measured the accuracy of the restoration , this should be noted when results are compared .(Alqahtani, 2017; Benli, 2018)

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To analyse the acceptance and stress perceived by the patients during impression making, homogenecity of the study population is necessary . This approach is important when it comes to objectively report patients' acceptance avoiding report of bias of patients who had previous experience with the dental impression techniques (Roggendorf et al., 2012) . Nausea, while performing dental procedures acts as a problem while providing good-quality dental treatment , especially when it is necessary to take impressions or when inserting removable maxillary prosthesis. The treatment plan could also be compromised due to the need to limit the impact of the gag reflex .Furthermore , some patients may require more invasive levels of intervention such as anesthesia (local or general) or conscious sedation . Data about the exact prevalence of the gag reflex in the general population are not available, but it undoubtedly affects many patients (Huang et al., 2015; Marcel et al., 2020).

The findings of this review indicated poor homogeneity of the study designs and populations. Also, there are a few number of studies available relating to the accuracy of digital and conventional implant impression, whether in vivo or in vitro , so the meta-analysis could not be performed . Based on the finding of this study, additional laboratory and clinical research is suggested to appraise the accuracy and validity of digital implant impression technique in the prosthodontic field .

CONCLUSION:

Research is lacking to draw robust conclusions about the relative benefits of Digital impressions in terms of restoration survival. The marginal fit and internal fit analysis suggested similar performance in both techniques. The quality of evidence of interproximal contacts and occlusal contacts were very low to draw any conclusions regarding how the impression techniques compared. With regard to the patient acceptance, the overall patients' acceptance of digital impression techniques was significantly higher than that of conventional impression techniques Intraoral scanner is of better value in terms of patient comfort with respect to gag reflex and breathing difficulty . No significant differences were found between the two techniques in terms of stress . With increasing popularity and adoption of digital scanners by dentists, pragmatic practice - based trials involving standardized , patient - centered outcomes may improve confidence in the comparative effectiveness of Digital impressions .

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