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Review Article

IMPRESSION TECHNIQUES AND IMPRESSION MATERIALS IN DENTAL IMPLANT SUPPORTED RESTORATIONS- A SYSTEMATIC REVIEW

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ABSTRACT

Statement of problem – Most of implant impression techniques, such as, pick-up, and transfer techniques and splint and non splint techniques, have been introduced, in search of the most accurate technique. In certain clinical situation, some of the factor such as the angulations or depth of implants, may affect the accuracy of the implant impressions.

Purpose -Purpose of this review was to compare the various impression techniques for dental implant restorations published in the literature and followed by statistical evaluation.

Material and methods - Electronic searches were performed in July 2014 from PubMed, and Google database with combinations, databases with the key words *dental implants*, *impression technique*, and *impressions*. The study which investigated the accuracy of implant impression techniques and are published in an English peer-reviewed journal are included for the review. After completing the search strategies 62 articles were chosen which will included in the review process.

Results: All of the selected articles were in vitro studies. Of the 14 studies that compared the accuracy between the splint and non splint techniques, 10 were in favour of the splint technique, 1 advocated the non splint technique, and 3 reported no difference. 11 studies compared the accuracy of transfer impression and pick-up impression techniques in which 5 showed more accurate impression with the pick-up techniques, 4 with the transfer technique, and 2 showed no difference. The number of implants affected the comparison of the pick-up and splint techniques.13 articles were analysed for checking affect of implant materials in which 6 articles showed polyether is better, while 2 articles supported addition silicone impression material, 3 studies supported activated polysilioxane whereas 1 article supported vinylsilioxane.10 articles was analysed for comparing conventional and digital impression techniques in which 1 article suggested cad cam was better than conventional,3 articles suggested accuracy as comparable to conventional and suggested that the accuracy is lower as compared to conventional. While 5 article suggested digital better than conventional techniques.

Conclusions: The review of abutment level or implant level internal connection implants showed that the splint technique have greater accuracy as compared to the non splint technique. It was seen that there was not much difference between the pick-up and transfer techniques when there were 3 or fewer implants, whereas studies showed superior results with the pick-up technique when more than 4 implants were used. In materials Polyether and VPS gave more accurate results for the implant impressions. In digital and conventional method, the digital impression technique was more efficient and overall time consumption was also less.

INTRODUCTION

Good emergence profile with aesthetics, proper fit of the restoration; have given clinicians a wide options of new treatment alternatives for fixed and removable implant supported rehabilitation. Implant dentistry has grown into every aspect of tooth replacement, which may starts from replacing a single missing tooth, multiple teeth to rehabilitation of full mouth. All of these options of treatment involve creed in treatment planning, clear sightedness in diagnostic approach, skills in surgical approach and different prosthetic reconstruction techniques[1].With the predictable incorporation of implants, precise prosthesis is emphasised,[2] It is of esteem importance to have appropriate transfer of proper position and orientation of the single tooth implant or multiple implants to the working casts.

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Dental impression is used to produce a positive replica of the structure for use as a permanent record or in the production of a dental restoration or prosthesis.[3]An inaccurate impression may result in prosthesis misfit, which may cause biological and/or mechanical complications. Various mechanical complications such as loosening of screw, fracture of screw or implant, and occlusal inaccuracy may have been arisen from prosthesis misfit.[2-7] To date, various implant impression techniques, like transfer and pickup techniques, or open or close techniques or splinted or nonsplinted technique and other factors related to the accuracy such as angulations depth, copings are studied for accuracy. Depicting same working conditions as in the mouth to a laboratory setting for implant dentistry is technique sensitive but critical to the success of implant therapy. Literature is swarming with articles on the pros and cons of various impression materials, techniques of impression, impression trays etc. The aim of this systematic review was to depict and assess the various techniques in impression making of implant, with their outcomes.

MATERIAL AND METHODS

Data Source and Search Strategies

Without language or date restrictions an electronic search was done in july 2014 in the PubMed website.The terms which were used in the search strategy are:

{Subject AND Adjective}
{*Subject*: (dental implant [text words])
AND
Adjective: (impressions OR impression techniques
[text words])}

The publications had to be included in the electronic database to be used in the review. The reference lists of the selected studies were hand-searched for more papers which might fit into the inclusion criteria. A complete report was obtained and analysis was done for all the studies which meet the inclusion criteria, and for which sufficient data was not there in the title and abstract to get a clear decision. Any disagreement regarding the inclusion or exclusion criteria of the selected articles was settled by discussing among reviewers.

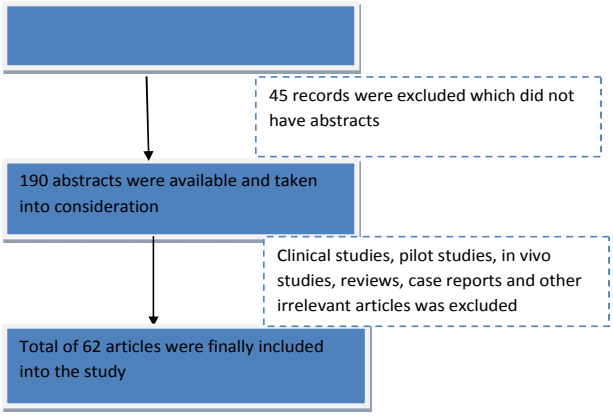

Figure 1 Study screening process.

Inclusion Criteria

To be included in the study, the articles had to be published in an English peer reviewed journal and should be an experimental study, clinical investigating, which had been carried to measure the accuracy of different techniques in impression of dental implant.

Exclusion Criteria

Simple case report articles and review articles which was not original data were not taken into study, although references to potentially applicable articles were noted for further follow-up. Clinical or technical reports, structurally deficient articles such as abstracts only, and review articles are not included.

Outcomes and Variables

All the articles included in this study was searched for the following data using a standard form i.e. publication year, design of the study, impression techniques and impression materials used.

RESULT

The study selection process was summarized (Fig1). The search strategy resulted in 235 papers. The abstracts were checked for those articles which the focus questions. After the initial screening of titles and abstracts 190 full-text papers were selected; 80 were cited in more than one research of terms. Thus, 75 studies were identified without repetition. Of the 75 studies found, six were excluded for being case report articles and three others for being review articles. Total of 62 articles was selected for the present review.

All of the selected articles were in vitro studies. All article was categorized into two broad techniques that is conventional (Table 1) and digital (Table 2). Conventional impression technique was further divided into the following categories

1. Pickup vs transfer (Table 1.a)
2. Splint vs non splint (Table 1b)
3. Effect of different angulations (Table 1c)
4. Coping modifications (Table 1d)
5. Impression materials (Table 1e)

Transfer vs pick impression- Eleven studies compared the accuracy of transfer and pick-up techniques for impression making[11-21].Out of which 2 studies showed more accurate impressions with the transfer impression technique.[18,19] However, the results of 1 of the 2 studies were questionable because the experimental design was not clinically relevant and favoured the transfer technique.[11,20].while 5 articles supported indirect technique[12,14,15,16] .

Effect of angulations on impression 5 studies was analysed 3 advocated that angulations does not affect the accuracy and 2 studies advocated accuracy is significantly affected by angulation[23,24]

Coping modification: 10 studies was reviewed in which 4 studies suggested that square coping gives better accuracy[30,31,33,35], 1 study suggested metal coping is better than plastic coping .one study suggested tapered coping is better .

Splinting vs non splinting ; 14 studies was analysed in which 10 studies advocated that splinting gives better accuracy[40,42,43,44,4546,47,48,49,50]., 1 advocated non splinted is better and 3 resulted in same accuracy in both splinted and non splinted.

Table 1.[a] Transfer vs pick up impression

Author	Impression technique	Impression materials used	Significance
Burns J[1]*et al* 2003 Mar[11]	open tray implant impressions comparing polycarbonate stock impression trays and rigid custom-made impression trays	Polyether impressions	rigid custom trays produced significantly more accurate impressions than the polycarbonate stock trays
Akça K[1], *et al* 2004 [12]	Implant-level impressions were made by direct and indirect techniques	a polyether impression material vinylpolysiloxane impression	The snap-on VPS indirect impression technique using a stock tray, which has the advantages of being clinically convenient and eliminating repositioning after removal of the impression, resulted in dimensional accuracy similar to that achieved with the PE direct technique.
Conrad HJ[1], *et al* 2007 [13]	open tray and closed tray	addition silicone impressions	The average angle errors for the closed and open tray impression techniques did not differ significantly
Walker MP[1],*et al* 2008 [14]	closed tray impressions using indirect, metal impression copings at the implant level or direct, plastic impression caps at the abutment level, and impression material viscosity combinations	medium-body or heavy-body polyether impression material	casts made with indirect, metal impression copings might be more accurate than casts made with direct, plastic impression caps
Kwon JH[1], *et al.*[15] 2011	the coping group (Group C), open tray impression copings were used for the final impressions. For the no-coping group (Group NC), cementable abutments were connected to the implant replicas		Implant impression with open tray impression copings produced more accurate definitive casts than those fabricated without impression copings, especially those with greater inter-abutment distance.
Rutkunas V[1], *et al* 2012[16]	open and closed trays	polyether and two polyvinyl siloxane impression	The open-tray technique was more accurate with highly nonaxially oriented implants for the small sample size investigated.
Mpikos P[1],*et al* 2012[17]	open- and closed-tray techniques	medium-consistency polyether material	the open- and closed-tray techniques had no effect on the accuracy of multiple implant impressions
Balamurugan T*et al* 2013 [18]	the closed tray technique with transfer coping and open tray technique		Direct transfer impression technique with less number of components ensures the high accuracy of transfer of implant positions from master cast to the laboratory cast compared to the indirect transfer impression technique
Balouch F*et al* . 2013 [19]	open tray and closed tray	poly ether	closed tray impression technique is more accurate.
Del'acqua MA *et al* [20].	two impression techniques (tapered and splinted) with two stock trays (plastic and metal) for implant-supported prostheses		rigidity of the metal stock tray ensured better results than the plastic stock tray for implant impressions with a high-viscosity impression material (putty).
Alikhasi M[1]*et al*[21]	Forty impressions of this model were made at implant (groups 1 and 2) or abutment (groups 3 and 4) levels with different techniques of direct or indirect, respectively		Impression technique (direct or indirect) had significant effect on the impression accuracy of tilted implants, and direct technique produced less inaccuracy. Also, abutment level impressions showed more accuracy than implant level impressions

Table 1[b]Angulation

Author	Impression technique used	Impression material used	Angulation	Significance
Conrad HJ[1], *et al* 2007 Jun[22]	Open tray and close try impression techniques	addition silicone impressions	5^0, 10^0, 15^0	The average angle errors for the closed and open tray impression techniques did not differ significantly.
Jang HK*et al*.[23]	implant-level impression technique		0, 5, 10, 15, and 20 degrees	Internal-connection implants were accurate when the divergence angle was less than 15 degrees. Inaccuracy of impressions increased as the divergence angle increased. The inaccuracy was significantly greater for the 20-degree-divergent implants than the other groups
Mpikos P *et al* 2012 [24]	open- and closed-tray techniques	medium-consistency polyether material	0, 15, and 25 degrees	implant angulation significantly affected the impression accuracy when implants with internal connections were used.
Ehsani S, Siadat H, Alikhasi M. 2013 [25]	open-tray impression technique	medium-consistency silicon impressions	two at 0 degrees and two at 30 degrees in relation to the perpendicular line	no significant difference in impression accuracy,
Ehsani S[1], Siadat H, Alikhasi M. 2014 [26]	open-tray impression technique		All-on-Four treatment plan (2 anterior implants at 0 degree and 2 posterior implants at 30 degrees in relation to the perpendicular line	the accuracy of the implant impressions did not differ for different implant angulations in All-on-Four treatment plan

Table 1[c] Coping

Author	Impression technique used	Impression material used	Coping	Significance
Carr AB. 1991[27]			indirect and direct transfer coping techniques	the direct technique produced more accurate working casts
Barrett MG[1] *et al* 1993[28]			tapered and square impression copings.	There was no significant difference between the techniques for the square copings but that there was a significant loss of accuracy in the z-axis with the tapered copings.
Herbst D *et al* 2000 [29]			Impressions were made using 4 techniques: (1) tapered impression copings not splinted; (2) squared impression copings not splinted; (3) squared impression copings splinted with autopolymerizing acrylic resin; and (4) squared impression copings with a lateral extension on one side not splinted	The dimensional accuracy of all the techniques was exceptional and the observed differences can be regarded as clinically negligible.
Vigolo P[1] *et al*. 2003 Feb[30]		medium-consistency polyether impressions	in group 1, nonmodified square impression copings were used; in group 2, square impression copings were used and joined together with autopolymerizing acrylic resin before the impression procedure; and in group 3, square impression copings previously airborne particle-abraded and coated with the manufacturer-recommended impression adhesive were used	improved accuracy of the master cast was achieved when the impression technique involved square impression copings joined together with autopolymerizing acrylic resin or square impression copings that had been airborne particle-abraded and adhesive-coated.
Vigolo P[1], *et al*[31].		medium-consistency polyether impressions	the first group, nonmodified square impression copings were used (NM group); in the second group, square impression copings were used and joined together with autopolymerizing acrylic resin before the impression procedure (R [resin] group); and in the third group, square impression copings previously airborne-particle abraded and coated with the manufacturer-recommended impression adhesive were used (M [modified] group)	Improved accuracy of the definitive cast was achieved when the square impression copings joined together with autopolymerizing acrylic resin were used to make an impression of multiple internal connection implants.
Rashidan N *et al*. 2012 [32]	open-tray and close-tray techniques	medium-consistency polyether impressions		The impression coping shape had more impact on impression inaccuracy than impression technique did.
Del'Acqua MA eta l 2010[33]		Vinyl polysiloxane impression material	Three groups of impressions were tested (n = 5): index (I), squared (S), and modified squared (MS)	the techniques modified squared and index generated more accurate casts than the squared technique.
Fernandez MA[1], *et al* 2013[34]			Plastic and metal copings	The metal impression copings were more accurate than plastic copings when using the Straumann system, and there was no difference between metal and plastic copings for the Nobel Replace system. The system-by-screw location was not conclusive, showing no correlation within each system.
Teo JW, *et al* 2014 [35]			direct implant-level impression copings (DR) the plastic impression copings (INDR	The accuracy of INDR and DR was comparable at all interimplant angulations for 3i and STR. For NB, INDR was comparable to DR at 0 and 8 degrees but was less accurate at 15 degrees
de Avila ED[1] *et al*.[36]	open and closed tray	Vinyl polysiloxane impression material	tapered impression copings (T), squared impression copings (S) and modified squared impression copings (MS) for implant-supported prostheses.	more accurate working cast is possible using tapered impression copings techniques and stone index.

Table 1 [d] Splinting Vs Non Splinting

Author	Impression technique	Impression materials used	Significance
Herbst D[1] *et al* 2000 [37]	Impressions were made using 4 techniques: (1) tapered impression copings not splinted; (2) squared impression copings not splinted; (3) squared impression copings splinted with autopolymerizing acrylic resin; and (4) squared impression copings with a lateral extension on one side not splinted		The dimensional accuracy of all the techniques was exceptional and the observed differences can be regarded as clinically negligible.
Kim S[1], *et al* 2006 [38]	a nonsplinted open-tray technique and a light-curing resin splinted open-tray technique		Connecting a component produced as great a displacement as that resulting solely from a impression or cast fabrication. The nonsplinted group was more accurate during impression making but less accurate during cast fabrication.

Choi JH[1] *et al.* 2007 [39]	implant-level impression techniques (direct nonsplinted and splinted)	polysiloxane impressions	the accuracy of implant-level impressions for internal-connection implant restorations was similar for the direct nonsplinted and splinted techniques in settings with divergence up to 8 degrees.
Filho HG *et al* 2009 [40]	Technique 1 (T1), direct technique with square copings without union in open trays; Technique 2 (T2), square copings splinted with dental floss and autopolymerizing acrylic resin; Technique 3 (T3),square copings splinted with dental floss and autopolymerizing acrylic resin, sectioned and splinted again with autopolymerizing acrylic resin; Technique 4 (T4), square copings splinted with prefabricated acrylic resin bar	Polyether	the splinting of pick-up impression copings is indicated for osseointegrated implant impressions. The square copings splinted with a prefabricated acrylic resin bar presented the best results among the pick-up impression techniques evaluated in this study.
Lee YJ[1], Heo SJ, Koak JY, Kim SK. 2009 Sep-Oct[41]	impression techniques were examined: octagonal transfer impression coping, nonoctagonal transfer impression coping, nonoctagonal pickup impression coping, and nonoctagonal pickup impression copings joined together with autopolymerizing acrylic resin.	polyether impressions	The casts produced from nonoctagonal pickup impression techniques were more accurate than those produced by transfer impression techniques, regardless of whether they were splinted, for angulated conical internal-connection implants.
Papaspyridakos P[1] *et al* 2011 [42]	Splinted (with acrylic resin) and nonsplinted pickup implant impression techniques	medium-bodied consistency polyether	the splinted impression technique generates more accurate implant impressions and master casts than the nonsplinted technique for complete-arch, one-piece fixed prostheses.
Al Quran FA[et] *et al* 2012 Feb[43]	Three techniques were tested: closed tray, open tray nonsplinted, and open tray splinted		the best accuracy of the definitive prosthesis was achieved when the impression copings were splinted with autopolymerized acrylic resin, sectioned, and rejoined
Tarib NA *et al* 2012[44]	four techniques: (A) indirect; (B) direct, unsplinted; (C) direct, splinted; and (D) direct, splinted, sectioned, and re-splinted		splinting of impression copings would be beneficial to obtain an accurate impression.
Ongül D[1] *et al* 2012 [45]	direct splinted technique (EG2 to EG5) and a non-splinted technique (EG1)		splinting impression copings with acrylic resin demonstrate superior results than the non-splinted technique and splinting with light-curing composite.
Martínez-Rus F[1], *et al* 2013 [46]	4 techniques (n = 5 per group): (1) indirect technique, (2) unsplinted direct technique, (3) acrylic resin-splinted direct technique, and (4) metal-splinted direct technique	medium-consistency polyether impressions	The metal-splinted direct technique produced the most accurate casts, followed by acrylic resin-splinted direct, indirect, and unsplinted direct techniques.
Assif D1 *et al.* 1999 [47]	Group A, an autopolymerizing acrylic resin was used to splint transfer copings. In group B, a dual-cure acrylic resin was used, and for group C, plaster,	Polyether impression material was used for groups A and B	Impression techniques using autopolymerizing acrylic resin or impression plaster as a splinting material were significantly more accurate than dual-cure acrylic resin. Plaster is the material of choice in completely edentulous patients, since it is much easier to manipulate, less time consuming, and less expensive.
Yamamoto E[1] *et al* 2010 [48]	scanning electron microscopy (SEM) squared impression copings indexed by the impression material and squared impression copings splinted with acrylic resin		The IH impression technique was the least accurate technique. There was no difference between IHS, P, and PS techniques with regard to the reference constant. The impression techniques that used splinted impression copings generated more accurate casts, irrespective of the impression material.
Stimmelmayr M[1].[49]	three different impressions (A, transfer; B, pick-up; and C, splinted pick-up) were taken		The splinted pick-up impression showed the least deviation between original and stone model; transfer and pick-up techniques showed similar results. For better accuracy of implant-supported prosthodontics, the splinted pick-up technique should be used for impressions of four implants evenly spread in edentulous jaws.
Martínez-Rus F[1], *et al.*[50] 2013 Jun	4 techniques (n = 5 per group): (1) indirect technique, (2) unsplinted direct technique, (3) acrylic resin-splinted direct technique, and (4) metal-splinted direct technique	medium-consistency polyether impressions	The metal-splinted direct technique produced the most accurate casts, followed by acrylic resin-splinted direct, indirect, and unsplinted direct techniques.

Table [e] Impression materials

Author	Impression technique	Impression materials used	Significance
Inturregui JA[1], *et al* 1993[51]		polyether, polyether and impression plaster, or polyether and acrylic resin	the polyether alone resulted in the closest duplication of the master cast.
Pujari M[1] *et al* 2014 [52]		polyether and vinyl polysiloxane (VPS) impression material	Casts obtained from polyether impression material were more accurate than casts obtained from vinyl polysiloxane impression material.
Wee AG. 2000[53]		Polyether (medium consistency) addition silicone (high consistency) polysulfide (medium consistency). medium viscosity polyether, a high viscosity addition silicone, and a medium viscosity polysulfide-condensation silicones	the use of either polyether (medium) or addition silicone (high) impression is recommended for direct implant impressions.

Assuncao WG1,*et al* 2004[54]		four elastomers: "P"-polysulfide; "I"-polyether; "A"-addition silicone; and "Z"-condensation silicone	The best materials were material polyether and silicone
Holst S1,*et al* 2007 [55]	open-tray technique	polyvinyl siloxane and polyether impression materials.	time cannot be neglected as a factor affecting the accuracy of implant master casts.
Walker MP1*et al* 2008 [56]		medium-body or heavy-body polyether impression material	Impression material viscosity does not appear to be a critical factor for implant cast accuracy.
Aguilar ML *et al* 2010 [57]		mixed polyether and hydrophilic addition silicone impression materials	Hydrophilic addition silicone and polyether impression materials have similar distortion effects for transfer procedures when using the direct impression technique and machine mixing. Silicone demonstrated superiority for perpendicularity distortion, though of a magnitude unlikely to have clinical significance.
Ferreira VF1, *et al* 2012 [58]		polyvinyl siloxane. condensation siloxane or irreversible hydrocolloid	Resin-splinted transfer copings in condensation siloxane or irreversible hydrocolloid produced impressions as accurately as polyvinyl siloxane.
Reddy S *et al*. 2013 [59]	open tray impression technique	polyvinyl siloxane and polyether impression materials	no significant difference in dimensional accuracy of the resultant casts made from two different impression materials (polyvinyl siloxane and polyether) by closed tray impression technique in parallel and angulated implants.
Buzayan M *et al* 2013 [60]	splinted or nonsplinted direct impression techniques	polyether (PE) and polyvinylsiloxane (PVS) impression materials	No significant differences were found between the various splinting groups for both PE and PVS impression materials in terms of linear and 3D distortions. However, small but significant differences were found between the two impression materials (PVS, 91 µm; PE, 103 µm) in terms of 3D discrepancies, irrespective of the splinting technique employed
Hoods-Moonsammy *et al* 2014 [61]		impression plaster (Plastogum, Harry J Bosworth), a polyether (Impregum Penta, 3M ESPE), and two polyvinyl siloxane (PVS) materials (Aquasil Monophase and Aquasil putty with light-body wash, Dentsply	The PVS monophase material reproduced the master model most accurately. Although there was no significant distortion between the impressions and the master model or between the impressions and their casts, there were distortions between the master model and the master casts, which highlighted the cumulative effects of the distortions. The polyether material proved to be the most reliable in terms of predictability
Buzayan M *et al* 2013 [62]		polyether (PE) and polyvinylsiloxane (PVS) impression materials	No significant differences
Inturregui JA[1]*et al* 1993 [63]	the three impression techniques	polyether, polyether and impression plaster, or polyether and acrylic resin	the polyether alone resulted in the closest duplication of the master cast.

Table 2 Conventional vs digital

Author	Impression technique used	Impression material used	Significance
Ortorp A*et al* 2005[64]	A three-dimensional photogrammetric technique conventional impression techniques.	photogrammetry and the polyether technique	Photogrammetry is a valid option for recording implant positions and has a precision comparable to that of conventional impression techniques.
Drago C *et al* 2010 [65]	computer-aided design/computer-assisted machining (CAD/CAM) and conventional casting with the lost wax technique		The CAD/CAM frameworks featured in this study were significantly more accurate than cast frameworks made with the lost-wax technique
Eliasson A[1], Ortorp A. 2012 [66]	using a robot technique and an impression of Encode healing abutments, with the traditional technique	vinylpolysiloxane material	Both conventional and robot technique presented low levels of displacement of the implant analogues in all casts. The test technique was less precise, but the difference in accuracy was small, and both techniques are precise enough for single crowns and short-span, implant-supported fixed partial prostheses
Karl M *et al* 2012 [67]	Conventional and optical impressions		Intraoral digitization of dental implants appears to be at least as precise as conventional impression taking and master cast fabrication using prefabricated transfer components and laboratory analogs.
van der Meer WJ[1], *et al* 2012[68]	three intra-oral scanners: the CEREC (Sirona), the iTero (Cadent) and the Lava COS (3M)		The distance errors were the smallest and most consistent for the Lava COS. The distance errors for the Cerec were the largest and least consistent. All the angulation errors were small.
Ono S[1],*et al* 2013 [69]	optical impression method computer-aided designing (CAD)/computer-aided manufacturing (CAM)and conventional impression		The proposed method took a significantly shorter time to obtain an impression than did the conventional method
Howell KJ[1], *et al* 2013 [70]	Robocast Technology (Biomet 3i) with that of master casts fabricated using traditional transfer (closed-tray) and pick-up (open-tray) techniques.		Within the limitations of this lab-based study and analysis, the Encode technique resulted in master casts that were less accurate than master casts made from traditional open- and closed-tray impression techniques
Al-Abdullah K *et al* 2013 [71]	CAD/CAM technology (Robocasts) and conventional implant impression techniques (open tray with splinted impression copings technique).		The implant definitive casts fabricated from the coded healing abutment impressions were found to be less accurate than those fabricated from the open tray with splinted impression copings technique
Patzelt SB[1], *et al* 2014 [72]	Intraoral scanners. computer-aided impression making (CAIM)		CAIM to be superior regarding time efficiency in comparison with conventional approaches and might accelerate the work flow of making impressions.
Abdel-Azim T,*et al* 2014 Nov-Dec[73]	conventional and digital implant impression/fabrication techniques: group 1 (conventional single implant), group 2 (digital single implant), group 3 (conventional complete arch), and group 4 (digital complete arch)		The conventional pathway resulted in a smaller marginal discrepancy for single-implant frameworks. In contrast, the digital pathway resulted in a smaller marginal discrepancy for full-arch implant frameworks.

Impression materials – 13 articles were analysed in which 6 articles advocated polyether is better[51,52,53,54,57,61,63], while 2 articles supported addition silicone impression material, 3 advocated activated polysilioxane impression materials is better[52, 58,61] and 1 article supported vinylsilioxane

Conventional vs digital 10 articles was analysed in which 1 article suggested cad cam was better than conventional ,3 articles suggested accuracy as comparable to conventional and suggested that the accuracy is lower as compared to conventional. while 5 article suggested digital better than conventional[62,68,72,73]

DISCUSSION

The preciseness of impression depends on two factors that are the types of impression techniques and the materials used. Each step in the process introduces potential human and/or material error. There is some variation in impressions and the resulting master casts obtained which depends on the technique and material used by the operator. To date, a number of implant impression techniques has been introduced, like transfer, pickup techniques, and splint, and other factors such as angulations, materials, copings are investigated for accuracy and time efficacy.

Transfer Vs Pick Up

Traditionally, the implant impression techniques which have been used for transferring the impression copings from the implants to the impression site such as open tray technique and close tray technique. In the transfer technique tapered copings and a closed tray is used to make an impression. In this technique the copings are connected to the implants, and an impression which is made is removed from the mouth, leaving the copings intraorally, later the copings are removed to which the implant analogs are connected, and lastly the coping-analog assemblies are placed into the impression before the definitive cast is poured. The various clinical situations in which the closed tray technique are indicated are when the patient has reduced interarch space, prone to gag, or when accessibility of an implant is difficult in the posterior region of the mouth [(22)]. Conversely in the pick-up impression square copings and an open tray (a tray with an opening) is used, allowing the upper ends of the impression coping screw to be exposed. The copings screws are unscrewed before separating the implants, that is removed along with the impression. The implant analogs which is in the impression are then connected to the copings after which the definitive cast fabricated.

Various in-vitro studies have examined implant restoration accuracy. Most of the authors have found that the open tray technique is more superior in accuracy than others. In a study where Carr compared the two techniques that is open and closed tray technique in which a five implant mandibular cast were used in which the inter abutment divergence angles were all less than 15 degrees. The most accurate working cast was produced by the open tray technique so considered to be superior. [27] Kwon JH *et al*, in their study suggested that implant impression with open tray impression copings gave more accurate definitive casts as compared to those which was fabricated without impression copings, especially those with larger inter-abutment distance.[15] Similarly, authors also concluded in their studies that precision of impression obtained from open tray technique better than closed technique.

What are the problems faced in the transfer impression?

The main issue is that the transfer does not become an integral part of the impression which is mechanically stuck in the impression material (such as PVS). In fact, it can be easily moved. Although, because of the friction between the surfaces of the transfer and the impression material, it may not come back to its initial position .That deportation cannot be ignored when the technician engages analogs into the impression. The irreversibly the logged implant parts may get displaced and mobilized forces in form of torque or pressure. The screw should be fastened into the analog without contacting the tray; however, that cannot be always assured especially in the molar areas the displacement of the transfer can also take place even due to the gravitational forces of the impression tray, A snap-fit plastic impression coping has been developed which cannot be catogerised as pick-up impression, as the manual connection of abutment is needed by the operators in the pick sleeves and neither it is a transfer impression, as the plastic impression copings are picked up in the impression. Akça K, and Cehreli MC, suggested that the snap-on VPS indirect impression technique using a stock tray, resulted in similar dimensional accuracy as achieved with the PE direct technique as it is clinically convenient and eliminates the repositioning after removal of the impression. [12] But in a study by Mpikos P *et al*, suggested that in case multiple implant impression accuracy of the open- and closed-tray techniques remains same.

Factors Affecting the Implant Impression Accuracy

Angulation

It is seen that with increase in divergence angle, inaccuracy also increases. Internal-connection implants show better accuracy, when the divergence angle was less than 15 degrees and the inaccuracy was significantly greater for the 20-degree-divergent implants.[23] In one of the study it was concluded that the impression technique was not affected by implant angulation.[24] However, when implants with internal connections were used, angulation of implant mostly affected the impression accuracy.

Coping Modification

An accurate placement and alignment of the antirotational mechanism of an implant to the working cast is of much importance to get optimal fit of the final restoration [34]. For a definitive restorations to be properly supported and to avoid placement of additional stresses on the implants, a accurate and exact recording of implant location is needed .The displacement of impression copings inside the impression material using an open-tray or close-tray impression technique in clinical and laboratory phases may lead to inaccuracy in the orientation of implants from intraoral to the definitive cast. Thus, a corrective procedure may be required by the restorations.

A number of studies have been performed to compare various types of impression coping like square, tapered coping . Vigolo P concluded that when the square impression copings were used along with autopolymerizing acrylic resin to make an impression for multiple internal connection implants, there was

improvement in the accuracy of impression and in comparison to plastic coping the accuracy of metal impression copings were more accurate when using the Straumann system, and in case of the Nobel Replace system there was no difference .[30]

Splinting Vs Non Splinting

Along with the evolution of a acrylic resin metal implant supported fixed complete denture for an edentulous jaw, the splint technique for an implant impression was introduced .[77] The underlying principle was that all the impression copings were joined together using a rigid material so that movement of individual coping movement is avoided during the impression-making procedure. The splinting has been one of the important objective for investigation from the first study examining implant impression accuracy [78].

Some of problems faced with the splint technique are fracture of the connection between the splint material and the impression copings and distortion of the splint materials. The metal-splinted direct technique produced the most accurate casts, then the acrylic resin-splinted direct, indirect, and unsplinted direct techniques.[46]

Although result showed the accuracy of one technique superior than other, splint or nonsplint was not consistent, most of the studies reported more superior results with the splint technique as compared with the non-splint technique .[40,42-50] So, it can be concluded that the splinted impression technique was more accurate than the non-splinted impression techniques.

IMPRESSION MATERIALS

The material used in the implant impression is of fundamental importance for enabling a passive seating for the prosthesis. Various studies are reviewed to evaluate the morpho-dimensional behaviour of the materials, such as, polysulphide, addition silicones, condensation silicone, polyether, and irreversible hydrocolloid which is used in an impression technique of the transfer of the dental implants which showed statistically significant dimensional alterations.

The addition silicones exhibited minor changes in dimension but greatest alteration is seen in the irreversible hydrocolloid. All addition silicones produced similar casts, which is followed by polyether, polysulphate, condensation silicone and irreversible hydrocolloid. Aguilar ML *et al*[57] concluded that though it doesn't have clinical significance, silicone is superior for distortion. Many other studies supported both addition and polyether to have superior accuracy .[51, 52, 53,54,61,63]

Lastly, it should be taken into consideration that during the performance of the clinical procedures, such as the transfer of impression for implant-supported prostheses, the factors which should be considered are the technique, the cast and the impression material should be taken into consideration, the knowledge of advantages and disadvantages of the materials and techniques attempting to minimize the unwanted errors and enables to get more satisfactory results.

Conventional Vs Digital Impression

The conventional method for making an implant impression for crowns & bridges requires a stock or custom impression tray loaded with a impression materials such as polyvinyl siloxane or polyether material that is placed in the mouth to record the position of a properly seated impression coping. A stone model is thus poured from the impression from which the final restoration is made.

In 1987 Siemens introduced Digital intraoral impressions with the CEREC 1. There are many well established systems that perform intraoral scanning and digital impression for the construction of crowns & bridges which does not require impression trays or materials.[74,75]

Various tedious works such as selection of the tray, dispensing and setting of impression materials, transfer of impression to the laboratory, disinfection were eliminated by digital impression techniques. Plus patient comfort and education and time efficacy are additional advantages. As compared to conventional techniques where stone casts must be stored physically, computer hard drives are used to store digital scanning datasets

In some of in-vitro studies the precision and reproducibility of digital impression technique was compared with conventional impression techniques and also the fabrication techniques for single units and full-arch implant frameworks was compared .The result showed a smaller marginal discrepancy for single-implant frameworks by using conventional techniques. whereas, the digital technique proved to have a minimal marginal inaccuracy for full-arch implant frameworks.[62,68,73] . Digital impression techniques have superior time efficiency as compared with conventional techniques .[69,72]

Digital implant impression technique is gaining popularity at rapid rate and has good potential; but, further studies are required to examine accuracy of digital vs conventional implant impression techniques clinically.

CONCLUSION

- Impressions with the splint technique were greater as compared to non-splint technique.
- There was no difference observed between the pick-up and transfer techniques when there were 3 or fewer implants, whereas more accurate impressions were obtained with the pick-up technique than the transfer technique for situations in which there were 4 or more implants. VinylPolysiloxane as well as poyether were the advised for the implant impressions.
- The digital impression technique was more accurate and efficient as compared to the conventional impression technique as showed smaller marginal discrepancy for full arch frameworks compared to conventional techniques. Digital impression techniques have superior time efficiency as compared with conventional techniques.
- When conducted by an experienced operator, the treatment comfort of the digital impression technique was much superior in comparison to the conventional impression technique.

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