A Meta Analysis of Accuracy of Conventional and Digital Impressions of Implants

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Abstract

Application of computer-aided impression procedures are preferable to conventional impression procedures for Implant supported prosthesis. Data about the accuracy of the digital impression-making technologies in comparison to the conventional ones is scarce. This meta analysis is an attempt to decipher the preferred method of impression making of implant superstructures by analyzing data about these two impression making procedures.

Keywords: *Implants, conventional impressions, digital impressions, Implant accuracy, computer aided impression, intra oral scanner.*

Introduction

To fabricate a prosthetic framework on multiple implants, high-precision procedures are required for most of which is the impression. For almost every step in the procedure, either conventional or computer-aided approaches can be utilized.[1]

Conventional approach

A accurate impressions of tilted abutments is clinically arduous. Elastic recovery of the impression material may not withstand the strain induced during the removal of impression. There is no unanimous scientific agreement regarding which quantity and angulation of implants causes non- compensated impression material distortions, and when they must be splinted. Direct open-tray and indirect closed-tray impression are widely discussed in the literature.[2]

A systematic review reported that more studies confirm a higher impression accuracy (for four or more implants) using an open-tray impression technique than a closed-tray method (H. Lee, So, Hochstedler, &Ercoli, 2008). Polyether and polyvinylsiloxane were recommended as statistically the most accurate materials to make a implant impression (Wee, 2000).[2]

Computer-aided approach

Computer-aided approach in restorative dentistry started late 1980s advances in data acquisition, processing, and manufacturing nowadays, afford much faster and more accurate final outcomes. Intraoral scanners (IOS) available currently.[1]

Materials and Method

The Pubmed library was searched for articles, reviews and meta analysis from year 2013 to 2018 using the following search terms.

Articles that explicitly mention the variables considered for the study were obtained.

INCLUSION CRITERIA

In vitro studies, studies reporting on the accuracy of conventional impression, studies reporting on the accuracy of digital impression, experimental and control groups, Studies providing quantitative results, articles should be in English.

Exclusion Criteria

Studies without experimental and control groups, expert opinions or literature reviews, studies based on charts and questionnaire only, animal studies, studies without author response to inquiry for data clarification.

Data Extraction

Seven articles were short listed and following parameters were retrieved

- Mean linear distortion of conventional and digital impressions.
- Standard deviation (SD) of conventional and digital impressions.
- Confidence interval of conventional and digital impressions.

Meta Analysis

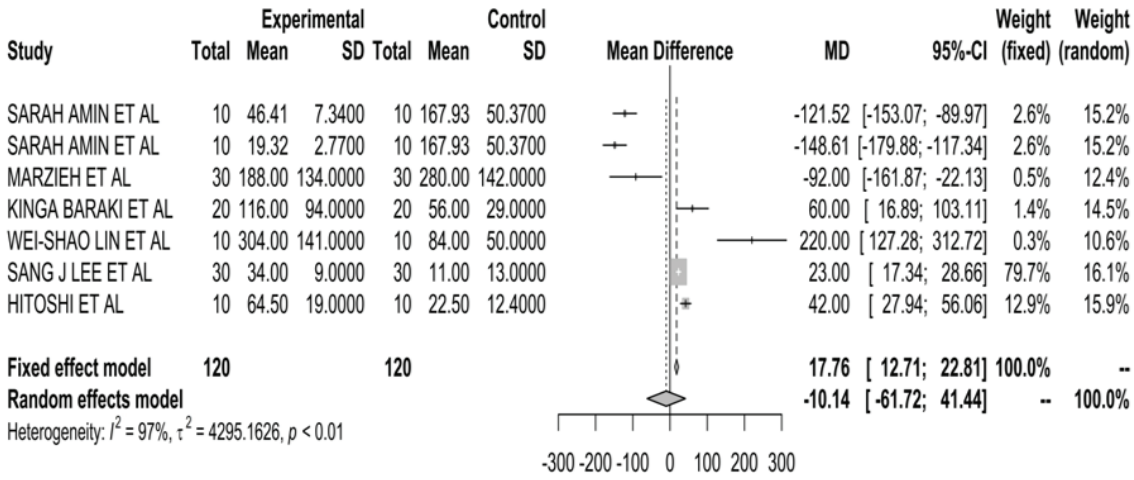
- Mean difference of the mean linear distortion was calculated for conventional impressions and digital impressions and compared using student T test at the confidence interval of 95%
- The data was presented as forest plot to aid incomparison of values

Meta analysis was done using R –3.5.1 statistical software

Data Extraction Table I

AUTHOR	IMPRESSION METHODOLOGY	IMPRESSION MATERIAL	SCANNING SYSTEM	IMPRESSION TECHNIQUE	N	MEAN	SD	CONFIDENCE INTERVAL		CONFIDENCE LEVEL	IMPLANT SYSTEM
								UPPER	LOWER		
SARAH AMIN ET AL	CONVENTIONAL	POLYETHER		SPLINTED OPEN TRAY	10	167.93	50.37	199.13	136.73	95%	STRAUMANN
	DIGITAL		CEREC OMNICAM		10	46.41	7.34	50.96	41.86	95%	STRAUMANN
	DIGITAL		3M TRUE DEFINTION		10	19.32	2.77	21.036	17.604	95%	STRAUMANN
MARZIEH ET AL	CONVENTIONAL	POLYVINYL SILOXANE		DIRECT OPEN TRAY	30	280	142	330.8	229.2	95%	NOBEL BIOCARE
	DIGITAL		TRIOS-3SHAPE		30	188	134	235.93	140.07	95%	NOBEL BIOCARE
KINGA BARAKI ET AL	CONVENTIONAL	POLYVINYL SILOXANE		DIRECT OPEN TRAY	20	56	29	68.7	43.3	95%	STRAUMANN
	DIGITAL		ITERO		20	116	94	157.18	74.82	95%	STRAUMANN
WEI-SHAO LIN ET AL	CONVENTIONAL	POLYVINYL SILOXANE		DIRECT OPEN TRAY	10	84	50	114.98	53.02	95%	STRAUMANN
	DIGITAL		ITERO		10	304	141	391.35	216.65	95%	STRAUMANN
SANG J LEE ET AL	CONVENTIONAL	POLYVINYL SILOXANE		CLOSED TRAY	30	34	9	37.22	30.78	95%	STRAUMANN
	DIGITAL		ITERO		30	11	13	15.652	6.348	95%	STRAUMANN
HITOSHI ET AL	CONVENTIONAL			DIRECT OPEN TRAY	10	22.5	12.4	31.4	13.7	95%	NOBEL BIOCARE
	DIGITAL		LAVA COS		10	64.5	19	78.1	51	95%	NOBEL BIOCARE

FOREST PLOT



FOREST PLOT - RESULTS

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                              MD                  95%-CI %W(fi
xed) %W(random)
SARAH AMIN ET AL    -121.5200 [-153.0688;  -89.9712]
 2.6       15.2
SARAH AMIN ET AL    -148.6100 [-179.8762; -117.3438]
 2.6       15.2
MARZIEH ET AL        -92.0000 [-161.8657;  -22.1343]
 0.5       12.4
KINGA BARAKI ET AL    60.0000 [ 16.8875;  103.1125]
1.4       14.5
WEI-SHAO LIN ET AL   220.0000 [ 127.2769;  312.7231]
 0.3       10.6
SANG J LEE ET AL      23.0000 [  17.3421;   28.6579]
79.7       16.1
HITOSHI ET AL         42.0000 [  27.9379;   56.0621]
12.9       15.9

Number of studies combined: k = 7
                              MD               95%-CI     z
p-value
Fixed effect model     17.7578 [ 12.7059; 22.8097]  6.89 <
 0.0001
Random effects model -10.1403 [-61.7222; 41.4416] -0.39
 0.7000

Quantifying heterogeneity:
tau^2 = 4295.1626; H = 6.19 [5.08; 7.54]; I^2 = 97.4% [96
.1%; 98.2%]

Test of heterogeneity:
Q d.f.p-value
229.79    6 < 0.0001
Details on meta-analytical method:
- Inverse variance method
- DerSimonian-Laird estimator for tau^
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The descriptive analysis revealed that splinted open tray impression technique has less inaccuracy than the direct non - splinted open tray technique. Of the scanning systems evaluated TRIOS 3 shape is better than the ITERO system followed by LAVA COS, CEREC OMNICAM and 3M True definition.[3] Polyether impression material is superior to polyvinylsiloxane impression material in terms of accuracy. Scan bodies from Nobel Biocare implant system result in better accuracy values compared to Straumann system.[7]

Amin et al(2016) reported that digital implant impressions were more accurate than the conventional direct splinted implant impressions. In vitro study by Papaspyridokos et al (2014) compared the accuracy of digital implant impressions using 3 shape scanner with conventional impression and showed that accuracy of digital impression was comparable to that of the conventional impression.[6]

Several recent studies by Howell et al(2013), Aliabdullah et al(2013) and Lin WS et al (2015) comparing digital vs conventional implant impressions have found a greater error using the digital approach. [5] Lin et al specifically examined the accuracy of models fabricated from conventional and iTero digital impressions and concluded that the digital pathway, with mean errors ranging from 158 to 328 μm, was significantly less accurate.[4]

Sang j lee et al (2015), ElliassonAotorp et al (2012) and Papaspyridakos et al (2016) have found equivalent accuracy between digital and analog impression techniques.[5] Abdel-Azim et al found equivalent error for full complete arch impressions when measuring the marginal fit of final prostheses fabricated using either analog technique or a complete CAD/CAM digital approach.[7] While Lee et al concluded that the accuracy of the digital method was equivalent to the conventional method when examining overall cast accuracy, they did find a statistically significant difference in vertical implant placement between the two approaches.[5] A recent study examining the accuracy of Straumann scan body with the TRIOS scanner found no difference when compared with two conventional impression approaches (papaspyridakos et al). However, the authors compared digitized analog casts to the digital impression–generated STL files and not actual fabricated casts.[6] The average 3D error for the conventional impression technique (56 μm) was found as per the study, to be within the clinically acceptable range and in agreement with previously published studies, which have reported errors ranging from 20 to 89 μm using similar measurement techniques. [5] Conversely, the digital impression technique resulted in an average 3D inter-implant error measurement of 116 μm, which was both in excess of the defined error limit of 60 μm and demonstrated a significantly greater error and variability than the conventional implant impression technique.[6]

Direct digitalization showed higher accuracy compared to the conventional impression making and indirect digitalization (Guth*et al.*, 2013).[7] Due to elastic properties of the impression materials, indirect digitization of the impression was not recommended. (DeLong *et al.*, 2001) the digitization of errors of the impressions was influenced by the shape and the interaction effect with the digitization source. (Quaas*et al.*, 2007; Rudolph *et al.*, 2007; Persson*et al.*, 2009) The digitization source with strong changes of curvature and smooth surface texture showed largest deviations due to high surface angles and light reflection from the digitization source to the object. (Persson*et al.*, 2008; Persson*et al.*, 2009)[3]

Marzieh et al (2018) concluded that digital impression has significantly less angular and linear distortion than

conventional impression. Digital impression of straight implants with internal connection was more accurate than that of the direct technique although the difference was not significant.[3]

The results of the present meta analysis and descriptive analysis show that 1. Statistically there is difference between conventional impressions and digital impressions in terms of accuracy. 2. The error for the digital impression technique was only slightly more than that of conventional impression. This may not be clinically highly significant.[2]

The accuracy values obtained from digital impressions has only a marginal difference from values of conventional impression. The results obtained are similar to the results of Hitoshi et al (2016) who stated that the results obtained in their study suggest that error of the optical impression was greater than that of conventional impression. Trends in digital dentistry are drastic, and a number of newly developed apparatuses may be provided in the near future. Further analyses must be conducted continuously. In the near future, the development of information technology should enable improvement in the accuracy of the optical impression with intraoral scanners.[5]

Scope for Further Studies

Although materials for making impression of the implants may not undergo drastic changes in composition/ techniques, considerable evolutionary enhancements in digital equipment for optical impressions have become an ongoing technical revolution. Hence, the inherent shortcomings of any developing technical system like intraoral scanners and implant systems will be overcome during this development. So, with improved equipments more studies can be done and increased data can be taken up for analysis.[7]

Conclusions

As per the results of the present meta analysis, the following conclusions can be drawn;

1. Accuracy of conventional impressions is marginally better than the accuracy of digitized impressions.

2. Splinted open tray technique resulted in lesser discrepancy than the direct open tray technique and closed tray technique.

3. Polyether yielded better impressions than polyvinylsiloxane.

4. Trios – 3shape was the best scanning system.

5. Nobel Biocare system was better than Straumann system

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