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RESEARCH ARTICLE

EFFECT OF CROWN MATERIAL, IMPLANT PLATFORM AND ABUTMENT DESIGN ON THE STRESS DISTRIBUTION AROUND IMPLANT-SUPPORTED DENTAL RESTORATIONS: A SYSTEMATIC REVIEW.

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Abstract

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To evaluate the effect of implant platform/abutment design/ crown material combinations on the stress distribution around implant-supported dental restorations. A literature search was made in three databases including PubMed, Cochrane and Web of Science. Inclusion criteria were in vitro studies, switched implant platform versus regular implant platform, titanium implants, internal hex connection and stress values of bone. Two review authors independently screened the articles for inclusion. This was followed by handsearching in the reference lists of all eligible studies for additional studies. Results: the search resulted in 16 eligible studies concerning the effect of platform switching on peri-implant bone stress, however no papers were found studying the effect of different implant platform/ abutment design /crown material complexes on bone stress. From the included studies, platform switching concept can replace conventional platform designs to improve implant survival rate, provided it should be used within its indications.

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Introduction:-

Dental implants are considered as a conservative treatment modality to replace missing dentition. Maintenance of bone around osseointegrated implants is important for their success and longevity. However, crestal bone loss occurs following functional implant loading[1]. This could be attributed to many factors one of which is excessive stress transmitted to the implant-surrounding structures which plays a major role in the peri-implant bone loss[2].

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Many attempts have been made to minimize such stresses, one of which was the ‘‘platform switching concept’’". It refers to using an abutment with a diameter smaller than the implant platform diameter or using an implant design with a wider neck diameter than implant body width. This implant-abutment design creates a horizontal gap that shifts the implant-abutment junction away from implant shoulder and towards the implant axis which in turn results in crestal bone preservation by keeping the inflammatory cell infiltrates and stresses away from the bone-implant interface[3,4].

Titanium abutments are the gold standard in implant dentistry. However their gray color results in bluish mucogingival discoloration which may in turn compromise esthetics especially in patients with thin gingival biotype. This led to the introduction of ceramic implant abutments, one of which is zirconia (3-yttria stabilized zirconia polycrystals)which provides a strong and esthetic alternative to titanium abutments[5].

Zirconia abutments are either stock or customized abutments. Despite their advantages, their mechanical behavior is influenced by the design of the implant-abutment connection[6, 7].
The majority are one-piece (OP) zirconia abutments which are made completely of zirconia ceramic. The direct contact between titanium implant/zirconia abutment interface and the excessive hardness of zirconia compared to titanium resulted in fretting wear of the implant hex which leads to many clinical problems including implant hex destruction, fracture of the zirconia abutment and abutment screw loosening [8, 6, 9].

To overcome these disadvantages, new two-piece (TP) zirconia abutments were introduced with a titanium insert at the apical end. These abutments perform better than do all-ceramic one-piece abutments due to the presence of titanium insert at the apical end of the abutment. This insert provides for a stable metal to metal implant/abutment interface. These hybrid abutments combine the esthetics of a zirconia coping with a titanium abutment connection, resulting in all-titanium implant/abutment interface[10, 5].

In 2015, Gehrke et al [11] assessed and compared the fatigue and fracture resistance of one-piece and two-piece computer-aided design/computer-assisted manufacturing (CAD/CAM) zirconia implant abutments with an internal-hex connection versus prefabricated zirconia stock abutments. Two-piece zirconia abutments showed superior fracture resistance which in turn might be clinically beneficial in high-load areas, such as premolar and molar regions.

In addition, proper selection of restorative materials especially those with stress absorbing behavior is also considered an important factor that may influence peri-implant stress distribution under functional forces[12,13].

The purpose of this systematic review was to evaluate the effect of different implant platform/abutment design/crown material combinations on the stress distribution around implant-supported dental restorations.

Materials and Methods:-

This systematic review was conducted according to the PRISMA[14] (Preferred Reporting Items for Systematic Reviews) as much as possible.

Search Strategy:-

A search was made in three databases including PubMed, Cochrane and Web of Science (up to 27 January 2017).

Pico statement:-

P (problem): Stress-induced bone resorption around single dental implants.
I (interventions):
I_1: Switched implant platform with two-piece zirconia abutment and lava ultimate crown.
I_2: Switched implant platform with two-piece zirconia abutment and zirconia crown.
I_3: Switched implant platform with titanium abutment and lava ultimate crown.
I_4: Switched implant platform with titanium abutment and zirconia crown.
C (comparator): Regular implant platform with titanium abutment and zirconia crown.
O (outcome measure): stress distribution around the implant supporting structures.

Research Question:-

For single dental implants, will the use of different implant/abutment/crown interventions (I_1,I_2,I_3, I_4), compared to regular implant platform with titanium abutment and zirconia crown, affect stress distribution around the implant supporting structures?

Inclusion and Exclusion Criteria:-

They are mentioned in Table 1

Study Characteristics:-

Three online databases were searched: PubMed (NLM—National Library of Medicine), The Cochrane Library and Web of Science. The search terms "Dental implant platform switching", "Dental Implant-Abutment Design", "Platform switched'', " Regular platform", "Matched implant", "Conventional platform", "Matching abutment", stress, "strain" and "dental stress analysis" were used to search for in vitro studies up to January 2017. We did not apply any language or date restrictions. The search strategy results are detailed in PRISMA flow diagram [14] (Figure 1). This search resulted in 1198 publications (PubMed=674, Cochrane=458, and Web of Science =66). After removal of duplicates (n=48), two review authors independently screened the titles and abstracts of the remaining 1150 articles following inclusion/exclusion criteria. Any disagreement was solved by discussion. Full text articles were obtained for abstracts (n=21) that seemed to meet eligibility criteria. This was followed by handsearching within the reference lists of included studies which resulted in one more article. Two review authors assessed independently the full text of 22 articles to decide if the exclusion standards applied. Any disagreement was also solved by discussion.

Data Extraction:-

A data-extraction form was developed and used by each author independently to collect the following data: 1) Study ID; 2) Bone layers; 3) Level of osseointegration; 4) Implant system and design; 5) Implant length; 6) Implant location; 7) Type of superstructure; 8) Load magnitude and direction; 9) Measurement units; 10) Implant prosthetic platform diameter; 11) Diameter of abutment and 12) Results. (Table 2)

Any discrepancies were resolved through discussion. When information was unclear, we attempted to contact authors of the original reports to provide further details.

Results:-

Following eligibility criteria, 6 studies were excluded while 16 studies were included in the systematic review as shown in Figure 1. These included studies were published between 2008 and 2017. Variations in the study designs of the included studies precluded the possibility of meta-analysis.

All studies were finite element analysis studies (FEA). They showed variations in simulation conditions:-

1. Bone model: all studies applied double-layered bone model (cortical& trabecular). Different shapes of bone models were selected, such as; a peri-implant bone cylinder, bone segment or full arch while some studies used 3D scanned models from volunteers to simulate reality.
2. Osseointegration level: for simplicity, the majority of these FEA studies referred to as complete, firm, perfect, rigidly anchored, optimal state or 100% integration, one study studied effect of platform switching with different levels of marginal bone loss, while no data were available from the other studies.
3. Implant systems and designs: some studies mentioned the type of implant systems. There was variations in implant diameters, lengths and designs (either implant body design; cylindrical versus tapered or implant neck design; smooth versus threaded).
4. Implant locations: most of studies were applied in posterior mandibular areas (premolars and molars), one in the maxillary molar area and one in the maxillary central incisor zone. On the other hand, other studies did not mention data regarding the site of implant.
5. Type of superstructure: the majority of studies were performed on implant-abutment models, while others included crowns as final restoration (gold, Co-Cr, porcelain fused to metal and IPS e-max Press crown).
6. Loading: different load vectors were applied; axial, horizontal or oblique loads. Loads ranged from 17.1 N-200N and the angles of oblique load ranged from 15°-45°.
7. Factors affecting stress distribution around osseointegrated implants:

The impact of platform switching on stress was described in all included studies. Peri-implant bone stress showed dependence on many factors such as, horizontal implant/ abutment mismatch in platform switching designs[15,16 ,17,18], load directions[15,16,19 ,17, 20,21,22,18,23,24 ,25 ,26], implant design characteristics [15, 17,18], implant diameter[27].

Figure1:- PRISMA 2009 Flow Diagram

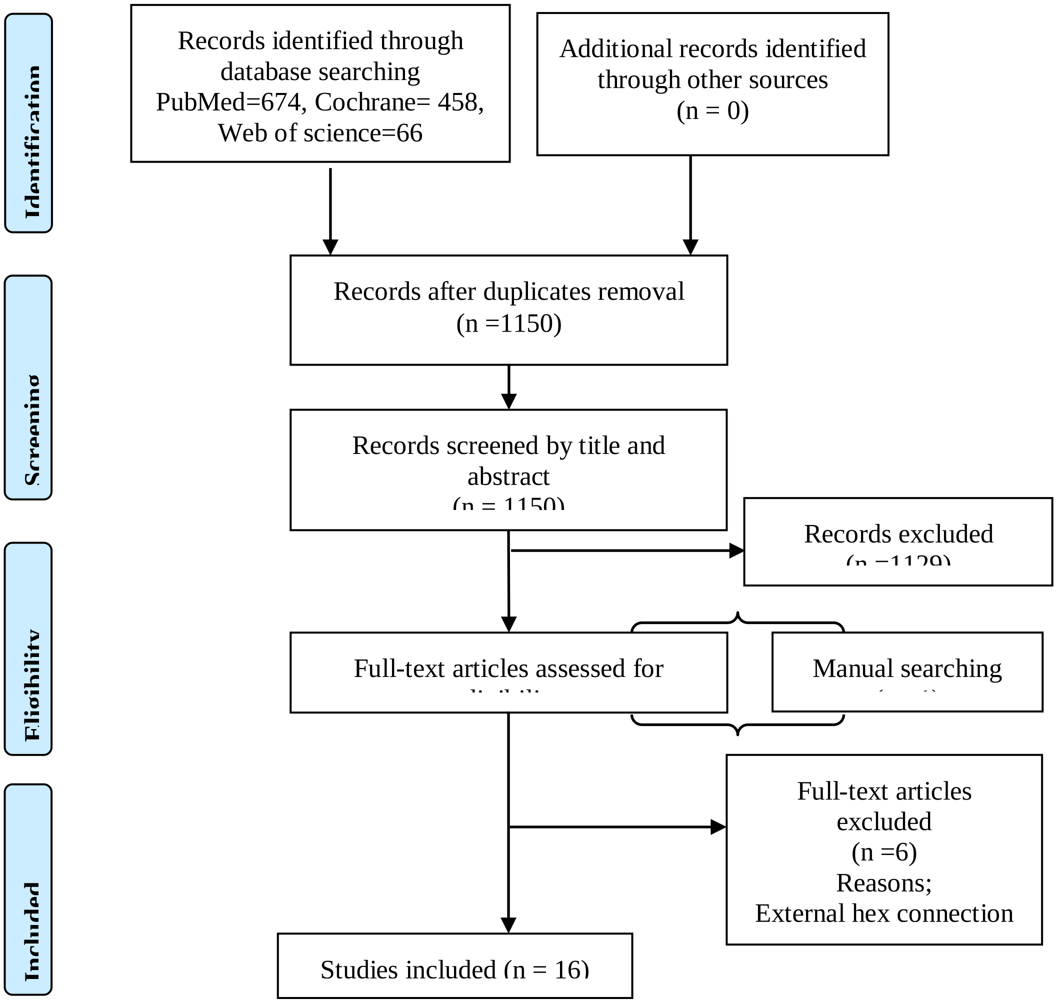

Table1:-Inclusion and Exclusion Criteria.

Inclusion criteria	Exclusion criteria
In vitro studies	Zirconia implants
Titanium implants	Studies assessed the effect of implant body design
Internal hex type implant	Studies concern on the effect of cementing medium
Platform switching versus platform matching	
Studies measuring stress values of bone	

Table2. Summary of included studies

Study ID	**Bone (B) layers**	**Osseo-integration level**	**Implant system**	**Implant design**	**Implant length (mm)**	**Implant location**	**Type of superstructure**	**Axial load**	**Oblique load**	**Oblique load angle**	**Stress (MPa) measurement**	**Notes**
Rasouli-Ghahroudi 2015[15]	C & T	ND	Nobel Biocare	Cyl & Tap Threaded	ND	ND	Abutment	100N	100 N	15°	Von Mises (σVM) (MPa)	-
Cimen and Yengine 2012[16]	C & T	Firm	ND	Cyl	11	ND	Ni-Cr crown	100 N	50 N	ND	Von Mises (σVM) (MPa)	-
Canay and Akça 2009[19]	C & T	ND	ND	Cyl	12	ND	Abutment	150N	150 N	30°	Von Mises (σVM) , tensile & compressive (MPa)	-
Chang et al 2010 [33]	C & T	Perfect 100%	OSSEOTITE^R Certain^R implant *	Cyl	10	1st molar Maxilla	Gold alloy crown	ND	200N vertical & 40 N HZ	ND	Von Mises (σVM) & principal stresses (σ) (MPa)	-
Schrotenboer et al 2008[17]	C & T	Complete 100%	ND	Tap	13	Posterior Mandible.	Abutment	100N	100N	15 °	Von Mises (σVM) (MPa)	-
Schrotenboer et al 2009 [20]	C & T	Complete	ND	Cyl	13	Posterior Mandible	Abutment	100N	100N	15 °	Von Mises (σVM) (MPa)	-
Tabata et al 2010[27]	C & T	Rigidly anchored	SIN; Implant Systems**	Cyl	15	ND	Co-Cr alloy crown	100N	NO	NO	Maximum stress (MPa)	-
Gurgel-Juarez et al 2012 [37]	C & T	Complete	SIN; Implant Systems**	ND	11.5	Central incisor Maxilla	IPS e-max Press crown	No	100 N	45 °	Von Mises (σVM) , principal stresses (MPa) & principal elastic strain (ε max)	External hex & principal elastic strain data were not mentioned
Sahabi et al 2013[21]	C & T	Complete	XiVE + 3i ++	ND	XiVE= 11 3i= 11.5	1st molar Mandible.	Abutment	100 N	100 N	15 °	Von Mises (σVM) (MPa)	Data of PMG (3.8 & 4 mm) were not mentioned; no PSG groups
Aradya et al 2016[22]	C & T	Complete	BIOMET 3i *	Tap	13	Molar Mandible.	Abutment	100 N	100 N	15°	Von Mises (σVM) (MPa)	-
Khurana et al 2013[18]	C & T	Complete	ND	ND	11	Premolar Mandible.	Abutment	100 N	100 N	40°	Von Mises (σVM) (MPa)	-
Canullo et al 2011[23]	C & T	ND		ND	ND	ND	Abutment	130N	90N	ND	Von Mises (σVM) (MPa)	Data of 3.8 mm implant was not mentioned;, no PSG group
Bouazza-Juanes et al 2015[24]	C & T	Optimal state	ND	ND	11	Mandible.	Abutment	100N	100N	15°	Von Mises (σVM) (MPa)	-
Álvarez-Arenal et al 2017[25]	C & T	100%	BIOMET 3i*	Threaded	13	Posterior Mandible.	Co-Cr alloy and porcelain-fused crown	150 N	150 N	15° 30° 45°	Von Mises (σVM) (MPa) & deformation	Deformation data were not mentioned
Мураев et al 2016 [26]	C & T	ND	LIKO # IRIS##	ND	10	Mandible	Abutment	11.4N	17.1 lingually & 23.4 N mesially	HZ & 75°	Equivalent stresses of Mises (MPa)	-
Xia et al 2013[38]	C & T	Bone loss from implant neck 0,0.5,1, & 2mm	ND	ND	11.5	1st molar Mandible.	Gold alloy crown	200N	200N	45°	Von Mises (σVM) & MES (MPa)	-

B= bone; C= cortical bone; T= trabecular bone; ND= no data; ; Cyl= Cylindrical implant; Tap=Tapered implant; MPa = Mega pascals; ****3i*** Implant Innovations, Inc., Palm Beach Gardens, FL; ; HZ=- horizontal load ; σ= principal stresses; ** Sa˜o Paulo, Brazil; PSG= platform-switching group; ; +XiVE S Plus (DENTSPLY Friadent, GmbH, Germany); ++3i Certain (Biomet 3i, Florida, USA); PMG= platform-matching group; PSG= platform switching group; # LIKO =Russian dental implants system with internal hex design; ## IRIS= Innovative Russian Implant System with inner cone, a hexagonal anti-rotational element & platform switching design; BL= bone loss; MES= Maximum Equivalent(EQV) stresses

Continued Table.2 Summary of included studies

Study	Implant prosthetic platform diameter (mm)	Abutment diameter (mm)				Results													
		PSG (mm)		PMG(mm)		PSG (MPa)								PMG (MPa)					
						Cyl				Tap				Cyl		Tap			
		Cyl	Tap	Cyl	Tap	P2= 4.3		P3=3.5		P2=4.3		P3=3.5		P1=5		P1=5			
Rasouli-Ghahroudi ,2015[15]	**5**	P2=4.3 P3=3.5	P2=4.3 P3=3.5	P1=5	P1=5	AX C= 2.77 T= 0.546	OB C= 7.066 T= 1.583	AX C=1.711 T= 0.496	OB C= 5.936 T= 1.496	AX C= 2.2678 T= 0.656	OB C= 9.393 T= 2.726	AX C= 1.961 T= 0.706	OB C= 7.861 T= 2.623	AX C=3.38 T= 0.79	OB C= 8.103 T= 1.726	AX C= 3.596 T= 0.683	OB C= 0.72 T= 2.88		
Cimen and Yengine, 2012[16]	4	3.2		4		B= 84 Imp =404 Cr= 100 SCW =78 Abut=404								B= 123 Imp =123 Cr=123 SCW =51 Abut=146					
Canay and Akça, 2009 [19]	4	HZ set-off	EP	Rest Ht	4	Tensile stresses (Bone)		Compressive stresses(Bone)		σVM (All)				Tensile stresses (Bone)		Compressive stresses (Bone)		σVM (All)	
						AX	OB	AX	OB	AX	OB			AX	OB	AX	OB	AX	OB
		1= 0.5	St	1.5		1=2.4573	1=16.3560	1=4.2845	1=17.6573	1=67.3481	1=137.5087			2.3045	19.3468	4.4774	19.8266	72.5940	169.3358
		2= 0.5	St	2.0		2=2.4216	2=16.5819	2=4.1631	2=17.5915	2=40.1985	2=149.5098								
		3= 0.5	Ang.	1.5		3=2.4220	3=16.1412	3=4.1474	3=17.1686	3=59.3997	3=114.0925								
		4= 0.5	Ang.	2.0		4=2.3996	4=16.2653	4=4.2461	4=17.7843	4=42.3246	4=109.4303								
		5= 0.75	St	1.5		5=2.3388	5=17.2561	5=4.4219	5=16.4339	5=86.7445	5=294.5805								
		6= 0.75	St	2.0		6=2.4701	6=18.0909	6=4.1584	6=18.3443	6=106.5150	6=342.1106								
		7= 0.75	Ang.	1.5		7=2.3588	7=16.0367	7=3.8151	7=16.9205	7=68.9654	7=218.3663								
		8= 0.75	Ang.	2.0		8=2.3721	8=16.4184	8=3.9122	8=17.0835	8=78.4143	8=221.5926								
Chang et al, 2010[33]	4	3.4		4.1		σVM C= 84.3 1st σ max =+98.8 2nd σ max =+25.1 3rd σ max =+11.8	σVM T= 33.6 σ min = -10.3 σ min = -15.8 σ min = -30.1							σVM C= 89.2 1st σ max =+130 2nd σ max =+51.5 3rd σ max =+27.9	σVM T= 18.4 σ min = -6 σ min = -18.2 σ min = -69.4				
Schrotenboer et al, 2008[17]	5	4.5 & 4 SN & MT		5		4.5		4						5					
						SN AX= 6.80 OB= 23.62	MT AX=8.72 OB=30.30	SN AX= 6.48 OB= 22.93	MT AX=8.26 OB=29.29					SN AX= 7.20 OB= 24.51	MT AX=9.31 OB= 31.61				
Schrotenboer et al, 2009 [20]	5	4.5		5		AX 6.50		OB 27.43						AX 6.97	OB 28.00				
Tabata et al, 2010[27]	4.1 & 5	Wide implant diameter=5 Abut= 4.1		Regular implant diameter = 4.1 Abut= 4.1		B= 34 Imp =649 Cr= 10566 SCW =568								B= 159 Imp =1610 Cr= 6574 SCW =479					
Gurgel-Juarez et	4.5	3.8		4.5		σVM C= 72.4	σVM T= 9.65							σVM C= 82.3	σVM T=5.62				

al, 2012 [37]				σ max C= 83.3 σ min C= -84.5 σ max T=12 σ min T=- 4.49	σ max C= 87.4 σ min C= -112 σ max T=4.95 σ min T=- 5.36
Sahabi et al 2013[21]	XiVE = 4.5 3i= 5	XiVE-b= 3.8 3i-b= 4.1	XiVE-c= 4.5 3i-b= 5	XiVE-b= 3.8/4.5 C: AX= 7.96 OB= 15.06 T: AX=3.68 OB= 3.28 AII: AX= 33.84 OB= 80.20 3i-b = 4.1/5 C: AX= 13.4 OB= 16.25 T: AX= 3.84 OB= 2.49 AII: AX= 21.3 OB= 70.76	XiVE-c= 4.5/4.5 C: AX= 10.52 OB= 20.94 T: AX= 3.09 OB= 2.83 AII: AX= 23.22 OB= 54.70 3i-c= 5/5 C: AX= 14.87 OB= 20.36 T: AX= 5.52 OB= 2.69 AII: AX= 16.82 OB= 34.60
Aradya et al 2016[22]	5	4.5	5	AX Overall=173.933 C =12.793 T =173.933 Imp = 173.933 OB Overall=239.556 C=39.952 T=239.556 Imp =239.556	AX Overall=126.248 C=13.914 T=126.248 Imp =126.248 OB Overall=191.928 C=59.329 T=191.928 Imp =191.928
Khurana et al 2013[18]	5	SN & MT Abut; (4.5, 4 & 3.5)	SN & MT Abut; 5	AX SN: 4.5=18.60 4=16.23 3.5=13.53 MT: 4.5=21.75 4=15.38 3.5=15.02 OB SN: 4.5=29.99 4=25.66 3.5=20.5 MT: 4.5=40.2 4=35.6 3.5=33.1	AX SN 22.75 MT 23.2 OB SN 36.99 MT 43.7
Canullo et al 2011[23]	3.5 & 5.5	3.8	5.5	C= 30 T =48 Imp=190-64 Abut=85-42	C =40 T =51 IMP=45-55 Abut= 70-55
Bouazza-Juanes et al2015[24]	4.1	3.2	4.1	AX C= 11.3 T= 2.78 OB C= 28.3 T= 3.27	AX C= 17.6 T= 2.90 OB C= 47.8 T= 3.1
Álvarez-Arenal et al 2017[25]	4.1	3.8	4.1	AX C= 9.731 T= 6.695 OB 15° C= 19.877 T=6.897 30° C= 30.099 T=7.087 45° C= 38.405 T=6.844	AX C= 11.581 T=5.839 OB 15° C= 23.395 T=5.513 30° C= 34.998 T=5.671 45° C= 44.384 T=5.507
Мураев et al 2016 [26]	4	ND Internal hex design I2 (LIKO) Inner cone design I4 (IRIS)	4 Internal hex design I1 (LIKO) Inner cone design I3	Internal hex design I2 C=13 T=4.1 Imp=481 Abut=565 SCW=466 Inner cone design I4 C=15 T=3.6 Imp=325 Abut=324 SCW=506	Internal hex design I1 C=25 T=3.3 Imp=309 Abut=241 SCW=500 Inner cone design I3 C=26 T=3.5 Imp=300 Abut=255 SCW=498
Xia et al 2013[38]	5	4.1	5	AX BL (0mm)= 8.96 BL (0.5mm)=6.25 BL (1mm)=6.10 BL (1.5mm)=3.72 BL (2mm)=3.30 OB BL (0mm)= 16.73 BL (0.5mm)=15.23 BL (1mm)=14.78 BL (1.5mm)=8.69 BL (2mm)=8.66	AX BL (0mm)= 11.17 BL (0.5mm)=9.38 BL (1mm)=8.76 BL (1.5mm)=4.66 BL (2mm)=3.71 OB BL (0mm)= 21.51 BL (0.5mm)=19.10 BL (1mm)=17.10 BL (1.5mm)=9.43 BL (2mm)=8.95

AX=axial load; OB= oblique load; Imp; implant; Cr; crown; SCW; screw; Abut; abutment; EP=Emergence profile; St=straight; Ang.= angled; Rest Ht; Restoration height; AII; Abutment-Implant Interface; σVM = Von Mises stress; Minimum; plus sign (+) represents tension and minus sign (-) represents compression; σ max= Maximum principal stress; σ min= minimum principal stress; SN= Smooth neck design; MT=microthreads neck design; ; BL=Bone loss

Discussion:-

This systematic review was performed to study the effect of different implant/abutment/crown complexes on the stress distribution around single implant-supported restorations. Successful osseointegrated implant must fulfil esthetic, mechanical and biological requirement[28,29]. Bone loss inevitably occurs around two-stage implant systems once they are exposed to the oral cavity for prosthetic rehabilitation[30]. This bone loss was attributed to many factors including the sensitivity of implant-abutment interface (IAI) to excessive loads and bacterial contamination[31, 32].

Results of included studies revealed more favorable stress distribution around implants with platform switching design compared to platform-matching design regardless of all other design variables. This response was interpreted as follows: platform switching configuration led not only to a relative decrease in stress levels compared to standard configurations, but also to a notable stress field shift from bone towards the implant system, potentially resulting in lower crestal bone overloading [21,23, 33,34]. This was in agreement with previous studies [35, 36] in which platform switching design resulted in lower stress and more favorable stress distribution compared to regular platform design which in turn may decrease the chance of loss of bone and osseointegration. This damping effect was higher on cortical bone and less significant on trabecular bone [15, 33,37 ,21,22,23,24,25,26].

Studies[15,19,17,18]have shown that the level of stress was inversely related to the extent of the horizontal implant-abutment mismatch regardless of loading direction and implant design.

A FEA study [38] evaluated the effect of platform switching on distribution of bone with different levels of marginal bone loss. The study confirmed the biomechanical advantage for platform switching in case of marginal bone resorption; however this advantage may be weakened when bone resorption is dramatic.

On contrary, one study [19] evaluated the effect of diameter shifting at implant-abutment interface on load distribution at peri-implant bone and within implant-abutment complex. They found that relocation of microgap and redefinition implant-abutment connection at bone level does not influence the stress characterization at peri-implant marginal bone but may noticeably affect the mechanical properties of the implant-abutment connection.

This was in agreement with Romanos and Javed 2014 [39]who systematically reviewed the currently available clinical evidence to assess the role of platform switching (PS) in minimizing crestal bone loss around dental implants. They claimed that the role of PS in minimizing crestal bone loss remains debatable. Bone loss around implants seemed to be governed by several factors, such as the cervical features of the implant design, 3D-implant positioning, prosthetic concept and the implant-abutment connection (IAC), width of alveolar ridge and prevention of micromotion at the implant-abutment interface and not merely placing implants according to the PS concept.

According to included studies [15, 19, 17, 20, 21, 22, 24,25, 38], there was a correlation between loading direction and stress level. The non-axial loads (oblique, horizontal) increased stresses on peri-implant bone compared to axial loads due to bending effect and shifting of load away from implant axis.

The design of the implant is another factor that could affect the stress distribution in peri-implant bone. A FEA study [15] analyzed and compared the stress distribution around tapered and cylindrical implants and found that tapered implants increased crestal bone stresses compared to cylindrical implant. This stress- reducing effect of cylindrical implant was attributed to the increase in the bone/implant interface area that results in more even stress distribution as it was also proved by other studies[40, 41].

In addition two included studies [17,18]investigated the effects of platform switching and implant collar design (microthreads versus smooth) on crestal bone stress level. They found that reduced abutment diameter (i.e., platform switching) resulted in less stress translated to the crestal bone in the microthreads and smooth-neck groups. In addition, microthreads increased crestal stress upon loading. However, implants with microthreads collar design are more preferable than smooth implant collar, provided stresses are not exceeding threshold stain values of bone, above which bone fails to heal after fatigue[42]. This was in agreement with prospective studies[43,44] which showed that implants with roughened and threaded implant neck design are more resistant to marginal bone loss compared to smooth, polished designs. This was attributed to the compressive nature of stresses around threads with bone being stronger under compressive forces while weaker under tensile and shear forces which are caused by smooth-neck implant designs.

One study [26]carried out a comparative finite element analysis of stress with different implant/ abutment designs (platform switching versus no platform switching) and connection interface (internal hexagon versus inner cone). Implants with platform switching and cone interface between implant and abutment showed the best results, therefore such combination would allow maintaining implant prosthetic stability and decrease the load on cortical bone.

Despite the advantageous effect of platform switching on bone response, it increased stresses on implant prosthetic components which could result in mechanical complications such as screw loosening or fracture[16, 27, 21, 22, 23, 26].

A FEA study[19] demonstrated that platform switching increase the risk of mechanical overloading on abutments particularly of those with increased set-off distance and straight emergence profile.

One attempt to minimize incidence of mechanical failure is the selection of high-strength abutments such as standard titanium abutment and their esthetic alternative zirconia abutments. Both exhibited the same survival, technical, biological and esthetical outcomes.[45]

In addition, proper selection of restorative material especially those with shock absorbing potential may compensate for lack of periodontal ligament around dental implants and in turn minimize stress-induced bone resorption.

No in vitro studies were found comparing the influence of different implant/ abutment/ restorative materials combinations on stress distribution around dental implants which could be due to limitation of finite element models.

Conclusions:-

Peri-implant crestal bone stresses could be minimized by many factors including; platform switching especially with increased implant/abutment diameter mismatch, axial loading, smooth implant neck design, cylindrical implants. However, platform switching increases the stress concentration at the implant-abutment interface leading to technical complications, such as screw or abutment loosening or fracture.

Recommendations:-

Studies are required to evaluate the effect of different implant platform/ abutment design/ restorative materials combinations on stress distribution around dental implants.

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The author declares that there is no conflict of interest.

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