Original Research Article

Assessment of the available restorative space for mandibular implant overdenture treatment using cone beam computer tomography (CBCT)

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Abstract

Background: Adequacy of restorative space is an important consideration in successful implant overdenture therapy. Early detection of restorative space over the anticipated implant positions allows formulation of a proper treatment plan for surgical intervention. **Aim:** To evaluate the available restorative space for mandibular implant supported overdenture on both right and left side of mandible for 20 edentulous patients using cone beam computer tomography. **Material and Methods:** Twenty patients who had class I ridge relationship were included. Cone beam computer tomography imaging techniques was used for 3D visualization of available restorative space. **Results:** The mean restorative space at right and left side for male patients was 9.9 mm and 10.6 mm respectively. The mean restorative space at right and left side for female patients was 9.6 mm and 10.1 mm respectively. The average restorative space at right side position was 9.8 mm, SD 3.642 where males have more space (10.10 mm, SD 4.322) than females (9.5 mm SD 4.611). The average restorative space at left side 9.25 mm SD 3.075, with males have more space (9.40mm SD 4.711) than females (9.10mm SD 4.211). **Conclusion:** The ball or locator attachment systems were suitable for both right and left side position was applicable. The ultimate choice of attachment type should be based on restorative space for mandibular implant overdenture, clinical performance of the attachments regarding the functional loads on the implant and surrounding tissues.

Keywords: Restorative space for mandibular implant, overdenture treatment, cone beam computer tomography

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Received Date: 21/11/2019 Revised Date: 16/12/2019 Accepted Date: 08/01/2020
DOI: https://doi.org/10.26611/10191312

Access this article online	
Quick Response Code:	Website: www.medpulse.in
	Accessed Date: 17 January 2020

INTRODUCTION

Complete loss of teeth leads to minimal oral functions with esthetic compromise, causing psychologic discomfort to the patient. As a restorative dentist, the prosthodontist have the responsibility to restore the patients comfort by giving a well-functioning dentures. The option of conventional dentures is well appreciated in maxilla than the mandible, because of the ease of adjustment towards it. Implant retained mandibular overdentures has become a standard treatment protocol for increased compliance. An implant-retained over denture gains its support from a combination of intraoral tissues and dental implants.[1] Adequacy of restorative space is an important consideration in successful implant overdenture therapy. It is pertinent to note the importance of restorative space (3 Dimensional space from the occlusal plane to tissue surface), in choosing the type of attachment systems like bar and clip attachment, ball attachment or locator attachment. Adequate restorative space is important to provide bulk of acrylic to resist fracture, space to set denture teeth without modifications and room for attachment, soft tissue and hygiene. The space requirements for prosthetic component is essential for selection of a particular attachment system ranging from locators to bar attachments with clips. Critical evaluation of available restorative space during the diagnostic phase of implant overdenture therapy is necessary.[2] Early detection of restorative space over the anticipated implant positions allows formulation of a

How to cite this article: Wasim Manzoor Bhat, Ruqaya Arif, Mir Mudasir Gul, Azia Manzoor Bhat. Assessment of the available restorative space for mandibular implant overdenture treatment using cone beam computer tomography (CBCT). *MedPulse – International Journal of Dentistry.* January 2020; 13(1): 05-10. http://www.medpulse.in/Dentistry

proper treatment plan for surgical intervention, such as alveoloplasty to create more inter-ridge space. Hence, this study was conducted to evaluate the available restorative space for mandibular implant supported overdenture on both right and left side of mandible for 20 edentulous patients. The results of this study will help us in establishing the correct choices of attachment systems in general, based on the available restorative space, before the implant or attachment is placed in an easier and more affordable manner.

MATERIAL AND METHODS

Twenty completely edentulous cases were selected randomly for this study who came to the outpatient department for complete denture treatment in our hospital. Patients had been informed about the study consequences, the purpose of study and the study procedure. Informed consent was received from all the patients.

Inclusion criteria

- Age in the range of 60 - 75 years
- Both male and females
- Patients who had class I ridge relationship and no systemic illness

Exclusion criteria

- Class 2 and class 3 ridge relation cases.
- Patients with systemic illness

Materials

1. Twenty Complete dentures.
2. Gutta percha sticks. (GT^{R} Series X^{TM} DENTSPLY)
3. Round bur No.4.
4. Myray Sky View 3D CBCT. (90kVp; 10 mA; field of view 18x21 cm; exposure time 15 seconds with a spatial resolution of 10 line pairs per centimeter and an isotropic 0.2-mm voxel size).
5. Myray digital imaging software.
6. Acquisition window overview.(Imaging applications).

Methodology

The radiographic marker (gutta percha) was placed on the tissue (intaglio) surface of the lower denture and on the cusp tip of canine and premolar region on both right and left side region represents A, B, D and E implant position by a single operator (Fig 1).

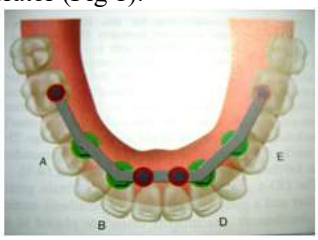

Figure 1: Overdenture option 4

Following which the patient was subjected to cone beam computed tomography (CBCT) and the space between the bone and the cusp tip (restorative space) was measured using the Myray digital imaging 3D scan (Fig 2) and Acquisition window overview(Fig 3)

Figure 2: Myray digital imaging 3D scan

Figure 3: Acquisition window overview

Procedure:

a) Radiographic template fabrication:

Ensured that the existing mandibular denture has been seated comfortably on the alveolar ridge and was in occlusal harmony with the maxillary denture and seated in maximum intercuspation (MI). Immediately before CBCT assessment, made a hole of 2-mm wide on the intaglio surface (fig 4a) as well as on the cusp tip (occlusal surface) of both right and left side of canine and premolar region using round bur No.4. (fig 4b). Then, placed the radiographic markers (gutta percha) on these holes ensuring that the markers (gutta percha) were in a straight line. Documented the location of the marking on the denture to allow for the transfer of this location during the surgical procedure.

Figure 4a: Prosthesis with the radio-opaque reference marking on the intaglio region of denture; **Figure 4b:** Prosthesis with the radio-opaque reference markings on canine and surface of denture.premolar

b) Diagnostic planning:

Oriented the image in such a way that the vertical plane was perpendicular to the axis of the ridge, for optimal accuracy when measuring available restorative space for implant attachment. For treatment planning purposes, moved the cross-sectional slices in 3 different planes (Sagittal, Vertical and Horizontal) towards the following positions: Displaced the sagittal and vertical planes on the viewer so that they intersected at the implant prospective site, which coincided with the radiopaque marking of the gutta percha (fig. 4).

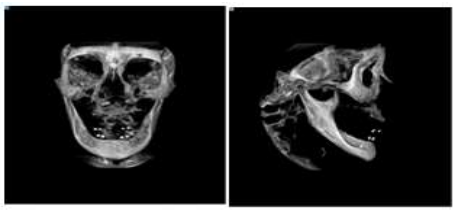

Figure 4: Screenshot from 3D-viewer with slices oriented to measure the restorative space available for implant attachment both at right and left side region.

On the vertical cross-section, determined the available restorative space, which was represented by the distance between the crest of the ridge and the most coronal (gutta percha) radiopaque marking. Based on this information, we can determine how much restorative space is needed for the prosthetic rehabilitation. For example, a Straumann Tissue Level Standard Plus Implant (Institut Straumann AG, Basel, Switzerland) with a Locator (Zest Anchors Inc., Calif) attachment incorporated in a mandibular overdenture requires a minimum of 7.3mm to 8.3mm (1.8mm of smooth implant collar +1mm for the soft tissue collar built in the Locator abutment+ 2.5mm Height of denture cap which includes the male Locator+ 2–3mm of acrylic resin). This gives the restorative space requirements for implant attachment systems. Fig 5.

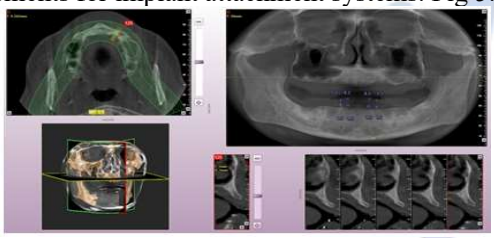

Figure 5: Distance from crest of alveolar bone to most coronal point of radio-opaque marking represents restorative space available.

Statistical analysis

Data entry, data cleaning, sorting, recoding, ranking, graphical presentation and report were done using Microsoft office 2007, Epi info and Statistical Package for Social Science [SPSS]. Qualitative data was presented in percentages and frequencies. Quantitative data were given in mean, 95% CI, standard deviation. Distribution of the outcome variables were analyzed using Kolmogorov – Smirnov test and Q - Q plot showed the outcome variable follow a normal distribution. Hence parametric tests were used. Students t-test analyzed the Right and Left side Restorative space in relation to gender.

RESULTS

In this study, 10 male and 10 female patients who had class I ridge relationship and no systemic illness were selected. The age distribution of patients selected in the range of 60-75 years. There were 4 male and 4 females in 60-65 years age group, 2 male and 3 females in 66-70 years age group and 4 male and 3 females in 71-75 years age group.The mean restorative space at right and left side for male patients was 9.9 mm and 10.6 mm respectively. The mean restorative space at right and left side for female patients was 9.6 mm and 10.1 mm respectively. The mean soft tissue thickness of the patients was 2.00±0.20050mm. The mean soft tissue thickness in male was 2.0115±0.20655mm and in female was 1.9917±0.19763mm. The restorative space at right side position around 35% of the patients have 9mm of space followed by 20% of patients have 11mm of space and 10% of patient have 10mm and 12mm respectively.

Table 1: Restorative Space at Right Side Position

Right Side		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	5mm	1	5.0	5.0	5.0
	9mm	7	35.0	35.0	40.0
	10mm	2	10.0	10.0	50.0
	11mm	4	20.0	20.0	70.0
	12mm	2	10.0	10.0	80.0
	13mm	1	5.0	5.0	85.0
	14mm	1	5.0	5.0	90.0
	15mm	1	5.0	5.0	95.0
	18mm	1	5.0	5.0	100.0
	Total	**20**	**100.0**	**100.0**	

The restorative space at the left side position around 30% of the patients have 9mm of space followed by 20% of patients have 10mm of space and 15% of patient have 8mm and 11mm respectively.

Table 2: Restorative Space at Left Side Position

Left Side		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1.00mm	1	5.0	5.0	5.0
	4.00mm	1	5.0	5.0	10.0
	8.00mm	3	15.0	15.0	25.0
	9.00mm	6	30.0	30.0	55.0
	10.00mm	4	20.0	20.0	75.0
	11.00mm	3	15.0	15.0	90.0
	12.00mm	1	5.0	5.0	95.0
	17.00mm	1	5.0	5.0	100.0
	Total	20	100.0	100.0	

The average restorative space at right side position is 9.8 mm, SD 3.642 where males have more space of 10.10 mm, SD 4.322 than females, 9.5 mm SD 4.611. The average restorative space at left side 9.25 mm SD 3.075, with males have more space 9.40mm SD 4.711 than females 9.10mm SD 4.211.

Table 3: Descriptive statistic – Right and left side space Vs gender

Outcome	Right side			Left side		
	Male	Female	Average	Male	Female	Average
Mean	10.1000	9.5000	9.8000	9.4000	9.1000	9.2500
95% CI	8.0363	7.5265-11.4735	8.5062-11.0938	7.8473-10.9527	6.3100-11.8900	7.8105-10.6895
SD	4.322	4.611	3.642	4.711	4.211	3.075
Variance	2.88483	2.75882	2.76444	2.17051	3.90014	9.461
t- value	0.475			0.213		
p value	0.640			0.300		

The student t test variance between the right and left restorative space shows t= -1.053, p value=0.315, where there was statistical difference between two groups of right and left restorative space.

Table 4: Independent Samples Test (Right side)

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Right Side	Equal variances assumed	.205	.656	.475	18	.640	.60000	1.26227	-2.05194	3.25194
	Equal variances not assumed			.475	17.964	.640	.60000	1.26227	-2.05232	3.25232

Table 5: Independent Samples Test (Left side)

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	T	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Left Side	Equal variances assumed	.719	.407	.213	18	.834	.30000	1.41146	-2.66537	3.26537
	Equal variances not assumed			.213	14.087	.835	.30000	1.41146	-2.72553	3.32553

Table 6: Independent Samples Test (Left and right side)

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	T	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Left and Right	Equal variances assumed	.311	.588	-1.053	11	.315	-4.52067	4.29409	-13.97190	4.93057
	Equal variances not assumed			-1.545	7.952	.161	-4.52067	2.92606	-11.27526	2.23393

DISCUSSION

The determination of space available between the jaws is required during the treatment planning phase for an implant overdenture. The more predictable implant overdenture attachment selection is important for the prognosis after the treatment. Assessing the available restorative space is very important to determine the selection of implant overdenture options. It can be done by several ways like matrix capture of denture teeth, occlusal denture tooth matrix, boleys gauge, wax trial denture on mounted casts and cone beam computed tomography. According to Ahuja and Cagna,[3] it is important to diagnostically evaluate available restorative space prior to implant placement. Failure to accurately assess restorative space may result in esthetically and structurally compromised prostheses and patient dissatisfaction. The periodontal probe and the reamer which is to calibrate the restorative space values of vertical restorative space available. This does not provide a clear 3 dimensional view of the available restorative space unless the selected attachment type is tried in the space within the putty index at the established site. The technique used in this study is a cone beam computed tomography scans of the patient's existing mandibular complete denture which is easy and most accurate for determining the restorative space. The placement of implants improves the support, stability and retention of the overdenture. By nature, the edentulous maxilla supports the denture through greater surface area and maxilla is also the more difficult area to place implants. The mandibular implant overdenture is the basic need of a patients and doctors to establish an ideal treatment modality. Hence, mandibular overdenture has been selected for this study. Cone beam computed tomography and computer based planning helps us to permit:[1] visualization of osseous structures in various 3-D and cross sectional perspectives;[2] visualization of the planned prosthesis in 3 dimensions and its relationship to underlying bone;[3] visualization of available restorative space in 3 dimensions to assist in prosthesis design and attachment selection;[4] virtual placement of dental implants in bone; and [5] fabrication of accurate and stable surgical templates. In this study, for measuring restorative space in implant mandibular overdenture cases were decided. The mandibular overdenture requires more than 12mm of space for bar attachment and 8mm for O-ring attachment. So, the study was designed to identify the restorative space using cone beam computed tomography which is simple to use, most accurate and helps us to fabricate surgical stents using CAD-CAM techniques. The greatest available height and optimal density bone in the anterior mandible between the mental foramen. According to Chiapasco *et al.*,[4] two single-standing implants with ball attachments were sometimes considered risk, and still four implants splinted by a bar are recommended. But, two-implant treatment modality has become increasingly popular within the past 20 years. The restorative space available on an average was between 9.25mm to 9.54mm which are best suited for ball and locator attachment. The bar and clip implant attachment systems is not possible in most of the cases, because it has been recommended that a minimum of approximately 12 mm of vertical restorative space (crest of bone to occlusal plane) is necessary to accomplish a mandibular implant assisted overdenture. Ahuja and Cagna[1] classified restorative space edentulous arches to be restores with implants. The Class I arch has available vertical restorative space equal to or greater than 15 mm. An arch with 12 to14 mm of available vertical restorative space is categorized as Class II. Class III represents an arch with 9 to 11 mm of available space, while an arch with less than 9 mm of vertical restorative space is categorized as Class IV.[1] In this study, the average right side position was found to be 9.54mm, SD-3.642, 95%CI 8.50-11.09 restorative space available for the prosthesis attachment, with this space for the study population the more suitable attachment systems at right side position is 2.5mm ball gold-8.6mm, Ti-8.6mm, 2.5 mm sphero flex ball-8.25mm, 1.8mm sphero flex ball – 7.5mm. locator- 8.17mm, rather than bar, magnets regular-10.5mm, ERA-10mm, ZAAG-standard-15mm, short-14mm.[5] In this study, the average left side restorative space was found to be 9.25mm, SD-3.075, 95%CI 7.81-10.68 restorative space available for the prosthesis attachment, with this space for the study population the more suitable attachment system at left side position, were 2.5mm ball gold-8.6mm, Ti-8.6mm, 2.5 mm

sphero flex ball-8.25mm, 1.8mm sphero flex ball – 7.5mm. locator- 8.17mm, rather than bar, magnets regular-10.5mm, ERA-10mm, ZAAG- standard-15mm, short-14mm.[5] The overall average restorative space was found to be 9.25mm and 9.54mm, where the attachment systems were suitable for left and right side position was applicable. In these clinical situations, if we decide to go for bar attachment system, then it is necessary to modify the treatment plan involving pre prosthetic surgeries like alveloplasty.

CONCLUSION

The average restorative space was found to be 9.25mm on left side and 9.54mm on right side. So, the ball or locator attachment systems were suitable for both right and left side position was applicable. The ultimate choice of attachment type should be based on restorative space for mandibular implant overdenture, clinical performance of the attachments regarding the functional loads on the implant and surrounding tissues. When the planned prosthesis contours are ideally replicated in surgical templates it will result in well-defined prosthesis which is functionally and esthetically acceptable.

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Source of Support: None Declared
Conflict of Interest: None Declared