

The Comparative Evaluation of the Masticatory Efficiency of Root Supported Attachment Retained Overdenture and Implant Supported Overdenture by EMG: An In Vivo Study

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Abstract: The masticatory efficiency of complete denture, implanted supported, root supported and attachment retained overdenture, was checked by the electromyography, which would help in gaining information about the neurophysiologic mechanisms regulating the complex masticatory action and deciding the best treatment for the patients. The study was divided into two groups. In group one, there were five patients, these patients were first given complete denture and then given two implant supported overdenture. In group two, there were five patients, these patients were first given root supported overdenture and then given root supported attachment retained overdenture. Their masticatory efficiency was evaluated during clenching and mastication of masseter and temporalis muscles. This was done by the best proven method which is electromyography. Mean masticatory efficiency was found out during clenching and mastication and was tabulated and statistically analyzed using unpaired and paired t-test. As a result, the unpaired and paired t-test suggest that a significant statistical difference was obtained in the mean masticatory efficiency of the two-implant supported overdenture while clenching and mastication ($P < 0.0001$). This showed that the two-implant supported overdenture had the maximum masticatory efficiency during clenching and mastication compared to the other three treatment modalities. **As a conclusion**, patient rehabilitated with two-implant supported overdenture gave the maximum masticatory efficiency values during clenching and mastication for both the muscles masseter & temporalis followed by attachment retained overdenture, root supported overdenture and conventional complete denture.

Keywords: two-implant supported overdenture, root supported overdenture, attachment retained overdenture, masticatory efficiency, and electromyography.

I. Introduction

“Being edentulous is considered a handicap, both with respect to oral function and psychological impact.”¹ Masticatory function is often poor; in fact, the masticatory force is 20% to 40% of complete denture wearers compared to that of healthy dentate subjects.² In spite of rapid development and success rate in the field of implantology, preservation of natural teeth or roots is more desirable which supports Devan’s dictum.³ Overdenture is any removable dental prosthesis that covers and rests on one or more remaining natural teeth, the roots of natural teeth, and/or dental implants; a dental prosthesis that covers and is partially supported by natural teeth, natural tooth roots, and/or dental implants.⁴ Advantages are the continued preservation of alveolar bone around the retained teeth and the continuing presence of periodontal sensory mechanisms that guides and monitor gnathodynamic functions.⁵ Retention and stability of overdentures can be further improved by attachments. Ball attachments are considered the simplest type of attachments for clinical application with tooth and implant supported overdentures. Because of the retention and stability of conventional mandibular complete dentures often is a poor, shaved natural tooth as denture abutments became common in the 1960’s. In the 1970’s introduction of titanium implants were used in implant-supported prostheses, and in the 1980’s implant-retained overdentures started to take over.⁶ When using natural teeth, a standard procedure was to select two anterior teeth for OD abutments. Minimum number of anterior teeth was a logical choice, especially in the mandible, as anterior teeth often are the last remaining and because endodontic treatment on them is easier to perform. Implant stabilization of complete dentures is often employed on the basis of the improvement in retention, stability and support provided for the patient.⁷ Oral function improves significantly after fabrication of a mandibular implant-supported overdentures and need 1.5 to 3.6 times fewer chewing strokes than conventional complete denture wearers to obtain an equivalent reduction in food particle size.² This is because the maximum masticatory force of an implant-retained denture is 60% to 200% greater than that a conventional denture.² The number of chewing cycles needed to halve the initial size of a test food decreased, on average, from 47 to 25 cycles after implant treatment.⁸ “Masticatory efficiency” is defined as the number of strokes needed to achieve a certain particle size reduction.⁹ Various treatment modality has been tested for masticatory efficiency those are ultrasonography, photocolormetry, sieve method and electromyography.¹⁰ The best method is recording of

electromyography (EMG) activity which is a convenient and useful method because it is easily done, there is fewer problems to the patients & operator and directly measures the muscle activity.¹¹ The elevator group of muscles that are routinely been tested include temporalis and masseter muscle. Electromyography is the recording and analysis of the electrical potentials of the muscle.¹² Muscle activity of the masseter and temporalis muscles is a measure of the force exerted during mastication. Muscle activity during mastication and clenching can be objectively evaluated by recording the surface electromyography of jaw muscles.¹³ However no extensive literature is present on the comparison of the root supported attachment retained and implant supported overdenture. Thus there is a need of the study to do a comparative evaluation of the masticatory efficiency of root supported attachment retained and implant supported over denture by EMG. The null hypothesis is that there will no difference between the masticatory efficiency of root supported, attachment retained overdenture, complete denture and implant supported overdenture.

II. Methodology

This study was conducted in the Department of the Prosthodontics and Crown & Bridge, K.M. Shah Dental College and Hospital, from 2011-2013 Vadodara, Gujarat. There was two groups of patients. Group.1 was complete denture and implant supported overdenture. Group.2 was root supported overdenture and root supported attachment retained overdenture. There were 5 Patients in both groups, which received 2 types of dentures. This study was done on 10 patients with following inclusion and exclusion criteria.

Inclusion Criteria For Impant Suppoted Overdenture¹⁴:

1. Total edentulism in mandible for at least 3 months
2. Absence of local inflammation
3. Absence of oral mucosal diseases
4. No history or radiotherapy
5. Residual bone volume should be at least 5mm in diameter and 10mm in length
6. Patient with Class 1,2,3 type of bone according to Lekholm and Zarb

Inclusion Criteria For Root Supported Attachment Retained Overdenture:

1. Patients with completely edentulous maxillary arch and with bilaterally presence of mandibular canine.
2. Patients with adequate interarch space.
3. Healthy periodontal condition and endodontic condition of the remaining mandibular canine.

Exclusion Criteria For Implant Supported Overdenture¹³:

1. Insufficient bone volume of less than 5mm in diameter and less than 10mm in length.
2. Severe intermaxillary skeletal discrepancy
3. Gagging reflex
4. Severe clenching habits or bruxism
5. Heavy smokers
6. Systemic disease

Exclusion Criteria For Root Supported Attachment Retained Overdenture:

1. Patient with bad periodontal status and endodontic status of the remaining bilateral mandibular canine.
2. Patient was grossly destructed tooth.

For Group.1 patients: Phase 1: Fabrication of conventional complete denture

Completely edentulous patients who reported of difficulty in retention and stability of the lower denture were screened to satisfy inclusion and exclusion criteria. Group.1 Patients were evaluated to have a minimum ridge thickness of 5 mm and interarch distance of at least 22mm. All patients selected had radiographic evaluation done using orthopantomogram to rule out any pathology. Also Computerized tomography (CT scan- denta scan) was done, to evaluate the exact location and the evaluate the bone quality. A set of maxillary and mandibular complete dentures was made. Orientation, vertical and centric jaw relations were recorded (Fig.1-4). Maxillary cast was oriented with semi adjustable articulator using spring bow (Hanau wide view articulator), (Fig.5-6). Mandibular cast was related to maxillary cast using centric record. Intraoral Gothic arch tracings were obtained and interocclusal records were made. The horizontal and lateral condylar guidances were set, upper and lower anteriors were arranged and the incisal guidance was adjusted. Teeth set (Acry rock, Ruthinium, cross link acrylic) were selected according to dentogenics and interarch relationships. The posterior teeth were arranged to balanced occlusion on articulator (Fig.7). Centric relation was confirmed during the balanced occlusion on articulator. Centric relation was confirmed during the balanced trial. Trial denture was then tried in the mouth, vertical dimension was verified, centric and eccentric contacts were evaluated. Trial

denture was processed into final dentures using heat cure acrylic resin and a long curing cycle was followed. Finished and polished dentures were inserted in the patients mouth (Fig.8). The retention, stability, esthetics, phonetics, jaw relation and occlusion was confirmed. Patient was recalled after 24 hours. Minor adjustments were done. Patient was recalled after 1 week for testing of masticatory efficiency by the EMG.



Fig.1: Primary Impression

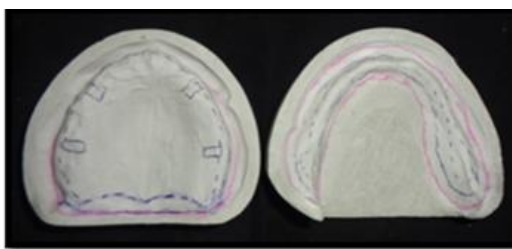


Fig.2 Primary Cast



Fig.3: Final Impression



Fig.4: Master Cast



Fig.5: Jaw relation

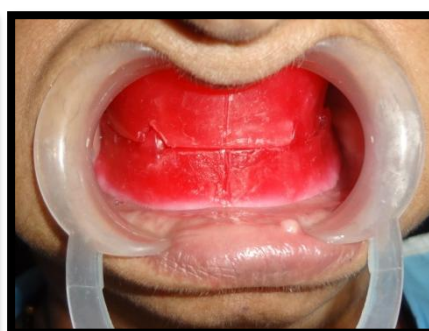


Fig.6: Face bow transfer



Fig.7: Teeth arrangement



Fig.8: Denture Insertion.

Surgical Stent fabrication procedure¹⁵:

Then radiographic template was made which is an exact duplication of the provisional restoration and can be used during the CT scan. First the original dentures is duplicated by making an impression of it in the dental plaster, by doing the flasking procedure.(Fig.9-10). After the plaster is set, the counter flask is opened and then the denture is removed. Then the impression of the teeth is covered by wax (Fig.11-12) and the radiopaque resin is placed and it is kept to set for a day. Then the flask is opened the next day and the radiopaque denture base is obtained, and then it is trimmed.(Fig.13-14). After that the wax is removed and then the other ratio is mixed for the teeth and placed in the flask with the radiopaque denture base. Then it is opened after 24 hours.

The resulting denture obtained is the radiopaque dentures- maxillary and mandibular (Fig.15). Then the mandibular denture was sectioned on the lingual flange from canine to canine region (Fig.16) for easy visualization of the surgical site. The radiopaque resin is obtained by mixing 40% of barium sulphate Barium sulphate (MERCK, Mumbai, India) into 60% resin polymer. This ratio of powder is then mixed with the autopolymerising resin monomer. This ratio was obtained for the denture base. The reduced ratio of 50% of barium sulphate and 60% resin polymer was used for the denture teeth, to make it more radiopaque, so the difference can be appreciated in the CT scan.



Fig.9: Duplication Of Maxillary denture



Fig.10: Duplication Of Mandibular denture



Fig.11: Modeling wax poured on poured on mandibular



Fig.12: Modeling wax occlusal surface maxillary occlusal surface



Fig.13: Surgical stent mandibular denture base



Fig.14: Surgical stent maxillary denture base



Fig.15: Surgical Stent



Fig.16: Surgical Stent cut lingually from canine to canine region

CT Scan Procedure¹⁶: Two CT scans were made of the same patient by the CT scan machine (Seimens,USA), first while no dentures were in the mouth and second with the radiopaque dentures in mouth with occlusion (Fig..17a). After the images were obtained the measurements were done in the CT scans.

Phase. 2: After placement of implant converting conventional complete denture into implant retained overdenture. After evaluating the masticatory efficiency of the conventional complete denture. Patients were scheduled for presurgical procedures for implant placement. A routine hemogram, blood sugar, renal function test and ECG were done. Denta scan was done before the surgical procedure to evaluate the bone height, the width and the length of the denture teeth, so that the implant size could be planned (Fig.18). Also the width of the alveolar crest at the site of implant placement was confirmed by the ridge mapping procedure. First the location was again confirmed on the dental scan and then by placing the surgical stent which was fabricated. The pilot hole was made by the initial drill through the patient's mandibular surgical stent. The implant used was of Biogenesis. There were 5 different sizes of the implants used of Biogenesis for 5 patients, the details are mentioned in a table below.

Table.1: Dimensions Of Implants Used

SR. No.	Diameter (mm)x Length (mm) for 33	Diameter (mm) x Length (mm) for 44
1	4.0 x 12mm	3.5 x 12mm
2	3.5 x 10mm	4.0 x 11.5mm
3	4.0 x 10mm	4.5 x 10mm
4	4.0 x 10mm	4.0 x 10mm
5	3.5 x 10mm	3.5 x 10mm

The implant type chosen was biogenesis implant titanium with rough microtextured surface (RMS) treatment and single threaded tapering design. The Physio Dispenser Unit (Setellac) was set at 1620 rpm as per manufacturers' instructions. First stage surgery was done. Once the site of the implant placement was finalized the patient was scheduled for surgery. Single dose of prophylactic antibiotic (2g amoxicillin or 600mg clindamycin) was given orally 1 hr before the surgery.¹⁷ A mouthrinse (Chlorhexidine 0.2%, Colgate, uf, India) was given 1 min prior to local anesthetic. Bilateral inferior alveolar nerve block and local infiltration in the buccal and lingual sulcus was administered with lignocaine 2% with 1:80,000 adrenalin. (Nircain- ADR, India). A minimal crestal incision was made and a mucoperiosteal flap was raised both on the labial and lingual aspects to enable adequate visualization of the lingual aspect of the mandible and to evenly divide the available keratinised tissue (Fig.19). The surgical stent was placed in the patient's mouth (Fig.20) and the pilot drill of 2.7mm (Fig.21) was placed, then it was removed and the progressive drill was placed. Drills were used in sequence of second drill of 3.0, third drill of 3.3mm, fourth drill of 3.6mm and final drill of 3.8mm was used. Final length was verified using depth gauge and positions were verified by paralleling pins (Fig.22). Then implant of the selected diameter was inserted into the prepared implant site using the torque wrench till the implant neck was at the crestal bone (Fig.37). A cover screw (Fig.23) was placed using nylon sutures (Deme Tech sutures, Nylon material) to approximate the flap. OPG was taken after implant placement. The denture was then relined around the bilateral canine regions where the implants were placed with tissue conditioner (Fig. 24). Patient was recalled after 1 week for removal of sutures and the healing was checked. The patient was then recalled for second stage surgery after 4 months. The suture site was reopened at the bilateral canine region. Again following the same protocols of surgery. Local infiltration was given, then crestal incision was made and then the cover screw was removed. Then gingival former were placed according to the implant size (Fig.25). Then sutures were given bilaterally on the surgical sites. The collar height of the gingival former was measured for the abutment placed. Then patient was recalled after 1 week for suture removal. Then after another 1 week, the gingival former was removed. After removal of the gingival former using the driver, the stud abutments were placed and tightened (Fig.26). Then the O-ring pick up was done (Fig.27). First the O rings were placed in the stud abutments. The tissue conditioner was removed from the conventional denture. The area was marked on the denture and then place was made for the metal housing to be incorporated. Autopolymerising acrylic resin was mixed and loaded in the space created in the denture at the dough stage and the metal housing was pushed in it. Then it was placed in the patient's mouth and the patient was told to close in occlusion. Then it was removed from the mouth in rubbery stage. Then the excess acrylic was trimmed off. Then an OPG was taken for verification of the stud abutments (Fig.28). The dentures were finished and polished again and then were given to the patient (Fig.29). After 1 week the EMG was done again to check the masticatory efficiency with the implant retained overdenture as described above in EMG measurement procedure.

For Group.2 patients: were evaluated for bilateral mandibular canines.

Phase 3: Fabrication of root supported overdenture: First all the patients were screened and included according to the inclusion criteria. The patient was evaluated for the endodontic and periodontal status of the remaining teeth. After the root canal treatment of 33 and 43, the teeth were reduced to a convex contour about 1-2 mm above the gingival margin⁴⁴ (Fig.30). Followed by fabrication of root supported overdenture. It is same as

described above in the complete denture fabrication procedure. 1 week after this treatment also EMG was recorded during clenching and mastication as described above in the EMG measurement procedure.

Phase 4: Fabrication of root supported attachment retained overdenture: After a week, the same patient in which root supported overdenture was fabricated, was recalled to carry out the placement of attachments access post (EDS, USA) in 33 and 43. 6mm of gutta purcha was removed from the root canal from gates gliden drill and was confirmed by making IOPA. The space for post was created by using primary reamer drill. After that the second tier of the space was made by the use of a countersink drill¹⁹ (Fig.31). Then the pre fabricated metal post was cemented (Fig.32) by flowable composite resin (NexCom Flow,Mumbai, India). Later in the denture the space was created and the O-rings were picked-up by self cure resin (Fig.33). An OPG was taken after the placement of the stud attachments for the verification of the parallelism (Fig.34). Attachment retained overdentures was delivered and post insertion instruction was given (Fig.35). Patient was recalled after 1 week to evaluate the abutments and periodontal tissues. Following this also an EMG activity was done during clenching and mastication as described above in the EMG measurement procedure. This was done with all the patients and post operative OPG was taken.

EMG Measurements procedure²⁰: The EMG machine (Seimens, USA) was used (Fig.36). The disc surface electrode of the EMG was used of 10mm diameter of AgCl material was used (Fig.37). The first procedure was done while clenching of two muscles first the massster muscle was palpated over the center of the fleshiest part of the superficial partion of the muscle. The hypotenuse of the triangle was placed on the Camper line, with the right angle facing downward. The line representing the height of a triangle (line vertical to the hypotenuse, connecting the right angle and the middle of the hypotenuse) was placed on the tragus of the ear (Fig.38) and then the temporalis was palpated by the triangle's hypotenuse was placed parallel to and above the Camper's line, with the right angle facing downwards. The center of the hypotenuse was placed at the point where the temporal line crossed the zygomatic process of the frontal bone at the level of the supraorbital margin then the patient was told to clench (Fig.39). This was done separately for the EMG measurements. Then the reference electrode and the measuring electrode were attached to the muscle by white tape. Prior to the electrode attachment, the skin was carefully degreased with alcohol and the electrode gel was applied. Recordings were done 5 to 6 minutes later, which allowed the conductive paste to adequately moisten the skin surface. Then the ground electrode was placed around the left forearm (Fig.40). Then by the help of the software the activity of the masseter and temporalis was seen in the maximum voluntary contraction (MVC) was seen while the patient had the denture in the mouth in the clenched position. This was done of the left side then on the right side separately. Then the second procedure was done while mastication. Again the muscles were palpated and the electrode was attached on the respective two muscles masseter and temporalis on both the sides. Then the patient is given the standard food material that is peanuts of 10grams, to be chewed for 1mins for 20 chewing strokes. Then the EMG is started and then the results are shown in the software. The peak to peak amplitude of the muscle activity is seen. This procedure was done after doing all the treatments.

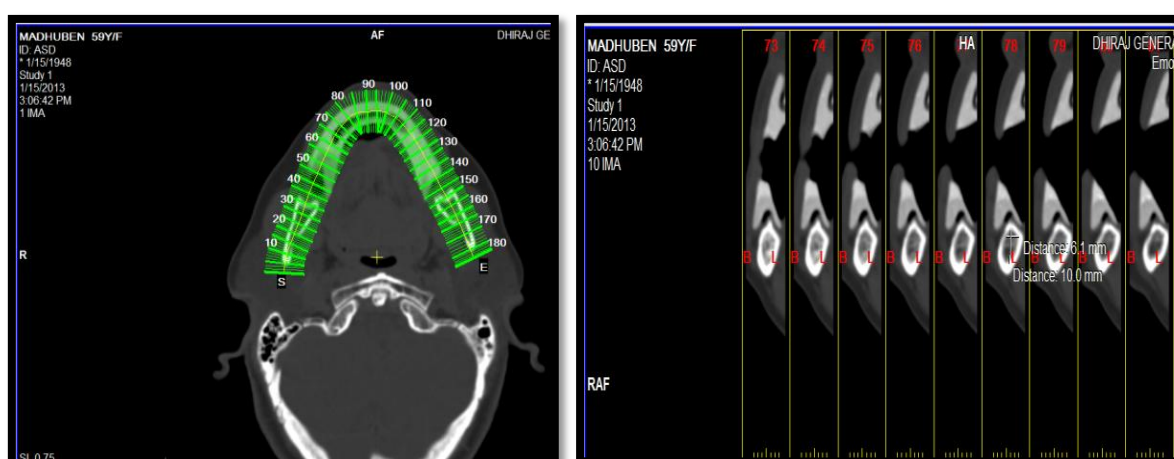


Fig.17a,b: Ct Scan - Coronal And Axial Slices.

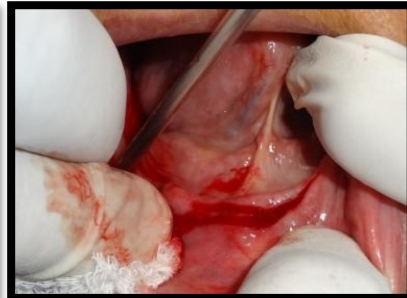
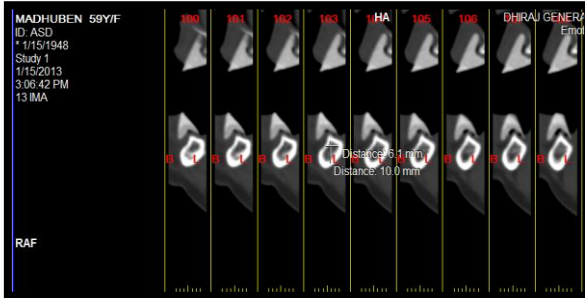


Fig.18: showing implant of 6x10 mm in 33 and 6X10mm in 43 **Fig.19:** Crestal incision

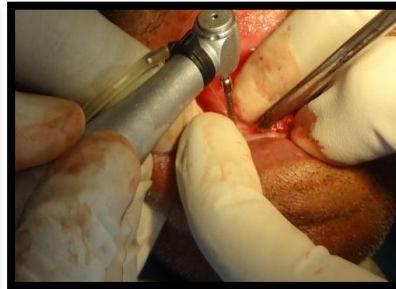


Fig.20: Placement of surgical stent to view the location **Fig.21:** Pilot drill

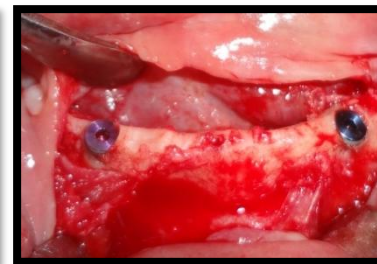


Fig.22: Paralleling pins

Fig.23: Cover screw in place

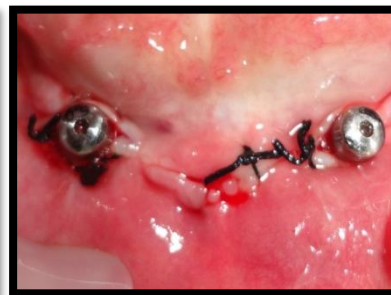


Fig.24: Denture relined in place

Fig.25: Gingival former from canine to canine region



Fig.26: Stud abutments Housing & O rings

Fig.27: Pickup of in place

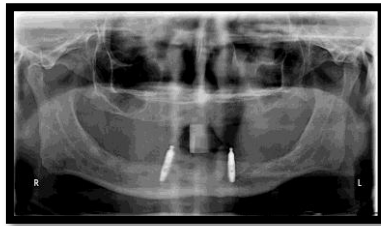


Fig.28: OPG after stud abutments overdenture in occlusion



Fig.29: Implant supported in place



Fig.30: Teeth were reduced to 1-2 mm above the gingival margin



Fig.31: Space created for attachment post



Fig.32: Accesspost cemented



Fig.33: O rings were picked up by self cure resin

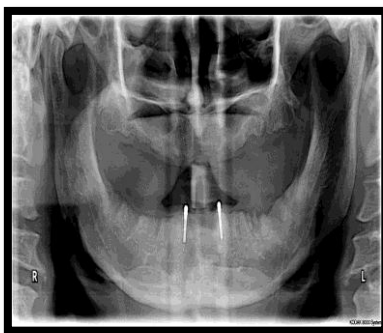


Fig.34: OPG of stud overdenture in occlusion

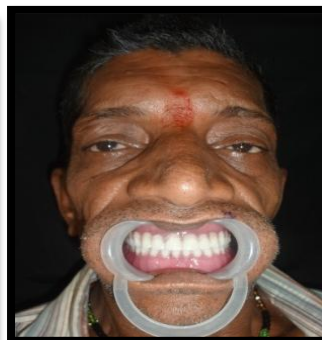


Fig.35: Attachment retained

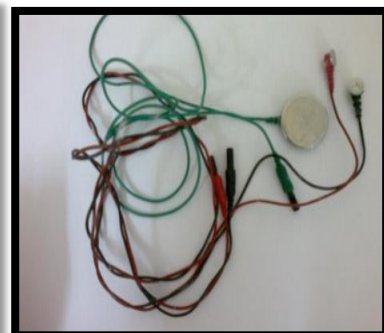


Fig.36: surface electrode attachments in place



Fig.37: EMG machine



Fig.38: EMG of Temporalis



Fig.39: EMG of Masseter

III. Observations & Results

Table.2: Group.1- Emg Values During Clenching In (μv)

No	CONVENTIONAL COMPLETE DENTURE				IMPLANT RETAINED OVERDENTURE			
	MASSETER		TEMPORALIS		MASSETER		TEMPORALIS	
	L	R	L	R	L	R	L	R
1.	457	387	443	400	9,216	8,582	9,234	8,845
2.	500	390	450	420	8,969	8,756	9,089	8,856
3.	467	389	430	417	9,808	8,677	9,001	8,877
4.	490	344	432	413	9,814	8,500	9,211	8,676
5.	499	383	451	412	9,713	8,517	9,312	8,777

The clenching values are shown as EMG values for the 5 patients which are tabulated. The left and right values for each patient are mentioned in relation to masseter and temporalis for both treatments.

Table. 3: Group. 2- Emg Values While Clenching In (μv)

No	CONVENTIONAL ROOT SUPPORTED OVERDENTURE				ROOT SUPPORTED ATTACHMENT RETAINED OVERDENTURE			
	MASSETER		TEMPORALIS		MASSETER		TEMPORALIS	
	L	R	L	R	L	R	L	R
1	500	323	412	367	710	550	656	594
2	527	410	480	550	740	650	701	700
3	509	579	531	688	759	701	742	700
4	510	400	490	600	700	550	710	751
5	513	530	500	580	740	689	710	695

The clenching values are shown as EMG values for the 5 patients which are tabulated. The left and right values for each patient are mentioned in relation to masseter and temporalis for both the treatments.

Table.4: Group.1- Emg Values During Mastication In (μv)

No	CONVENTIONAL COMPLETE DENTURE				IMPLANT RETAINED OVERDENTURE			
	MASSETER		TEMPORALIS		MASSETER		TEMPORALIS	
	L	R	L	R	L	R	L	R
1	788	774	701	760	17,726	17,019	17,199	17,343
2	802	780	723	879	16,987	17,013	17,999	16,877
3	799	788	725	743	17,879	17,223	16,789	17,455
4	762	777	800	762	17,900	17,355	17,877	17,588
5	783	812	767	788	17,982	17,455	16,900	17,788

The mastication values are shown as EMG values for the 5 patients which are tabulated. The left and right values for each patient are mentioned in relation to masseter and temporalis for both the treatment.

Table.5: Group.2-Emg Values During Mastication In (μv)

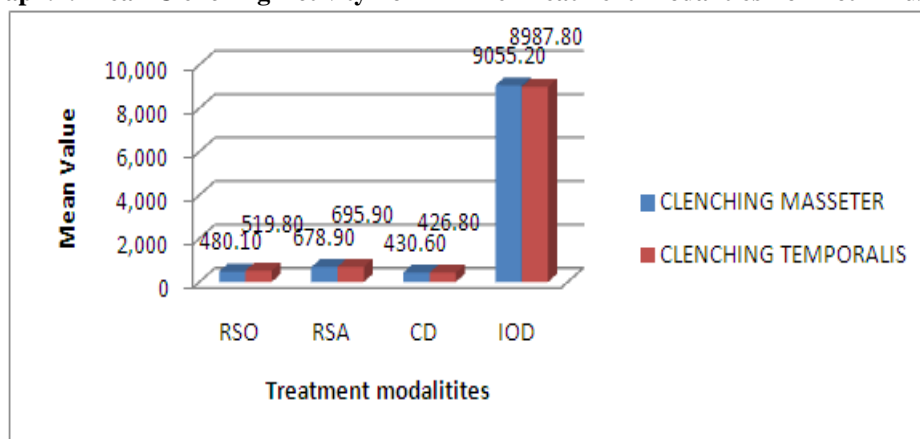
No	CONVENTIONAL ROOT SUPPORTED OVERDENTURE				ROOT SUPPORTED ATTACHMENT RETAINED OVERDENTURE			
	MASSETER		TEMPORALIS		MASSETER		TEMPORALIS	
	L	R	L	R	L	R	L	R
1.	1188	1219	1002	1150	1947	1436	1478	1415
2.	1351	1024	1221	1408	1814	1893	1932	1850
3.	1107	1125	1234	1096	1623	1601	1976	1930
4.	1201	1112	1125	1304	1701	1505	1585	1701
5.	1150	1110	1200	1250	1650	1500	1700	1750

The left and right values for each patient are mentioned in relation to masseter and temporalis for both the treatments.

Table.6: Mean Values Of All Treatment Groups For Clenching

	CLENCHING MASSETER	CLENCHING TEMPORALIS
RSO	480.10	519.80
RSA	678.90	695.90
CD	430.60	426.80
IOD	9055.20	8987.80

Graph.1: Mean Clenching Activity For All The Treatment Modalities For Both Muscles

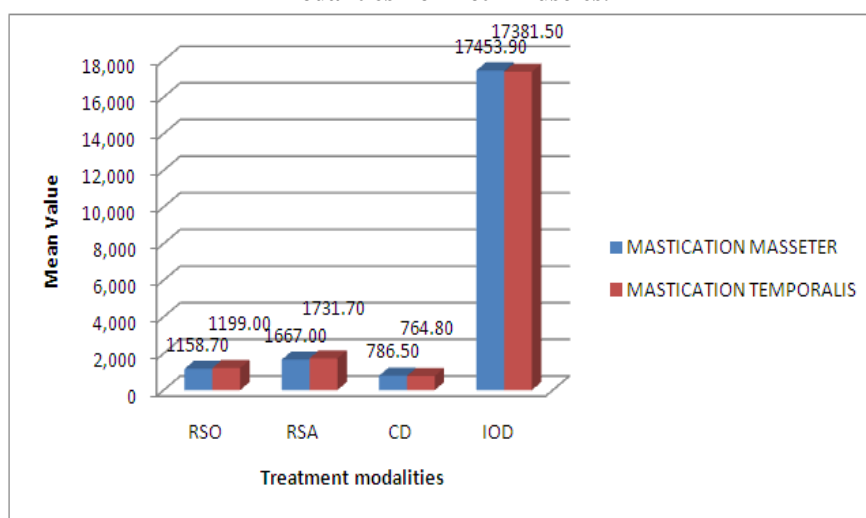


Graph.1: shows the highest clenching activity was seen in the IOD group with the values of masseter and temporalis- 9055.20 ± 166.25 and 8987.80 ± 51.15 was the highest, then was RSA group with values of masseter and temporalis- 678.90 ± 48.56 and 695.90 ± 18.60 , then was RSO group with values of masseter and temporalis- 480.10 ± 53.07 and 519.80 ± 80.76 , and the lowest with CD group with the values of masseter and temporalis- 430.60 ± 12.05 and 519.80 ± 6.06 .

Table.7: Mean Values Of All Treatment Groups For Mastication

	MASTICATION MASSETER	MASTICATION TEMPORALIS
RSO	1158.70	1199.00
RSA	1667.00	1731.70
CD	786.50	764.80
IOD	17453.90	17381.50

Graph.2: Mean Mastication Activity For All The Treatment For All The Treatment Modalities For Both Muscles.



Graph.2: shows the highest mastication activity was seen in the IOD group with the values of masseter and temporalis- 17453.90 ± 283.83 and 17381.50 ± 227.68 was the highest, then was RSA group with values of masseter and temporalis- 1667.00 ± 112.88 and 1713.70 ± 202.24 , then was RSO group with values of masseter and temporalis- 1158.70 ± 37.04 and 1199.00 ± 87.38 , and the lowest with CD group with the values of masseter and temporalis- 786.50 ± 11.29 and 764.80 ± 31.06

Table.8 : Descriptive Statistics For Clenching Masseter

Shows the combination of paired and unpaired t-test. Paired t-test was done for RSO with RSA clenching masseter and CD with IOD clenching masseter. Unpaired t-test was done for the rest of the treatment modalities.

	N	Mean	SD	Std. Error	Minim.	Maxim.	Mean Diff.	p value
1.RSO CLENCHING MASSETER	5	480.10	53.07	23.74	411.50	544.00	-198.8	.015
RSA CLENCHING MASSETER	5	678.90	48.56	21.72	625.00	730.00		
2.RSO CLENCHING MASSETER	5	480.10	53.07	23.74	411.50	544.00	49.50000	.824
CD CLENCHINGMASSETER	5	430.60	12.05	5.39	417.00	445.00		
3.RSO CLENCHING MASSETER	5	480.10	53.07	23.74	411.50	544.00	-8575.1	<0.0001
IOD CLENCHING MASSETER	5	9055.20	166.25	74.35	8862.50	9242.50		
4.RSA CLENCHING MASSETER	5	678.90	48.56	21.72	625.00	730.00	248.3	.003
CD CLENCHINGMASSETER	5	430.60	12.05	5.39	417.00	445.00		
5.RSA CLENCHING MASSETER	5	678.90	48.56	21.72	625.00	730.00	-8376.3	<0.0001
IOD CLENCHING MASSETER	5	9055.20	166.25	74.35	8862.50	9242.50		
6.CD CLENCHING MASSETER	5	430.60	12.05	5.39	417.00	445.00	-8624.6	<0.0001
IOD CLENCHING MASSETER	5	9055.20	166.25	74.35	8862.50	9242.50		

This table shows the clenching activity with the masseter for all the treatment modalities. Highly statically significant EMG values were obtained by RSO with IOD, RSA with IOD and CD with IOD the values were <0.0001. . Statically significant results were with RSO with RSA and RSA with CD, which were 0.015 and 0.003 respectively. However RSO and CD results were statically not significant, the value is 0.

Table.9: Descriptive Statistics For Mastication With Masseter

Shows the combination of paired and unpaired t-test. Paired t-test was done for RSO with RSA mastication masseter and CD with IOD mastication masseter. Unpaired t-test was done for the rest of the treatment modalities.

	N	Mean	SD	Std. Error	Minim.	Maxim.	Mean Diff.	p value
1.RSO CLENCHING TEMPORALIS	5	519.80	80.76	36.12	389.50	609.50	-176.10	<0.0001
RSA CLENCHING TEMPORALIS	5	695.90	41.59	18.60	625.00	730.50		
2.RSO CLENCHING TEMPORALIS	5	519.80	80.76	36.12	389.50	609.50	93.00	.054
CD CLENCHING TEMPORALIS	5	426.80	6.06	2.71	421.50	435.00		
3.RSO CLENCHING TEMPORALIS	5	519.80	80.76	36.12	389.50	609.50	-8468.00	<0.0001
IOD CLENCHING TEMPORALIS	5	8987.80	51.15	22.88	8939.00	9044.50		
4.RSA CLENCHING TEMPORALIS	5	695.90	41.59	18.60	625.00	730.50	269.10	<0.0001
CD CLENCHING TEMPORALIS	5	426.80	6.06	2.71	421.50	435.00		
5.RSA CLENCHING TEMPORALIS	5	695.90	41.59	18.60	625.00	730.50	-8291.90	<0.0001
IOD CLENCHING TEMPORALIS	5	8987.80	51.15	22.88	8939.00	9044.50		
6.CD CLENCHING TEMPORALIS	5	426.80	6.06	2.71	421.50	435.00	-8561.00	<0.0001
IOD CLENCHING TEMPORALIS	5	8987.80	51.15	22.88	8939.00	9044.50		

This table shows the mastication activity with the masseter for all the treatment modalities. Highly statically significant EMG values were obtained by RSA with RSO, RSO with IOD, RSA with CD, RSA with IOD, CD with IOD the values were <0.0001. Statically significant results were with RSO and CD, which were 0.007.

Table.10: Descriptive Statistics For Clenching With Temporalis

Shows the combination of paired and unpaired t-test. Paired t-test was done for RSO with RSA clenching temporalis and CD with IOD clenching temporalis. Unpaired t-test was done for the rest of the treatment modalities.

	N	Mean	SD	Std. Error	Minim.	Maxim.	Mean Diff.	p value
1.RSO MASTICATION MASSETER	5	1158.70	37.04	16.57	1116.00	1203.50	-508.30	<0.0001
RSA MASTICATION MASSETER	5	1667.00	112.88	50.48	1575.00	1853.50		
2.RSO MASTICATION MASSETER	5	1158.70	37.04	16.57	1116.00	1203.50	372.20	.007
CD MASTICATION MASSETER	5	786.50	11.29	5.05	769.50	797.50		
3.RSO MASTICATION MASSETER	5	1158.70	37.04	16.57	1116.00	1203.50	-16295.2	<0.0001
IOD MASTICATION MASSETER	5	17453.90	283.83	126.93	17000.00	17718.50		
4.RSA MASTICATION MASSETER	5	1667.00	112.88	50.48	1575.00	1853.50	880.50	<0.0001
CD MASTICATION MASSETER	5	786.50	11.29	5.05	769.50	797.50		
5.RSA MASTICATION MASSETER	5	1667.00	112.88	50.48	1575.00	1853.50	-15786.9	<0.0001
IOD MASTICATION MASSETER	5	17453.90	283.83	126.93	17000.00	17718.50		
6.CD MASTICATION MASSETER	5	786.50	11.29	5.05	769.50	797.50	-16667.4	<0.0001
IOD MASTICATION MASSETER	5	17453.90	283.83	126.93	17000.00	17718.50		

This table shows the clenching activity with temporalis for all the treatment modalities. Highly stastically significant EMG values were obtained by RSO with RSA, RSO with IOD, RSA with CD, RSA with IOD and CD with IOD the values were <0.0001. However RSO and CD results were stastically not significant, the value is 0.054.

Table.11: Descriptive Statistics For Mastication With Temporalis

Shows the combination of paired and unpaired t-test. Paired t-test was done for RSO with RSA mastication temporalis and CD with IOD mastication temporalis. Unpaired t-test was done for the rest of the treatment modalities

	N	Mean	SD	Std. Error	Minim.	Maxim.	Mean Diff.	p value
1.RSO MASTICATION TEMPORALIS	5	1199.00	87.38	39.08	1076.00	1314.50	-532.70	<0.0001
RSA MASTICATION TEMPORALIS	5	1731.70	202.24	90.44	1446.50	1953.00		
2.RSO MASTICATION TEMPORALIS	5	1199.00	87.38	39.08	1076.00	1314.50	434.20	.003
CD MASTICATION TEMPORALIS	5	764.80	31.06	13.89	730.50	801.00		
3.RSO MASTICATION TEMPORALIS	5	1199.00	87.38	39.08	1076.00	1314.50	-16182.50	<0.0001
IOD MASTICATION TEMPORALIS	5	17381.50	227.68	101.82	17122.00	17732.50		
4.RSA MASTICATION TEMPORALIS	5	1731.70	202.24	90.44	1446.50	1953.00	966.90	.003
CD MASTICATION TEMPORALIS	5	764.80	31.06	13.89	730.50	801.00		
5.RSA MASTICATION TEMPORALIS	5	1731.70	202.24	90.44	1446.50	1953.00	-15649.80	<0.0001
IOD MASTICATION TEMPORALIS	5	17381.50	227.68	101.82	17122.00	17732.50		
6.CD MASTICATION TEMPORALIS	5	764.80	31.06	13.89	730.50	801.00	-16616.70	<0.0001
IOD MASTICATION TEMPORALIS	5	17381.50	227.68	101.82	17122.00	17732.50		

. This table shows the mastication activity with the temporalis for all the treatment modalities. Highly stastically significant EMG values were obtained by RSO with RSA, RSO with IOD, RSA with IOD and CD with IOD the values were <0.0001. Stastically significant results were with RSO with CD and RSA with CD, which were 0.003 with both.

IV. Discussion

The rehabilitation of edentulous patients is one of the main challenges in Dentistry, especially for the mandibular arch. Besides retention and stability problems, masticatory function in subjects with conventional dentures is poor. However, with oral rehabilitation with mandibular implant retained overdentures, masticatory function improves. The best method to check the masticatory efficiency is the Electromyography. Since, no comparison has been done on all four treatment modalities chosen for this study, a need to evaluate the masticatory efficiency was felt. The sample size was fixed at 5 per group, achieve 80% power to detect a difference of 20 between the null hypothesis that both the group means are and estimated group standard

deviations of 10 and with a significant level (alpha) of 0.05 using a two-sided two sample t- test. An OPG covers both the maxilla and mandible, which makes it ideal for the detection of pathoses as well as anatomic limitations for implant placement. This initial radiograph may rule out certain sites for implant placement and thus save the patient further cost and radiation exposure from additional imaging.¹⁶ CT scan¹⁶ was done in this study because on the scan, the template made in this study appears as a radiopaque structure. According to the anticipated implant position, the vertical CT views are selected from the horizontal CT overview. The vertical CT views provide a 1:1 image and are best for planning the length and diameter as well as angulation of placement of the implants. The two implant overdenture was used since it provides a satisfactory treatment outcome without the added treatment of two additional implants and interconnecting bar attachments. The two independent abutments require less space in the denture base, and data from another study²¹ demonstrated that they are easier to clean than those with a bar. The ball attachment are less expensive, require less chairtime⁹, less technical expertise and will probably provide the same initial level of patient satisfaction. Magnetic attachments were not used as the magnetic force tends to deteriorate as the time progresses.²² An advantage of chairside pick-up of O-ring is that it avoids potential distortions associated with the clinical and laboratory procedures during overdenture fabrication, ensuring acceptable fit of the overdenture.²³ In literature, there are various studies which are done on different number of implants and types of prosthesis. Six studies presented data of the implant survival rate which ranged from 95% to 100% for 2 and 4 implant group and 81% for 1 implant group.²⁴ The most common type of prosthetic maintenance and complications were replacement or reattaching of loose clips for 4 implants and denture repair due to fracture around 1 implant group. The 3 implant placement in implant supported mandibular overdenture showed moderate stress accumulations, as a photoelastic stress analysis was done.²⁵ Traditionally, mandibular overdenture supported by two or four implants and connected abutments have shown high success rates with significant improvement in patient oral comfort and function.²⁶ Donatsky in a study,²⁷ reported a success rate of 97% to 98% with a prosthesis function rate of 100% with separate ball attachment-retained mandibular overdentures. According to Liu et al,²⁸ the EMG activity of the masticatory muscles at rest was higher in individuals with stomatognathic system dysfunctions compared with healthy individuals. The reason for canine being included in the study is that they most richly innervated and sensitive amongst all teeth, have long triangular roots they are retained in the system for longer duration, a relatively large root surface, with great periodontal attachment and also a wider attached epithelium.²⁹ However, to improve the benefits of overdenture, attachments were used to enhance retention of the prosthesis. Accessposts are stud attachments that work well with overdentures. They occupy a small vertical space and the male units on the different roots do not require absolute parallelism. The ball and socket attachment of Accesspost allows rotation of the denture attachment. As EMG is the best proven method so it was done in this study. EMG is the recording of action potential from motor units.³⁰ In the surface electrode EMG which is done in this study checks the peak to peak amplitude of the muscle. As the muscle contraction increases, the muscle gives a higher EMG values and works better. There is an increase in the EMG values if the retention is better, if the prosthesis functions better or also if the muscle works better. Hence, better readings are obtained. Analysis of masseter and temporalis muscles permits determining muscle activity during function. The present surface EMG analysis of both static (clenching) and dynamic (chewing) procedures were taken into account due to it being the combination of the masticatory efficiency.³¹ In this study peanuts were choose as the standard food material because they are nonsynthetic, relatively hard, popular, swallowable and represent a test food used in previous studies of mastication. The reasons for evaluating the 2 muscles only are firstly as these are one of the two muscles of mastication, and as these are the muscles which are not deep and can be palpated and so their function can be recorded by the surface EMG. However in the literature there are certain comparison done with complete denture and implant supported prosthesis patients. But, no comparison is done of the masticatory efficiency with EMG activity with all the different types of prosthesis that is complete denture, overdenture, attachment retained overdenture and implant supported overdenture. Thus the null hypothesis was rejected and the alternate hypothesis is that there is difference in the masticatory efficiency between the four treatment modalities during two procedures is accepted.

In the present study, EMG results were calculated in (μ V) with the average of the results obtained from the left and right masseter and temporalis muscles. The EMG mean values of the clenching of masseter in (μ V) for CD is 430.6, for IOD is 9055.2, RSO is 480.10, for RSA is 678.9 and EMG mean values of the clenching of temporalis in (μ V) for CD is 426.8, for IOD is 8987.8, RSO is 519.8, for RSA 695.9. EMG mean values of the mastication of masseter in (μ V) for CD is 786.5, for IOD is 17453.9, for RSO is 1158.7, for RSA is 1667.0. EMG mean values of the mastication of temporalis in (μ V) for CD is 764.8, for IOD is 17381.5, for RSO is 1199.0, 1731.70. Highest values were seen with IOD and lowest with seen with CD. Elderly patients exhibited significantly lower maximum EMG voltage than the other groups of subjects. This is mainly due to a late and progressive weakening of masticatory muscle that takes place with ageing. Ageing seems to modify the neuromuscular controls involved in mastication³². In tooth supported overdenture, the remaining canine teeth are important to keep the chewing ability of the elders. Maintenance of natural teeth in the older population is

therefore essential to maintain a high level of the quality of life. In complete denture wearers, mucosal exteroceptors seem to play a particularly important role, since chewing with dentures favours their stimulation.³¹ The mucosal receptors take over and the functional role of the lost periodontal receptors. So the muscles are not able to function as properly as they were before. IOD exhibited highest EMG values. It has been suggested that implant-supported prostheses may activate remote proprioceptors through the transmission of vibrations via the facial bone. Finally the mucosal support of the implant supported overdentures offers additional neural input through stimulation of the mucosal exteroceptors which seem to take over, to some extent, the role of the lost periodontal receptors. Hence there is a higher muscle activity.

The results of this study was in accordance with the study done by Cune³³. In this study the masticatory efficiency was checked by EMG activity for implant supported overdenture with different attachment systems and of complete denture. There was a remarkable difference in the ratio between temporalis and masseter muscle activity for implant supported overdentures. The temporalis muscle activity was significantly lower than the masseter activity when the subjects clenched with a complete denture. A study done by Bilt¹³, observed the muscle activity during chewing of soft food which significantly did not increase between the old complete denture and the implant-supported new denture. However, the masticatory performance of this group of subjects significantly improved after implant treatment. A study done by Kawazoe³⁴ did a comparative mean evaluation of electrical activity values of the masseter muscles and the temporalis muscles during the tooth clenching test, after five months of having the new complete dentures. The masseter works better and even according to Lippold³⁵, the mean electrical activities recorded as the surface of the muscles increases with the force of muscular contraction. However the temporalis showed reduced activity. Study by Feine³⁶ shows the surface EMG analysis of both static (clenching) and dynamic (chewing) tasks showed that mandibular fixed implant-supported prosthesis and implant overdentures were functionally equivalent. Also, during the chewing task both types of prosthetic reconstruction were inferior to natural dentitions. In the study done by Bilt,³⁷ there was an increase in masticatory function when the implant supported overdenture was compared with complete denture. Maximum bite force doubled after the mandibular denture was attached to the implants. A recent long-term study by Heckmann³⁸ on neuromuscular adaptation after implant-treatment reported an increase in myodynamic and EMG parameters approaching the values for normal dentate subjects. In a study done by Karkazis³⁹ found that the masseter muscle activity for hard foods was greater than for soft foods. In this study, 1 g peanut was chosen as a standard food material. The mean EMG values obtained while chewing peanuts were higher than the values obtained while chewing other standard softer food materials, for both temporalis and masseter muscles and also for complete dentures and implant supported denture. Grubwisers et al⁴⁰ reported that the masseter EMG generally shows higher potentials and is therefore more significant compared with the values for the temporalis muscle. Another research by Tekamp,⁴¹ showed that overdentures wearers have masticatory conditions more similar to that of dentate individuals than complete dentures wearers. In the study done by Tallgren et al,⁴² observed the EMG activity of the masseter and temporalis muscles of 21 patients. Masticatory efficiency was highest for implant-supported overdentures, followed by subjects with overdentures supported by natural teeth, then complete denture wearers.

V. Conclusion

Results indicated a statistically significant difference in the masticatory efficiency between the four treatment modalities ($P < 0.0001$). The result showed that the two implant supported overdenture showed the best EMG activity ($P < 0.001$), followed by attachment retained overdenture, then the root supported overdenture and lastly was complete denture group. The possible limitations that can be proposed in the study are an unequal distribution of patients with respect to gender in each group: group.1 M:F- 1:4 and in group.2 M:F- 4:1. Longer term evaluation may be better for confirming the masticatory efficiency. A comparison could have been done on comparing the best direct method that is sieve method and EMG, to get more precise results. Further studies can be conducted on comparing all treatment modalities with the EMG activity to find out the significance and doing a QOL survey. Within the limitation of the study, it can be inferred that placing two implants in the mandibular canine region improves the masticatory efficiency, given so many benefits, in the long term, with favourable results and comparisons. The result of this study correspond well with the McGill Consensus Statement,⁴³ on Overdentures, which concluded that restoration of the edentulous mandible with a CD is no longer the most appropriate first-choice prosthodontic treatment, but that there is currently enough evidence to support the concept that a 2-implant overdenture should become the first choice of treatment for patients with an edentulous mandible.

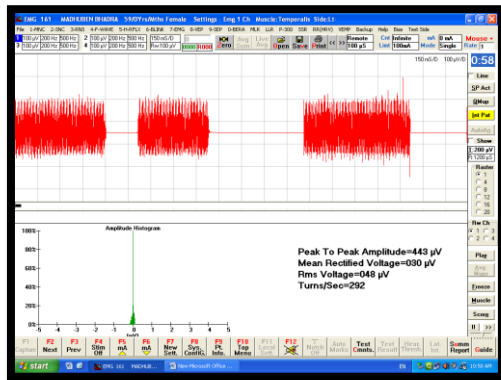


Fig.41: EMG of Complete denture

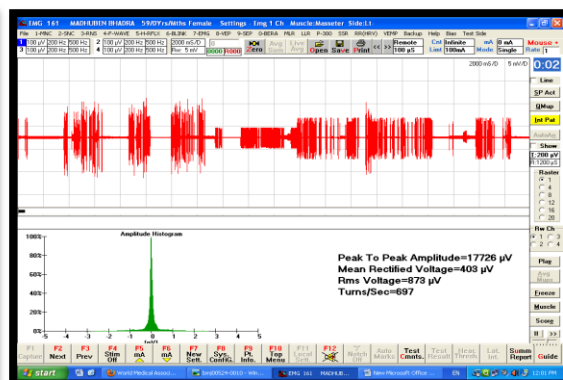


Fig.42: EMG of Implant supported overdenture

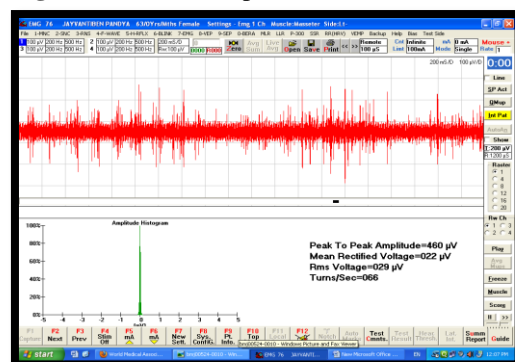


Fig.43: EMG of root supported overdenture

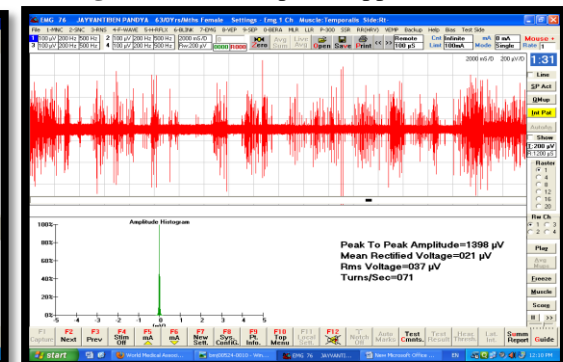


Fig.44: EMG of Attachment retained overdenture

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