ORIGINAL ARTICLE

Assessment of Masticatory Efficiency in Shortened Dental Arch with and without Removable Partial Dentures

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OBJECTIVE: The objective of this study was to compare masticatory efficiency of shortened dental arch subjects before and after insertion of removable partial denture.

METHODOLOGY: A total of 66 patients fulfilling the inclusion criteria were enrolled in the study. Masticatory efficiency and performance were evaluated with the help of sieve method before and after insertion of removable partial denture based on a procedure described by Gunne.[9] The masticatory efficiency ratio was determined as volume of raw carrot that passed through sieve divided by total volume of raw carrot recovered and was expressed as percentage.

RESULTS: The mean value of pre-treatment masticatory performance of the patients was 34.66 ± 2.96 while the mean value of post-treatment masticatory performance of the patients was 53.98 ± 45.91 (p-value=<0.001). The mean change from pre and post treatment of masticatory performance of the patients was 19.32 ± 3.03.

CONCLUSION: According to this study there is significant improvement in masticatory performance after provision of removable partial denture in patients with shortened dental arches.

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INTRODUCTION

Effectiveness of masticatory function is one of the prime objectives in prosthetic rehabilitation of partially dentate patients. The ability to masticate effectively is not only a reflection of a healthy stomatognathic system but has also been associated with good general physical health. Masticatory performance is known as the percentage distribution of food particles size when masticated for a particular no. of strokes.[9] Primary determinants of masticatory efficiency in subjects having natural teeth are number and size of teeth in contact. Occluding surfaces of teeth determine the total surface area accessible for grinding and shearing of food during every single cycle of chewing.[1] Minimum total of teeth required for functional demands of mastication are 8 premolars and 4 molars.[2] 1st molars provide greatest effective occlusal contact area that is 36.7% for masticatory performance. The 2nd and 3rd molar provide 27.9 and 15.4 % occlusal contact area respectively.[3] The concept of shortened dental arch was first proposed in 1981 as the minimum treatment intervention based on the notion that for successful and satisfactory oral function all exclusive functions performed by molars are also provided by anterior teeth and premolars and the lost teeth do not always need replacement.[13,14] This concept was evolved mainly for the older patients suggesting that the minimal number of pairs of occluding teeth needed to provide adequate oral function can be variable depending on age with 12 occluding pairs of teeth for 20-40 years of age and only 10 occluding pairs for 50-70 years of age.[2]

Clinical studies supporting shortened dental arch concept have highlighted that even enough of adaptive capacity persists in subjects having left with a minimum of four

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occluding units and it has no reported impairment in masticatory performance except when less than 10 occluding pair of teeth were present.[9,12] However conflict still exists about ideal number of functional tooth units required for satisfactory masticatory performance.[13] Loss of only mandibular 1st molar in healthy dentate patients causes 40% reduction in chewing efficiency.[4] Moreover 2nd and 1st premolar provide least amount of occlusal contact area required for mastication 12.9, and 8.1% respectively.[3]

Removable partial dentures improve masticatory performance by increasing number of functional or occluding dental units.[5] It is believed that restoration of posterior teeth by removable partial denture prevents posterior collapsed bite, drifting of premolar teeth, increasing interdental spacing, lowering of occlusal vertical dimension, alterations in temporo-mandibular condylar position, over eruptions among unopposed teeth and anterior teeth flaring along with increase in overbite and overjet.[15] MM August et al. evaluated that in middle age patients after 5 year follow up, provision of removable partial denture showed improvement in masticatory efficiency. Their study concluded that dietary fiber intake was more in people having more artificial tooth replacements.[5] Feuki et al. found in their study that young age, number of missing teeth, asymmetry in dental arches and chewing complaints are significant reasons for pursuing prosthetic solution in shortened dental arch patients.[8] Another study conducted by M Bessadet et al. with 1 year follow up concluded that rehabilitation with removable partial denture prosthesis improved ability to reduce food bolus particles size.[6] Further investigation by Allen et al. showed significant improvement in masticatory efficiency following RPD insertion in subjects having shortened dental arches[2], but notice must be taken regarding lesser than optimal oral function, an increased caries risk, periodontal problems and poor patient compliance with removable prosthesis.[12] Some studies reported no difference in masticatory effectiveness of patients having shortened dental arches with and without removable partial denture treatment.[8] However, dialogue on most suitable treatment modality is still ongoing.[7]

In existence of differing opinions in previous studies on improvement of masticatory efficiency of shortened dental arch patients with removable partial dentures, it is demanding to analyze masticatory efficiency of shortened dental arch patients after insertion of dentures. This study will help clinician to have better understanding of treatment needs of shortened dental arch patients and also will provide guidelines for management of shortened dental arch patients.

METHODOLOGY

Using non- probability (consecutive) sampling, this cross-sectional study was carried out in prosthodontics department, Punjab dental hospital, Lahore between 1st December 2019 to 30th May 2020. Patients with Shortened Dental Arches comprising bilateral free end saddle in upper and lower arches not involving 1st and 2nd premolars and intact anterior teeth were included in this study. Patients with Temporomandibular disorders, Periodontal disease, Attrition and malocclusion were excluded from study.

Patients who presented in Outdoor of Prosthodontics department at Punjab Dental Hospital, Lahore, among them, 66 shortened dental arch patients with age range 34-64 were selected. After approval from local ethical committee, and after fulfilling inclusion criteria, informed consent was signed and taken from each subject after taking demographic history (age, gender, place of living, socioeconomic status). Masticatory performance in subjects with pre and post removable partial denture treatment was evaluated as explained by Gunne[9] i.e. the study subjects were asked to chew 5g of raw carrot with 20 number of chewing strokes. The chewed carrot then was recovered in a cup and mesh sieve measuring 5mm x 1mm was used to strain it. It was air-dried for up to 30 minutes, weighed using a FEM mini digital weighing scale. Volume remaining on sieve and that which passed through it was calculated and determined.

The ratio of masticatory efficiency was determined by calculating the volume of raw carrot that passed through the sieve and dividing it by the total volume of raw carrot recovered and was expressed as percentage. The values were recorded, calculated and entered on data collection sheets. The test was repeated after 3 months of RPD provision with denture inserted in subject mouth. Outcome variable was recorded as per operational definition by researcher herself.

RESULTS

SPSS version 25 was used for data analysis. Mean and standard deviation was calculated for age and change percentage was calculated for gender. Effect modifiers like age, place of living (rural/urban) and gender was controlled through Stratification. T-test was applied and $p < 0.05$ was taken as significant.

In this study total 66 patients participated. The mean age was 47.74±9.00 years-Table 1. Out of 66 patients 48(72.73%) were male and 18(27.27%) were females-Fig 1. Out of 66 patients, 36(54.55) patients were from rural area and 30(45.45%) patients were from urban area-Fig 2. In our study the mean value of pretreatment masticatory performance of participants was 34.66±2.96 while mean value of post-treatment masticatory performance of the patients was 53.98±45.91. Statistically significant difference

Fig 1: Frequency distribution of Gender

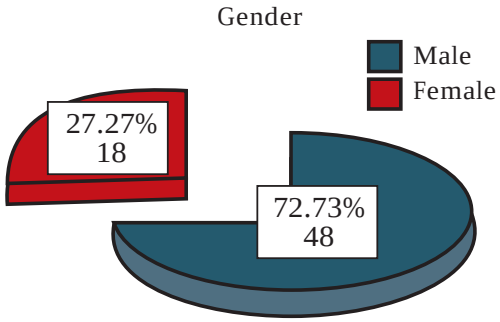
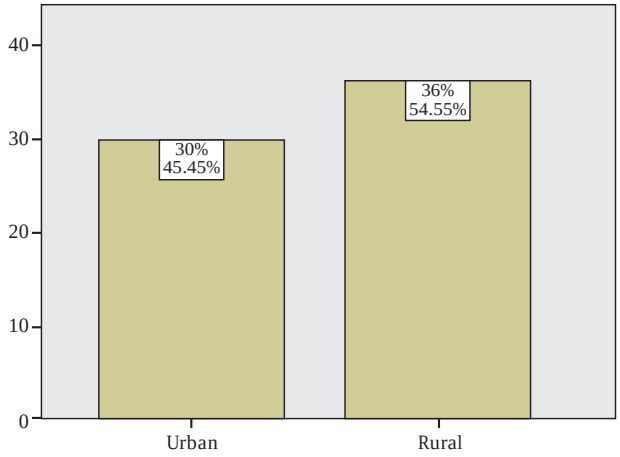


Fig 2: Place of Living



was established between before and after comparison of masticatory performance of the patients. i.e. p-value <0.001-Table 2. The mean change from pre and post treatment of masticatory performance of the patients was 19.32±3.03 with minimum and maximum values of 11.54 & 32.39 respectively-Table 3. Among patient's form ≤ 50 years the mean change on masticatory performance of the patients was 20.61±2.66 while in patients from age >50 years the mean change on masticatory performance of the patients was 17.86±2.78. Statistically insignificant difference was established between age and change in masticatory performance i.e. p-value =<0.001-Table 4. Among male patients the mean change on masticatory performance of the patients was 19.77±3.12 while in female patients the mean change on masticatory performance of the patients was 18.12±2.48. Statistically significant difference was established between gender and change in masticatory performance. i.e. p-value=0.048-Table 5.

Table 1: Age (years) and its statistics

Age (years)	
N	66
Mean	47.74
Std. Deviation	9.00
Minimum	34
Maximum	64

Table 2: Pre and post treatment comparison of Masticatory performance

Masticatory performance	Pre-treatment	Post treatment	p-value
N	66	66	<0.001
Mean	34.66	53.98	
Std. Deviation	2.96	2.85	
Minimum	23.02	45.91	
Maximum	40.87	60.12	

Table 3: Descriptive statistics of change in masticatory performance

Change in masticatory performance	
N	66
Mean	19.32
Std. Deviation	3.03
Minimum	11.54
Maximum	32.39

Table 4: Comparison of masticatory performance between age groups

		Age (years)		p-value
		≤ 50	>50	
Change in Masticatory performance	N	35	31	<0.001
	Mean	20.61	17.86	
	Std. Deviation	2.66	2.78	

Table 5: Comparison of masticatory performance between genders

		Gender		p-value
		Male	Female	
Change in Masticatory performance	N	36	30	0.048
	Mean	19.77	18.12	
	Std. Deviation	3.12	2.48	

DISCUSSION

The replacement of missing dentition with removable partial denture is often done to enhance masticatory functions of the patients.[5] The connection between masticatory performance and dental/ prosthodontic status has attracted many cross-sectional studies having most of them describing a strong interrelation.[10] MZ Nassani et al. reported that pursuing prosthodontic replacement was found in 3% of shortened dental arch patients with missing 2nd molars, in 58% with missing 1st and 2nd molars and in 93% with missing premolars.[8] Methods to measure masticatory performance include subjective and objective method. Sieve

method is gold standard to measure masticatory efficiency. Smaller the particle size of masticated test food obtained using sieves, greater will be the masticatory efficiency.[15] In this study the mean change from pre and post treatment of masticatory performance of the patients was 19.32±3.03 with minimum and maximum values of 11.54 & 32.39 respectively. The mean value of pretreatment masticatory performance of the patients was 34.66±2.96 while the mean value of post-treatment masticatory performance of the patients was 53.98±45.91 with significant difference between the before and after comparison of masticatory performance of the patients. This is in accordance with previous studies.

The significant improvement in the masticatory performance after RPD treatment could be explained by having a greater occlusal surface area due to additional occlusal units accessible for mastication.[10] Male subjects showed greater masticatory performance after provision of removable partial denture than female subjects. It is in compliance with other studies 5,6 stating that a greater masticatory performance in males is due to more muscle mass and bite force.[9]

Superior masticatory efficiency was noted in younger subjects when compared to the older ones. This is also in accordance to the earlier studies.[9,21] This could be attributed to having greater adaptability, increased biting forces and optimal neuromuscular control and coordination in younger subjects.[9] Witter et al observed that the study group having at least 21 functional teeth had no eating difficulties. S. Van Waas et al revealed that the study subjects were more satisfied when the occlusal units that were replaced by partial denture were increased.[16,17] More the occlusal surface area more is the probability of better grinding and crushing of food.[18,19] Yurkstas stated that masticatory performance can be relatively predicted if occlusal contact surface area is known.[16] Some studies stated that with a minimum of 20 well aligned teeth or 4 functional occluding units, adequate adaptive capacity ensuring sufficient masticatory ability can be achievable.[12] On contrary some other studies stated that adequate masticatory ability was achievable with 20 or more teeth or six functional tooth units having premolars along with at least one occluding pair of molars.[11] A review of literature unfolded that bilateral distal extension removable partial denture in SDA compensated for only fifty percent of the masticatory efficacy of complete dentate arches.[10,20] People with fixed dental prosthesis can achieve masticatory performance nearer to natural dentition.[16,19] Dental literature states that dental arches having teeth up to premolar region, fulfills the requisites of a functionally sound dentition. Nevertheless, functional requirements, and the number of occluding pairs of teeth to cater them, varies from person to person, and therefore dental rehabilitation must be considered according to individual's adaptive capability and needs.[23,24,25]

CONCLUSION

According to this study there is after insertion of removable partial denture insertion has shown evident improvement in mastication among subjects having shortened dental arches. Hence provision of removable partial dentures in individuals having shortened dental arches should be practiced to improve masticatory performance.

CONFLICT OF INTEREST

None declared

REFERENCES

1. English JD, Buschang P, Throckmorton G. Does malocclusion affect masticatory performance? The Angle Orthodontist. 2002;72:21-7.

2. Fernandes VA, Chitre V. The shortened dental arch concept: A treatment modality for the partially dentate patient. J Indian Prosthodontic Society. 2008;8:134.
https://doi.org/10.4103/0972-4052.49016

3. Yurkstas A, Manly R. Measurement of occlusal contact area effective in mastication. Am J Orthodontics.1949;35:185-95.
https://doi.org/10.1016/0002-9416(49)90028-7

4. Bowley J. Minimal intervention prosthodontics: current knowledge and societal implications. Medical Principles and Practice. 2002;11(Suppl. 1):22-31.
https://doi.org/10.1159/000057775

5. Augustin MM, Joke D, Bourleyi SI, Shenda LP, Fidele NB, Van TM, et al. The effect of partial removable denture use on oral health related quality of life and masticatory function, after 5 years use. Open J Stomatology. 2016;6:201.
https://doi.org/10.4236/ojst.2016.610026

6. Bessadet M, Nicolas E, Sochat M, Hennequin M, Veyrune J-L. Impact of removable partial denture prosthesis on chewing efficiency. J Applied Oral Scie. 2013;21:392-6.
https://doi.org/10.1590/1679-775720130046

7. Nassani MZ, Ibraheem S, Al-Hallak KR, El Khalifa MOA, Baroudi K. A study of dentists' preferences for the restoration of shortened dental arches with partial dentures. European J Dent. 2015;9:183-8.
https://doi.org/10.4103/1305-7456.156802

8. Nassani MZ, Tarakji B, Baroudi K, Sakka S. Reappraisal of the removable partial denture as a treatment option for the shortened dental arch. European J Dent. 2013;7:251.
https://doi.org/10.4103/1305-7456.110199

9. Omo J, Sede M, Esan T. Masticatory efficiency of shortened dental

arch subjects with removable partial denture: A comparative study. Nigerian J Clinical Practice. 2017;20:459-63.

10. Zhang Q, Witter DJ, Bronkhorst EM, Creugers NH. The relationship between masticatory ability, age, and dental and prosthodontic status in an institutionalized elderly dentate population in Qingdao, China. Clinical oral investigations. 2019;23:633-40. *https://doi.org/10.1007/s00784-018-2477-z*

11. Naka O, Anastassiadou V, Pissiotis A. Association between functional tooth units and chewing ability in older adults: a systematic review. Gerodontology. 2014;31:166-7 *https://doi.org/10.1111/ger.12016*

12. Kumar AB, Walmsley AD. Treatment options for the free end saddle. Dental update. 2011;38:382-8 *https://doi.org/10.12968/denu.2011.38.6.382*

13. Olley RC, Renton T, Frost PM. Observational study investigating tooth extraction and the shortened dental arch approach. Journal of Oral Rehabilitation. 2017;44:610-6. *https://doi.org/10.1111/joor.12523*

14. Alam M, Joshi S, Joshi P. Shortened dental arch: A simplified treatment approach. J Nepal Dent Assoc. 2014;14:1-4.

15. Oliveira NM, Shaddox LM, Toda C, Paleari AG, Pero AC, Compagnoni MA. Methods for evaluation of masticatory efficiency in conventional complete denture wearers: a systematized review. Oral health and dental management. 2014;13:757-62.

16. Mazurat NM, Mazurat RD. Discuss Before Fabricating: Communicating the Realities of Partial Denture Therapy. Part I: Patient Expectations. J Canadian Dent Assoc. 2003;69:90-4.

17. Magalhães IB, Pereira LJ, Marques LS, Gameiro GH. The influence of malocclusion on masticatory performance: a systematic review. Angle Orthodon. 2010;80:981-7. *https://doi.org/10.2319/011910-33.1*

18. Owens S, Buschang PH, Throckmorton GS, Palmer L, English J. Masticatory performance and areas of occlusal contact and near contact in subjects with normal occlusion and malocclusion. Am J Orthod Dentofac Orthopedics. 2002;121:602-9. *https://doi.org/10.1067/mod.2002.122829*

19. Oliver S, Micheal H. Impact of shortened dental arch on oral health-related quality of life. J Evidence Based Dental Practice.2021;21: *https://doi.org/10.1016/j.jebdp.2021.101622*

20. Reissmann DR, Wolfart S, John MT. Impact of shortened dental arch on oral health -related quality of life over a period of 10 years-A randomized controlled trial. J Dent.2019; 80:55-62 *https://doi.org/10.1016/j.jdent.2018.10.006*

21. Micheal H Jens D, Torsten M. Periodontal health in shortened dental arches: A 10- year RCT. J Prosthodontics Res. 2020;64:498-505 *https://doi.org/10.1016/j.jpor.2020.01.005*

22. Saadika.B. Translation of the shortened dental arch research into clinical practice: a stakeholder mapping approach. BDJ Open. 2020; 6:10 *https://doi.org/10.1038/s41405-020-0039-3*

23. Javed MU, Asim MA. Association of tooth loss with temporomandibular disorders. Khyber Medical University J.2020;12:29-33

24. Narendra B, Lama A, Othman W. Role of shortened Dental Arch (SDA) concept in treatment planning- A case report. J Dent Medi Sci.2019;18:48-52.

25. Sulema G, Chaturvedi S, Shareef RA. An assessment of Dentist's Attitude to the shortened dental arch Concept. Open Access Macedonian J Medi Sci.2020;8:14-22 *https://doi.org/10.3889/oamjms.2020.3748*