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CLINICAL RESEARCH

Is predicting masticatory function based on mandibular bone atrophy as defined by clinical and radiographic parameters possible? A clinical study

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ABSTRACT

Statement of problem. The degree of mandibular bone atrophy can guide and determine the choice of prosthetic treatment. Although several methodologies have been proposed for classifying atrophy, the clinical and radiographic parameters considered for the classification of mandibular bone atrophy should be standardized.

Purpose. The purpose of this clinical study was to evaluate the influence of methodologies of mandibular bone atrophy categorization on the masticatory function in complete denture (CD) wearers and to verify the relationship between these parameters according to the retention and stability of the mandibular CD.

Material and methods. CD wearers were radiographically and clinically evaluated to determine the mandibular bone atrophy levels. Three classifications were adopted: the Cawood and Howell criteria, the Wical and Swoope criteria, and the Kapur classification. CD retention and stability were scored based on the Sato et al method. The masticatory function was evaluated by the multiple sieve method using optical test food to determine the masticatory performance (MP) indexes (median particle size, MP X50; homogeneity index, MP B) and the masticatory efficiency (sieves 4 and 2.8).

Results. In this sample of 63 individuals (mean age of 67.4 years), atrophic participants presented significant differences in all radiographic parameters (Mann–Whitney test, $P<.05$) with both the Cawood and Howell and Wical and Swoope methodologies. No differences in masticatory function were found, except for atrophic participants classified by Wical and Swoope criteria, who had worse MP X50 ($P=.047$) than nonatrophic participants, with a medium effect size of 0.7. The retention of the mandibular CD significantly affected the masticatory outcomes, with higher values for MP X50 ($P=.012$) and MP B ($P=.040$) and lower values for masticatory efficiency, 2.8 ($P=.008$) for atrophic participants. The presence of mandibular bone atrophy showed an association with poor retention ($P=.04$) and poor stability ($P=.002$) when the Cawood and Howell criteria were adopted (Fisher exact test, $P<.05$).

Conclusions. The Kapur classification confirmed the clinical condition of the participants' atrophy, and the most clinically atrophic participants showed poor retention and stability of the mandibular CD. Only the poor retention directly affected the masticatory function. Radiographic evaluations alone did not provide sufficient data to determine the predictability of CD treatment regarding the participants' masticatory function. Radiographically, atrophic participants with poor retention had impaired mastication. (J Prosthet Dent 2019;121:432-9)

Residual ridge bone resorption (RRR) rates after tooth loss vary between the maxilla and the mandible, and RRR results in the severe bone atrophy commonly observed in edentulous jaws.[1] This process is more pronounced in the mandible because the inferior ridge responds with greater intensity to the functional forces transmitted by the prosthesis because of its smaller area and the unfavorable shape of the mandibular base.[2-4] Functional, anatomic, metabolic, and prosthetic factors are also related to RRR occurring in the mandible in the facial anterior region and in the lingual posterior region.[5-8] RRR results in a knife-edge alveolar ridge, mainly in the anterior region, followed by vertical resorption until the basal jaw bone, which results in significant problems with the mandibular prosthesis for complete denture (CD) wearers.[9,10]

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Clinical Implications

The combination of both clinical and radiographic methods is recommended for an adequate assessment because completed denture retention can negatively influence masticatory function when mandibular bone atrophy is present. The categorization of mandibular bone atrophy may help in the treatment planning of completely edentulous patients.

Common problems include insufficient retention and stability of the prosthesis by causing soft-tissue injuries and discomfort in speaking, mastication difficulties, and changes in the facial appearance, in addition to the decreased muscular activity and occlusal force that is reflected in impaired mastication.[11-14]

Mandibular bone atrophy and RRR are also related to individual factors such as pathological condition, age, sex, and osteoporosis, as well as the time since edentulism.[15,16] Therefore, prosthetic rehabilitation of atrophic mandibles presents a challenge.[15] Methods of evaluating the condition of the alveolar ridge and the supporting tissues before CD rehabilitation can indicate the patient's treatment, prognosis, and treatment expectations.[17-22] This evaluation can be performed clinically, radiographically, or with a combination of both, with different methods of measuring and classifying RRR.[23-28] Panoramic or cephalogram radiographs can be used to measure the ridge height that guides the bone atrophy classification.[3,7,15,29,30]

This study used 2 classifications based on the height of the residual ridge, such as in the mental foramen and in the anterior and posterior region of the mandible.[25,26] Clinical evaluation was based on the patient's anatomy, ridge shape, height of muscle insertions, and tissue resilience.[24] Patients who have been edentulous a long time likely have poor denture-bearing tissues as a consequence of the chronic and progressive RRR, which results in the superficialization of anatomical features and muscle insertions.[2] In these patients, the prognosis may be unfavorable because RRR directly affects the retention and stability of the CD, impairing masticatory function and causing occasional pain, dissatisfaction, and difficulty in adapting.[2,16,20,31-34]

Several methods have been proposed to classify the atrophy as the degree of mandibular bone atrophy can guide and determine the choice of prosthetic treatment. Considering that the classification of mandibular bone atrophy may be considered as a predictor of masticatory function, the objective of the present clinical study was to evaluate the influence of the different methods of categorizing mandibular bone atrophy on the masticatory function of CD users and to verify the relationship between these parameters according to the retention and stability of the mandibular CD.

MATERIAL AND METHODS

This cross-sectional clinical study was conducted on individuals rehabilitated at the School of Dentistry at UFPel in the Prosthesis Clinic and approved by the Ethics Committee in Local Search (69/2013), in accordance with the Declaration of Helsinki, 2008. The following inclusion criteria were applied: good general health, CD user for at least 3 months, CD in adequate conditions for use, and participants to be available to attend the FO-UFPel on predetermined days. Participants with xerostomia, severe oral manifestations of systemic diseases, and psychological or psychiatric conditions that could influence the data collection were excluded from the study. Radiographic evaluations, functional tests of retention and stability, and masticatory function tests were performed to establish the relationship between radiographic, clinical, and functional parameters associated with the mandibular bone atrophy process. The sample size calculation was based on the masticatory performance (MP) outcome of a previous study using the following parameters: smallest expected difference between means, standard deviations of the difference between means, beta error of 10%, and one-tailed alpha error of 5%.[35] The sample size was increased by 20% to account for potential losses and refusals. The calculations indicate a minimum of 12 participants required per group for this study.

Digital panoramic radiographs were made by a single experienced professional in the radiology service of the FO-UFPel (Rotograph Apparatus Plus, [Villa Sistemi Medicali] with digital imaging plate system Dentascan sensors). The measurements related to morphology and mandibular height were performed in DBSWIN software (Digital System VistaScan; Dürr Dental) by a single calibrated examiner, following the methodology described by Xie et al.[15] The following data were collected: mandibular body length, midline height, height in the region of the first premolars and molars, gonial angle, and distance from the top edge of the mental foramen to the alveolar ridge.

Based on these data, the participants were classified into atrophic and nonatrophic participants by applying 2 criteria: the bone atrophy stage described by Cawood and Howell[26] classification system and the severity of the RRR proposed by Wical and Swoope.[25] Cawood and Howell[26] describes edentulous mandibles with ridge heights in the anterior region of ≥25 mm and posterior region of ≥16 mm as nonatrophic and ridge heights below these 2 values as atrophic (Fig. 1). Wical and Swoope[25] estimated the original mandibular height using

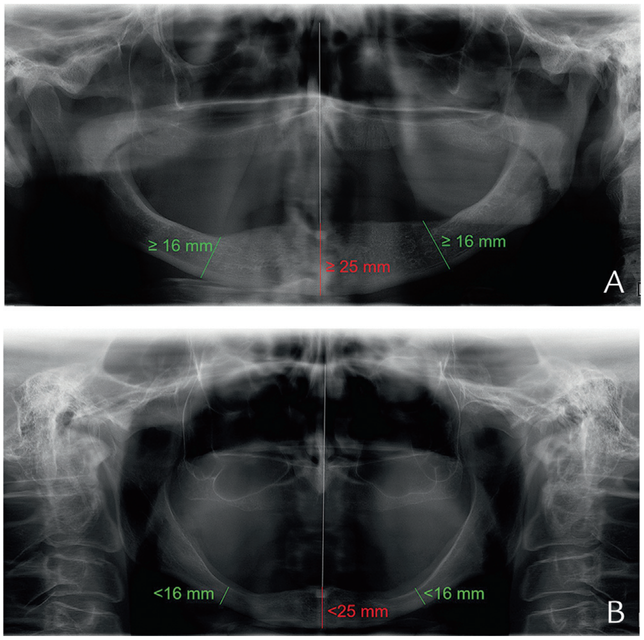

Figure 1. Panoramic radiographs showing bone atrophy according to Cawood and Howell classification. A, Nonatrophic mandible, ridge height in anterior region ≥25 mm and ridge height in posterior region ≥16 mm. B, Atrophic mandible, height in anterior region <25 mm and height in posterior region <16 mm.

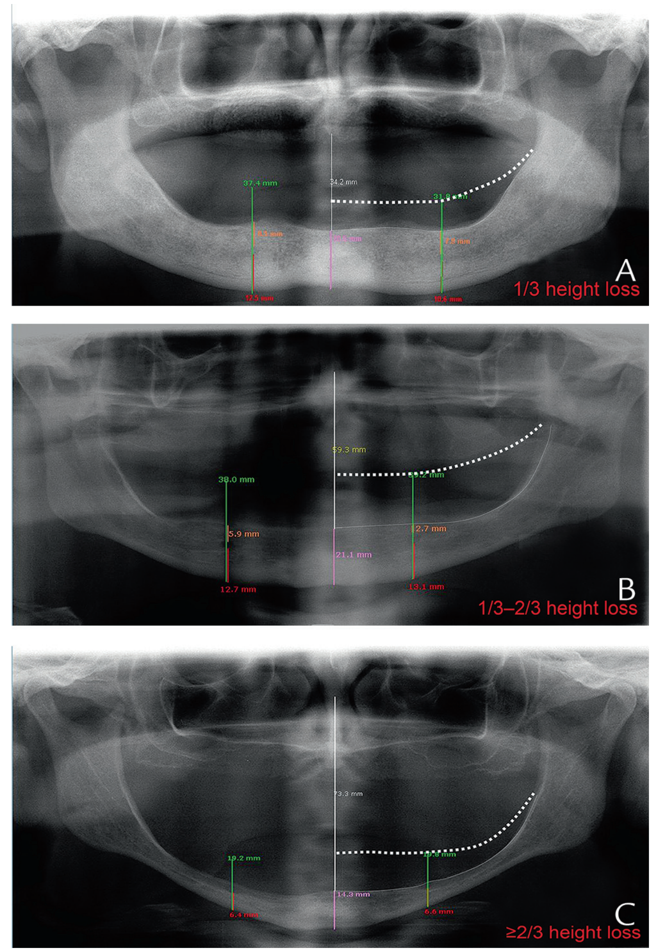

Figure 2. Panoramic radiographs showing residual ridge bone reabsorption (RRR) severity according to Wical and Swoope classification. A, RRR with less than one-third lost. B, RRR with between one-third and two-third loss. C, RRR more than two-third lost.

the distance between the inferior border of the mental foramen and the lower edge of the mandible, which is assumed to correspond to one-third of the mandibular ridge height of a dentate individual. This linear measurement classifies the ridge resorption level as follows: less than one-third lost, between one-third and two-third lost, and more than two-third lost. Participants presenting less than 1/3 lost were classified as nonatrophic, and those presenting more than 1/3 lost were classified as atrophic (Fig. 2).

The clinical classification of the atrophy, based on the prosthesis-supporting tissues, was made according to the parameters described by Kapur.[24] The methodology categorizes the shape of the alveolar ridge on a 4-point scale (flat, V-shaped, shaped between U and V, and U-shaped). The tissue resilience and the location of the muscular inserts are classified on a 3-point scale (resilience: flabby, resilient, and firm; and location: high, low, and medium). According to the sum of the scores of each category, the prostheses-supporting tissues were classified as atrophic (poor conditions of the supporting tissues) when the final score was less than 7. The stability and retention of the mandibular CD were assessed according to the scores described by Sato et al.[36] The stability was evaluated through the horizontal movement induced by the index finger and pressure applied by the middle finger on the first molars, and the scores registered were as follows: S1–Good, the movement of the prosthesis represents a normal tissue pattern; S2–Reasonable, the prosthesis presents some instability; and S3–Poor, the prosthesis moves. The retention was determined by the dislodgement of the prosthesis in the vertical direction after applying pressure on the central incisors, and the scores registered were as follows: S1–Good, no dislodgement; S2–Acceptable, dislodgement with difficulty; and S3–Poor, easy dislodgement. For analytical purposes, the obtained scores in the retention and stability tests were grouped into 2 categories as follows: Good/Acceptable (S1 and S2) and Poor (S3).

Masticatory function was evaluated using a food-simulating test material (Optocal).[13,37,38] Each volunteer masticated a standardized portion (3.7 g) of the material for 40 masticatory cycles. The triturated mass was expelled on a disposable paper filter, washed, and allowed to dry. Subsequently, the particles were passed through a stack of 9 sieves with progressively smaller mesh size between 5.6 mm and 0.5 mm. The material contained in each sieve was weighed on a precision scale to determine the MP and masticatory efficiency (ME).

Table 1. Mean (SD) and median (range) of clinical and radiographic outcomes according to Cawood and Howell and Wical and Swoope classifications (Mann–Whitney test, *P*<.05)

	Cawood and Howell				Wical and Swoope			
Clinical and Radiographic Outcomes	**Nonatrophic (n=26) Mean (SD)/Median (Range)**	**Atrophic (n=37) Mean (SD)/Median (Range)**	***P***	**ES**	**Nonatrophic (n=7) Mean (SD)/Median (Range)**	**Atrophic (n=56) Mean (SD)/Median (Range)**	***P***	**ES**
Time since edentulism - Maxilla (y)	24.2 (13.9)/30 (1-54)	36.3 (12.54)/33 (10-65)	.001	0.9	19.9 (13.17)/15 (4-42)	32.7 (13.9)/30 (1-65)	.019	1.1
Time since edentulism - Mandible (y)	15.8 (12.2)/25 (1-40)	31.1 (14.11)/30 (7-61)	<.001	1.3	12.7 (7.69)/12 (1-22)	26.3 (15.4)/25 (1-61)	.009	1.9
Mandible length (mm)	113.3 (8.2)/110.5 (100.4-127.1)	115.7 (41.2)/109.1 (93.7-135.2)	.046	0.4	116.3 (5.69)/118.15 (108.6-124.1)	114.5 (33.8)/109.8 (93.7-355.2)	.037	0.3
Height in the anterior region (mm)	27.5 (3.20)/22.7 (20.5-34.6)	20.3 (2.89)/20.6 (13.7-25.2)	<.001	2.3	30.0 (3.07)/29.8 (24.20-34.60)	22.5 (4.1)/22.5 (13.6-32.7)	<.001	2.2
Height in the posterior region (mm)	18.5 (2.83)/14.4 (13-27.1)	12.4 (2.44)/12.6 (7.35-16.4)	<.001	2.2	20.7 (3.34)/19.8 (16.4-27.1)	14.2 (3.5)/14.11 (7.4-21.2)	<.001	2.1
Upper height in the foramen region (mm)	24.3 (3.6)/2.6 (2.2-16.4)	16.5 (3.5)/1.35 (0-5.4)	<.001	1.6	11.2 (3.5)/11.1 (7-16.4)	2.9 (2.4)/2.3 (0-8.2)	<.001	2.6

ES, effect size; SD, standard deviation.

The MP was determined by 2 indexes as follows: median particle size (MP X50) calculated based on the sieve mesh through which 50% of the weight of the triturated particles can pass and the homogeneity index (MP B) that represents the particle size distribution during the mastication−lower MPB values reflect a more homogenous food bolus distribution during mastication. The ME was evaluated by using the percentage of the total volume of masticated test material retained in the sieves with a 4.0-mm square aperture (ME 4.0) and with a 2.8-mm-square aperture (ME 2.8).[13,37]

Data were submitted to descriptive analysis to verify the sample distribution and asymmetry. As the data presented a nonnormal distribution, nonparametric tests were used. The Mann−Whitney test was used for all the comparisons between the atrophic and nonatrophic groups (α=.05 for all tests). The variables of atrophy and retention and stability of the CD were also analyzed using the Fisher exact test. The standardized differences in means were evaluated by calculating the effect size (ES).[39] The ES was classified based on the final score as small (ES$\simeq$0.2), moderate (ES$\simeq$0.5), and large (ES$\simeq$0.8).[40]

RESULTS

The study sample consisted of 63 completely edentulous participants, of whom 18 were men (28.6%, mean age 68.8 years) and 45 were women (71.4%, mean age 67.3 years). The mean time since edentulism in the maxilla was 31.6 years and 22.2 years in the mandible. Table 1 lists the clinical and radiographic parameters evaluated according to the radiographic classification of mandibular bone atrophy. According to the Kapur[24] criteria, only 2 participants were clinically nonatrophic, and therefore, statistical tests were not performed. According to both the radiographic classifications, atrophic participants had statistically significant differences in all the clinical and radiographic parameters (Mann−Whitney test, *P*<.05). Large ES values (ranging from 0.9 to 2.6) were obtained between atrophic and nonatrophic participants, except for the mandibular length that presented a medium ES (ES=0.3 and 0.4). Figure 3 illustrates that mandibular bone atrophy did not significantly affect the MP (Fig. 3A) nor the ME (Fig. 3B) (*P*>.05), irrespective of the classification adopted. Only 1 exception was observed, atrophic participants according to the Wical and Swoope[25] criteria presented worse MP X50 than nonatrophic participants (*P*=.047) with a medium ES of 0.7.

Considering the stability and retention outcomes of the complete study sample, the score/number of mandibular CD was registered as follows: for stability−S1/11 (17.5%), S2/15 (23.8%), and S3/37 (58.7%) and for retention−S1/6 (9.5%), S2/12 (19%), and S3/45 (71.5%). These data are listed in the Table 2 and 3 according to mandibular atrophy classifications. Figure 4 shows the comparison between the stability and retention scores of the mandibular CD and masticatory function outcomes. Significant differences were observed only for the MP X50 parameter between the good/reasonable retention and poor retention categories (Fig. 4.A; *P*=.037) with a medium ES (ES=0.6). In addition, Table 2 lists the stability and retention scores of the CD and the masticatory function outcomes of participants classified by the Cawood and Howell[26] criteria, whereas Table 3 lists these scores according to the Wical and Swoope[25] classification. Table 2 shows that only the retention of mandibular CD significantly affected the masticatory outcomes of atrophic participants, with statistically higher values for MP X50 (*P*=.012) and MP B (*P*=.040) and lower values for ME 2.8 (*P*=.008). The comparisons presented in Table 3 showed that only the retention of the mandibular CD affected the ME, with statistically lower values for ME 2.8 (*P*=.022) in the atrophic participants.

The Fisher exact test revealed an association between the presence of mandibular bone atrophy and poor

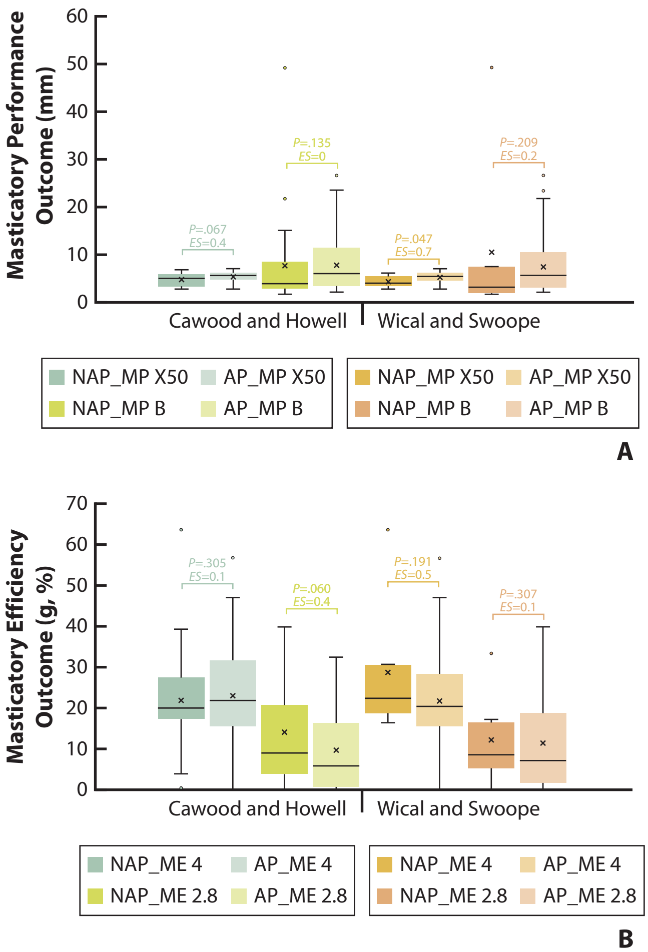

Figure 3. Box-plot shows masticatory function outcomes according to Cawood and Howell and Wical and Swoope classifications (Mann–Witney test, P<.05). A, Masticatory performance outcomes (MP X50 and MP B). B, Masticatory efficiency outcomes (ME 4 and ME 2.8). AP, atrophic participant; ES, effect size; ME, masticatory efficiency; MP, masticatory performance; NAP, nonatrophic participant.

retention (P=.04) and the presence of mandibular bone atrophy and poor stability (P=.002) when the participants were classified according to the Cawood and Howell[26] criteria. However, according to the Wical and Swoope[25] criteria, no association was found between the presence of mandibular bone atrophy and the retention and stability scores (P>.05).

DISCUSSION

Because RRR is progressive, irreversible, and directly dependent on the time since edentulism, the significant differences between the groups in the clinical parameters (mandibular and maxillary time since edentulism) and radiographic parameters (jaw length, height in the anterior and posterior region, superficial location of the mental foramen) are not unexpected.[2,16] The comparison between the radiographic classification schemes showed that the classification proposed by Cawood and Howell[26] appears to be better suited to evaluating mandibular bone atrophy as it was able to detect the relationship between the masticatory outcomes (MP X50, MP B, and ME 2.8) and the poor retention of prostheses in atrophic participants. In addition, this classification indicated an association between mandibular bone atrophy and the poor retention and stability conditions. Consequently, the use of a clinical evaluation, based on the Kapur[24] criteria, in addition to the radiographic evaluation, is of fundamental importance to obtain a more objective and reliable prognosis based on the mandibular bone atrophy of edentulous patients and can also help to inform the patients about the treatment expectations and the difficulties in adapting to mandibular CD. This recommendation is in accordance with the classification method recommended by the American College of Prosthodontics (ACP), which evaluates the radiographic and clinical parameters of edentulism.[28] The only methodological difference with the classifications adopted in this study is that the ACP guidelines recommend a measurement of the vertical bone height at the location with the lowest vertical height.

This study showed that the radiographic evaluation did not provide sufficient data to determine the predictability of CD treatment with regard to the participants' masticatory function. Only the classification of Wical and Swoope[25] suggested a medium-sized, weakly significant difference in one masticatory parameter, MP X50 (Fig. 3A). In addition, a relationship between ME outcome (ME 2.8; Table 3) and the poor CD retention group was observed in atrophic participants (78% of the participants according to the Wical and Swoope[25] classification) because 97% of the participants in the sample were clinically atrophic; this finding was not unexpected.

However, this result should be carefully interpreted mainly because of methodological problems associated with the Wical and Swoope[25] classification raised by previous studies regarding the location of the mental foramen. The mental foramen is not always a reliable landmark in edentulous individuals, as its position varies between individuals and is dependent on age and sex.[29,30] Therefore, the clinical condition of the residual ridge can interfere significantly with the mastication parameters of CD wearers. In the total sample, participants with poor retention of the prostheses had worse MP X50 than participants with good/reasonable retention (Fig. 4).

The Cawood and Howell[26] classification parameters were able to detect the association between mandibular bone atrophy and the conditions of stability and retention of the mandibular CD, as well as the relationship between mandibular bone atrophy, masticatory parameters (X50, MP B, and ME 2.8), and poor retention in atrophic participants. Previous studies have reported that

Table 2. Mean (SD) and median (range) values of masticatory function outcomes (MP X50, MP B, ME 4, and ME 2.8) of nonatrophic and atrophic participants (Cawood and Howell classification) according to stability and retention criteria (Mann–Whitney test, *P*<.05)

	Atrophy Classification—Cawood and Howell											
	Stability						Retention					
	Nonatrophic			Atrophic			Nonatrophic			Atrophic		
Masticatory Function Outcomes	Good/ Reasonable (n=17), Mean (SD)/Median (Range)	Poor (n=9), Mean (SD)/ Median (Range)	*P*	Good/ Reasonable (n=9), Mean (SD)/Median (Range)	Poor (n=28), Mean (SD)/ Median (Range)	*P*	Good/ Reasonable (n=13), Mean (SD)/Median (Range)	Poor (n=13), Mean (SD)/ Median (Range)	*P*	Good/ Reasonable (n=5), Mean (SD)/ Median (Range)	Poor (n=32), Mean (SD)/ Median (Range)	*P*
MP X50 (mm)	4.7 (1.4)/ 4.7 (2.8-6.9)	5.3 (1.1)/5.4 (3.0-6.7)	.129	5.6 (1.1)/5.8 (3.4-7.1)	5.2 (1.2)/5.5 (2.8-6.7)	.135	4.8 (1.4)/ 5.0 (2.8-6.9)	4.9 (1.5)/5.1 (2.8-6.7)	.362	4.2 (1.33)/4.0 (2.8-6.3)	5.6 (0.9)/7 (2.9-7.1)	.012
MP B (mm)	6.3 (6.0)/ 3.4 (1.7-21.8)	7.4 (5.0)/6.1 (2.2-18.0)	.119	7.6 (6.3)/5.5 (23.6-2.1)	8.9 (9.8)/6.2 (2.3-49.4)	.406	9.5 (13.4)/3.1 (1.7-49.4)	5.9 (3.2)/5.5 (2.5-12.9)	.343	4.3 (2.41)/3.1 (2.1-7.8)	8.4 (6.1)/6.24 (2.2-26.7)	.040
ME 4 (%)	22.8 (11.9)/22.3 (0.3-40.9)	23.3 (17.9)/ 24.7 (0-63.6)	.399	19.8 (11.0)/19.2 (0-37.6)	23.2 (13.3)/ 20.0 (0-56.7)	.341	20.7 (10.0)/19.2 (0.3-39.3)	23.1 (14.6)/20.6 (3.9-63.6)	.420	24.4 (9.9)/21.8 (12.9-38.0)	22.8 (14.7)/ 22.6 (0-56.7)	.404
ME 2.8 (%)	14.6 (12.1)/15.7 (0-34.7)	9.2 (10.0)/7.3 (0-32.9)	.099	9.6 (10.2)/6.9 (0-28.5)	11.5 (12.0)/6.7 (0-39.8)	.445	13.1 (11.5)/15.7 (0-32.9)	15.2 (13.8)/7.6 (1.3-39.8)	.289	21.4 (12.0)/25.1 (1.7-32.5)	7.6 (8.7)/5.41 (0-29.9)	.008

ME, masticatory efficiency; MP, masticatory performance; SD, standard deviation.

Table 3. Mean (SD) and median (range) values of masticatory function outcomes (MP X 50, MP B, ME 4, and ME 2.8) of nonatrophic and atrophic participants (Wical and Swoope classification) according to stability and retention criteria (Mann–Whitney test, *P*<.05)

	Atrophy classification—Wical and Swoope											
	Stability						Retention					
	Nonatrophic			Atrophic			Nonatrophic			Atrophic		
Masticatory Function Outcomes	Good/ Reasonable (n=4), Mean (SD)/Median (Range)	Poor (n=3), Mean (SD)/ Median (Range)	*P*	Good/ Reasonable (n=22), Mean (SD)/Median (Range)	Poor (n=34), Mean (SD)/ Median (Range)	*P*	Good/ Reasonable (n=4), Mean (SD)/Median (Range)	Poor (n=3), Mean (SD)/ Median (Range)	*P*	Good/ Reasonable (n=14), Mean (SD)/Median (Range)	Poor (n=42), Mean (SD)/ Median (Range)	*P*
MP X50 (mm)	4.6 (1.3)/5.0 (2.8-5.8)	4.6 (0.0)/4.6 (4.6-4.6)	.429	5.2 (1.4)/5.4 (2.8-7.1)	5.3 (1.2)/5.6 (2.8-6.7)	.406	3.9 (1.9)/3.7 (2.8-5.6)	5.0 (1.3)/5.1 (3.7-6.2)	.200	4.8 (1.4)/4.8 (2.8-6.9)	5.4 (1.1)/5.7 (2.8-7.1)	.075
MP B (mm)	7.1 (8.2)/3.4 (2.8-21.8)	2.7 (0.6)/2.7 (2.2-3.1)	.095	6.8 (5.7)/3.7 (1.7-23.6)	8.8 (8.7)/6.3 (2.3-49.4)	.123	14.0 (23.6)/2.5 (1.7-49.4)	6.0 (2.4)/7.1 (3.2-7.5)	.200	6.3 (5.8)/3.3 (2.1-21.8)	7.8 (5.7)/6.1 (2.2-26.7)	.093
ME 4 (%)	40.0 (7.0)/30.5 (21.7-40.9)	31.4 (9.4)/31.4 (24.7-38.0)	.571	19.3 (11.2)/19.2 (0-39.3)	22.8 (14.8)/ 20.3 (0-63.7)	.306	21.6 (6.7)/19.5 (16.4-30.8)	38.2 (22.5)/30.5 (20.6-63.6)	.200	21.8 (10.8)/20.5 (0.3-39.3)	21.8 (13.6)/ 20.3 (0-56.70)	.480
ME 2.8 (%)	13.8 (13.2)/9.4 (0-33.2)	16.8 (4.7)/16.2 (12.9-19.5)	.429	12.2 (11.2)/7.6 (0-34.7)	10.5 (11.6)/ 6.5 (0-39.8)	.205	9.2 (8.5)/9.9 (0-17.1)	16.1 (14.9)/8.6 (6.5-33.2)	.314	17.1 (12.4)/19.0 (0-32.9)	9.5 (10.6)/5.6 (0-39.8)	.022

ME, masticatory efficiency; MP, masticatory performance; SD, standard deviation.

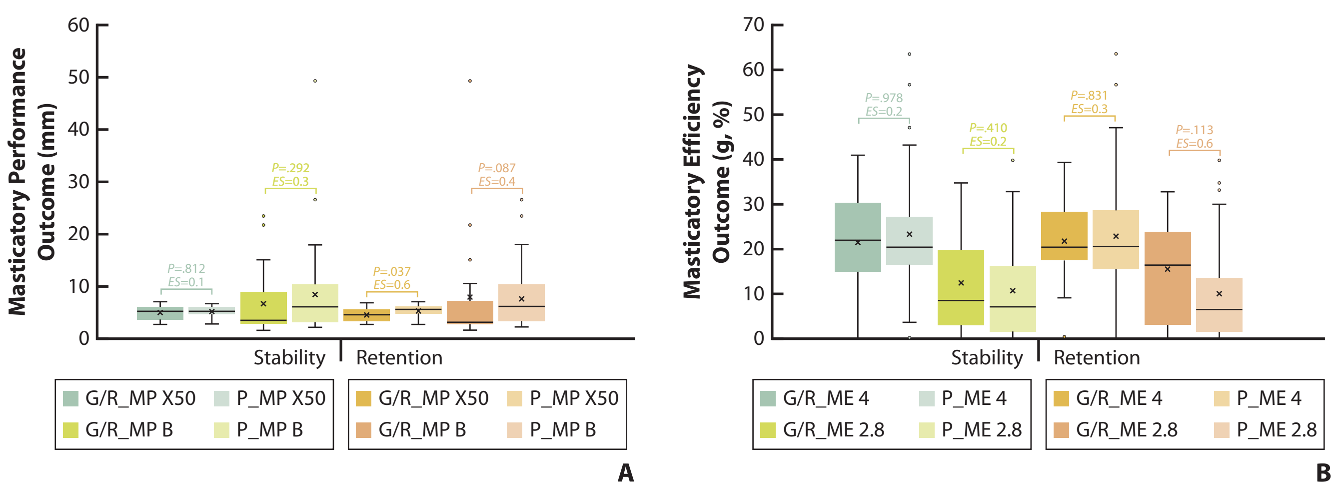

Figure 4. Box-plot shows masticatory function outcomes according to stability and retention evaluation categorized as good/reasonable (G/R) and poor (P) (Mann–Whitney test, *P*<.05). A, Masticatory performance outcomes (MP X50 and MP B). B, Masticatory efficiency outcomes (ME 4 and ME 2.8). ES, effect size; ME, masticatory efficiency; MP, masticatory performance.

the masticatory function of completely edentulous patients has an intimate relationship with the retention and stability of the CD and with the degree of bone atrophy and condition of the prosthesis-supporting tissues.[16,32–34] The data listed in Tables 2 and 3 indicate that the CD retention is a better predictor of masticatory function impairment than stability. The lack of retention and stability of the CD is a result of the changes that occur in the prosthesis-supporting tissues caused by prolonged usage and long-term edentulism.[16,24] The results suggest that the conditions of the prostheses-supporting tissues have more impact on the masticatory function than bone height. In addition, many participants who are radiographically classified as nonatrophic are clinically considered atrophic, and the lack of CD retention significantly affected the mastication irrespective of the classification of mandibular atrophy.

Besides the RRR and the profile of the prosthesis support tissue, another factor capable of affecting the mastication of CD wearers is the occlusal force that is directly related to muscular atrophy.[11,13] Complete edentulism decreases the number and size of muscle fibers in the masticatory muscles, along with a concomitant reduction in occlusal force.[11] Increased occlusal force results in improved masticatory function because of the more efficient grinding of the food particles that lodge in the posterior region of the prosthesis during the masticatory movements.[13] However, the reduction of muscular activity observed in CD wearers was also related to the instability of the mandibular prosthesis and to psychological factors, such as the fear of fracturing the prosthesis and the fear of feeling pain during mastication, mainly in the presence of mandibular bone atrophy.[11]

Limitations of the study include the disparity between the number of participants included in each group, especially since only 2 participants were classified as clinically nonatrophic according to the Kapur criteria.[24] The greater heterogeneity in the distribution of atrophic and nonatrophic participants according to Wical and Swoope[25] can be attributed to the use of a single height measurement from the lower edge of the mental foramen to the lower edge of the mandible.[25] Cawood and Howell[26] measured a greater number of anatomical landmarks, thus determining the degree of mandibular bone resorption in a more representative area of the mandible that includes the anterior and posterior region. However, the anatomical landmarks are significantly affected by complete tooth loss.[26] The mental foramen descends after tooth loss, and significant differences were described for posterior mandibular height, midline height, posterior mandibular edge length, and mandibular ramus width and height.[8] Other limitations of this study include having a single calibrated examiner and not evaluating parameters such as occlusal force, salivary flow, and the swallowing threshold.

CONCLUSIONS

Based on the findings of this clinical study, the following conclusions were drawn:

1. Most clinically atrophic participants showed poor retention and stability of the mandibular CD.
2. Only the poor retention directly affected the masticatory function.
3. Radiographic evaluations alone did not provide sufficient data to determine the predictability of CD treatment regarding the participants' masticatory function.
4. Radiographically atrophic participants with poor retention had impaired mastication.

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