Bite force and its correlations in different denture types

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Maximal bite force was measured and intraoral condition was examined in 89 patients at the Institute of Dentistry, University of Turku. These patients formed three different denture groups: those with complete dentures, those with full maxillary denture and partial mandibular denture, and those with natural dentition or skeleton-supported partial maxillary denture and partial mandibular denture. There were three age groups: ≥70, 60–69, and ≤59 years old. Maximal bite force was recorded with an appliance at seven different measuring points by placing a biting fork between the antagonistic teeth while at the same time the occlusion was stabilized contralaterally with a plastic tube. Maximal bite force had a correlation with age and sex ($P < 0.01$). In partial-denture groups high bite force had a positive correlation with the breaking of dentures ($P < 0.001$ and $P < 0.05$, respectively). Satisfied patients had a higher bite force than dissatisfied ones. When there was some disturbance in occlusion, the bite force was smaller, especially in full-denture groups ($P < 0.001$). Full-denture wearers also had a good bite force, but the best biting area was located more posteriorly than in patients who still had some natural teeth left in both jaws. Changes in the denture-bearing mucosa in patients with complete dentures and negative height of the mandibular alveolar process decreased the bite force slightly. □ *Alveolar process; mastication; occlusion; removable denture*

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The bite force in the masticatory system has been examined with the help of an electronic apparatus designed for this purpose. Both maximal and submaximal forces have been objects of research, and a positive correlation has been found between bite force and, for example, age, sex, the general condition of muscles, and the state and number of teeth (1–10). Physiologists examining bite force have been interested in how the bite forces respond to disturbances in occlusion and to the results of their treatment (9, 11–14). The facial anatomy and morphology also influence the bite force (15–18), as do psychological factors (19).

Some effects of bite force on prosthetic treatment have also been examined (1, 2, 4, 20–23), but bite force in connection with different types of dentures has not received the same attention.

In this study maximal bite force will be examined in various types of denture groups. The bite force will be compared with the age, sex, and fracture of the dentures, the patients' opinions of their dentures, and with the observations made in a clinical study of occlusion, oral mucosa, alveolar process, and periodontium.

Materials and methods

The material consisted of 89 randomly chosen patients who had been treated at the Institute of Dentistry, University of Turku. The patients, of whom 42 were women and 47 men, formed 3 age groups, and the average ages of these were 74.2, 64.8, and 48.5 years (Table 1). About 60% of the patients in the older age groups had some illness that needed continuous medication. The commonest of these illnesses were disturbances of the cardiovascular system and illnesses in the skeletal structure. In the youngest age group 22% was under continuous medication. However, the general condition of the patients was good.

The patients formed three denture groups: full denture in both jaws (Fd/Fd), full upper-denture/partial lower-denture group (Fd/Pd), and natural upper dentition or dentally supported upper partial-denture/partial

Table 1. Distribution of age, sex, and denture types*

Age groups, years	Sex	Fd/Fd, *n*	Fd/Pd, *n*	Nd, Pd/Pd, *n*	Total, *n*
≤70	F	8	3	2	13
	M	3	3	4	10
60–69	F	7	5	2	14
	M	4	5	8	17
≤59	F	4	4	7	15
	M	4	11	5	20
Total		30	31	28	89

* Fd = full denture; Pd = partial denture; Nd = natural dentition.

lower-denture group (Nd, Pd/Pd) (Table 1). Partial lower dentures were mainly dentogingivally supported skeleton dentures with bilateral extension saddles, and only the Nd, Pd/Pd group had some dentures with unilateral extension saddles. The age of the dentures varied from 6 months to 10 years, and the number of relined dentures increased with age. About a third of the patients in all denture groups had fractured and repaired dentures. There were great differences in the patients' satisfaction with their dentures, and most of the satisfied patients were in the Nd, Pd/Pd groups (Table 2).

The instability and interferences in occlusion and the changes in denture-supporting mucosa were registered mainly in accordance with the criteria given by Bergman et al. (24). The height of the mandibular alveolar process was estimated as high, low, or negative, and the changes in the periodontium, inflammation, and mobility around the abutment teeth were registered (Table 2).

The measurement of bite force

The measurement of bite force was carried out with an appliance especially designed for this purpose in the Technical Research Centre of Finland (6) (Bitex TRC, no. 802). The function of the appliance is based on a piezo-electric phenomenon created in the power fork, from which the charge is changed with the help of an amplifier to a current comparable to power. The current is finally brought to a digital recorder, from which the value in question can be read either directly or with the help of a graphic recorder. In this work only the maximal force that is effective between zero point and the moment of recording was examined. The recording area of the appliance is 1–199 kp (1 kp = 9.8 N). The measurement was carried out so that the roughly 3-mm-thick biting fork, which is covered with plastic, is placed between the teeth of the subject, and on the opposite side contralaterally is placed an elastic plastic tube of the same thickness, to stabilize the occlusion (Fig. 1). The subject was asked to

Table 2. Review of dentures and patients

	Fd/Fd, %	Fd/Pd, %	Nd, Pd/Pd, %
Fractured and repaired dentures	33.3	29.0	35.7
Satisfied patients	36.7	48.4	71.4
Instability and interferences in occlusion	37.5	32.3	14.9
Changes in denture-supporting mucosa	70.0	61.3	57.1
Height of mandibular alveolar process			
Low	59.1	58.1	53.6
Negative	40.9	16.1	0.0
Change in periodontium	—	22.6	17.9

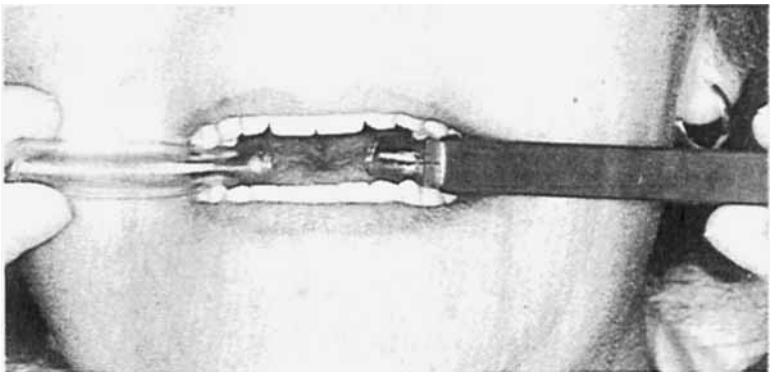

Fig. 1. Measurement of bite force with biting fork and stabilization contralaterally with plastic tube.

bite with maximum force. The measurement was repeated two to three times, and the sequential measurements were done at different points. The interval between measurements was about 15–30 sec. The measurement was always done by the same person, and another researcher recorded the results. Seven regions were measured: the molar (I, VI), the premolar (II, V), the canine (III_1, III_2), and the incisor region (IV). From the patients wearing partial dentures recordings were made separately in natural and artificial teeth. When the bite force of molar and premolar regions was measured, the occlusive position of the teeth was close to the centric relation. In recordings of the canine and incisor regions the mandibula was moved to a lateral position. The mean of the two highest recordings was accepted as the maximum value of the bite force.

Results

The youngest age group had the greatest bite force. In the Fd/Fd and Fd/Pd groups the bite force clearly decreased with age. In the Nd, Pd/Pd group, who had the greatest number of natural teeth left, the differences were the smallest (Fig. 2).

Women had a smaller bite force than men in all denture groups (Fig. 3). The result was statistically significant ($P < 0.01$).

Similar maximal bite force was recorded in Fd/Fd and Fd/Pd groups in different areas. In the areas of natural dentition the bite force was, however, somewhat greater. In the Nd, Pd/Pd group the bite force was considerably greater than in other groups, and in the areas of natural teeth the force was remarkably great in the canine and premolar regions (Fig. 4).

The fracture of dentures had in the complete-dentures group no correlation with the bite force. There was, however, a high correlation between bite force and denture fracture in the Fd/Pd group ($P < 0.001$), and in the Nd, Pd/Pd group the result was statistically almost significant ($P < 0.05$).

Patients who were satisfied with their dentures had in all denture groups on the average a slightly greater maximal bite force than the dissatisfied ones. The result was also statistically significant ($P < 0.01$) in the other groups, except in the Nd, Pd/Pd group ($P < 0.1$).

Instability and interferences in occlusion meant that the bite force decreased significantly in the Fd/Fd and Fd/Pd groups ($P < 0.001$). In the Nd, Pd/Pd group, however, there was no clear correlation between interference and bite force ($P < 0.1$) (Fig. 5).

The bite force of complete-dentures patients who had changes in denture-bearing mucosa was slightly decreased ($P < 0.1$). In partial-denture groups the bite force was on the contrary statistically significantly greater ($P < 0.01$) in patients who had changes in the denture-covered mucosa.

No mandibular alveolar process that could be estimated as high was found among the complete-dentures patients. A negative alveolar process in the complete-dentures

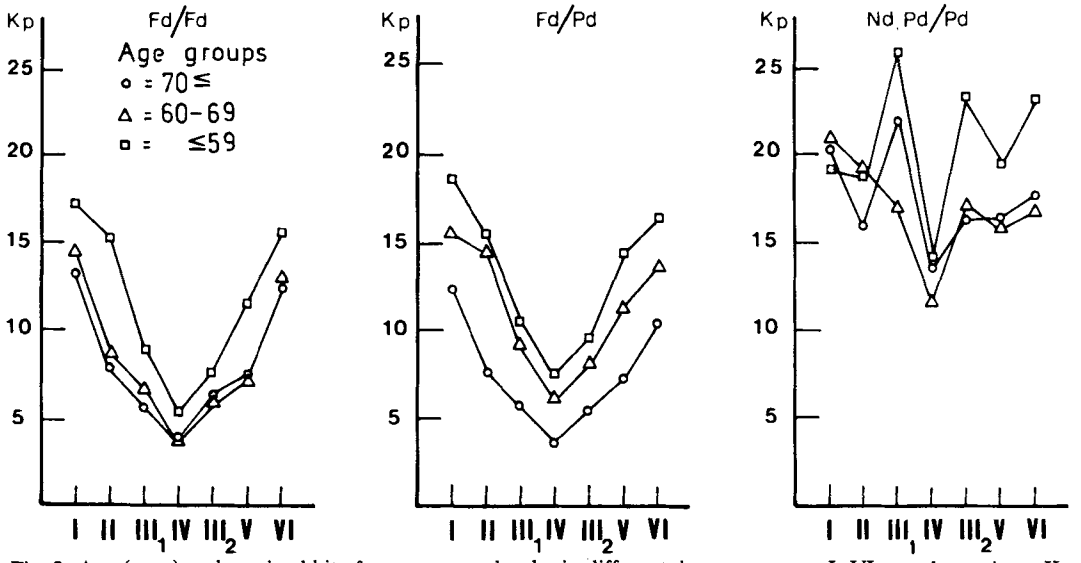

Fig. 2. Age (year) and maximal bite force expressed as kp in different denture groups. I, VI = molar regions; II, V = premolar regions, III_1, III_2 = canine regions; IV = incisor regions. 1 kp = 9.8 N.

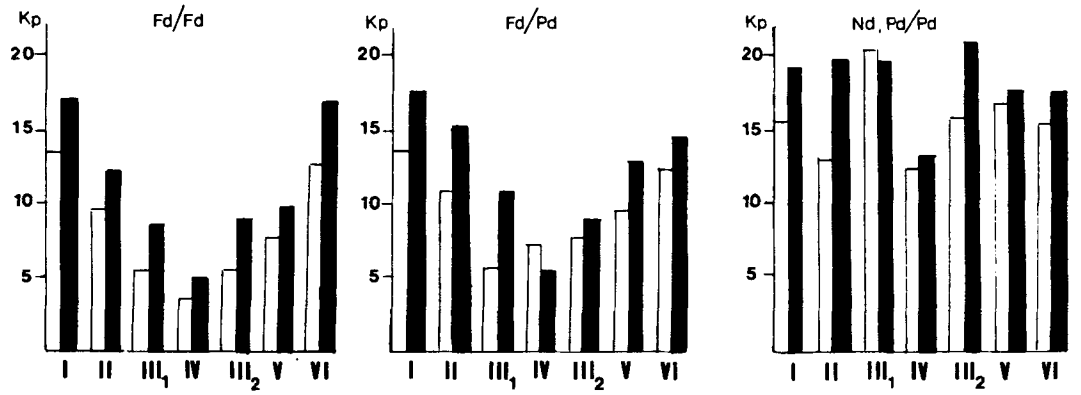

Fig. 3. Comparison of maximal bite force in women (open bar) and in men (closed bar) in different denture groups. For explanation of symbols, see Fig. 2.

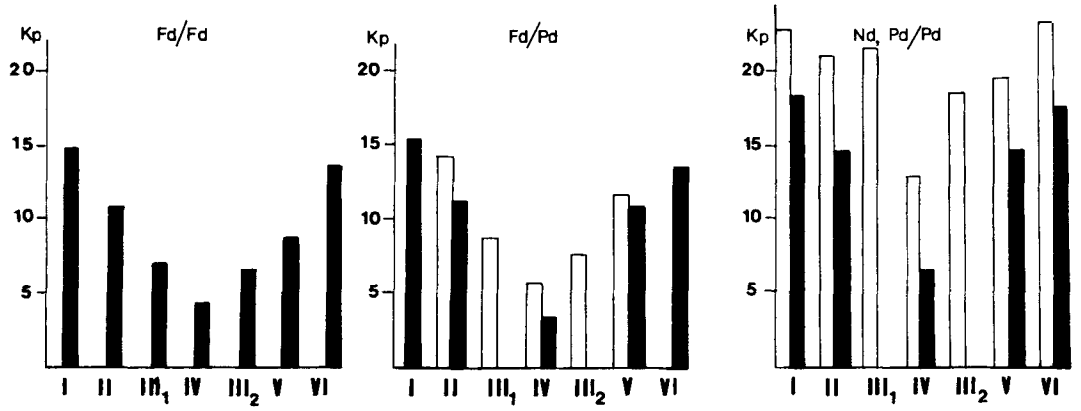

Fig. 4. Maximal bite force in different denture groups. Open bars indicate natural teeth and closed bars artificial teeth in the mandible. For explanation of symbols, see Fig. 2.

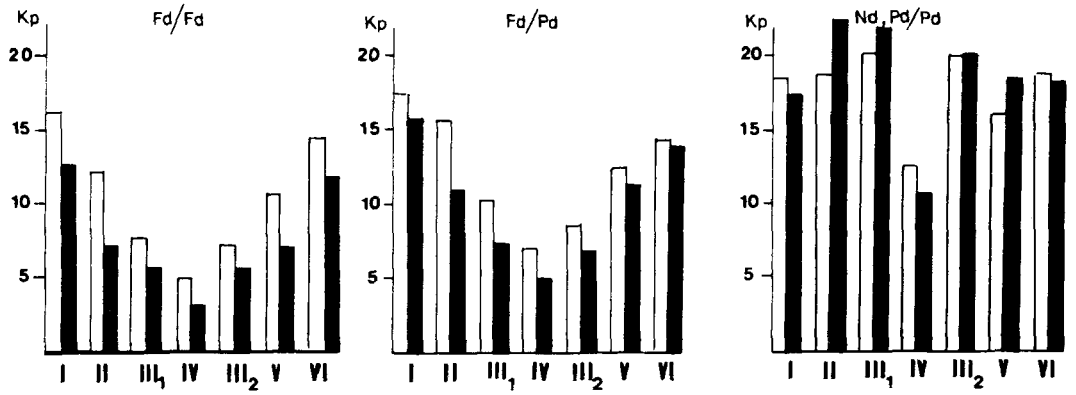

Fig. 5. Maximal bite force and instability and interferences in occlusion. Dark column indicates disturbances in occlusion. For explanation of symbols, see Fig. 2.

group caused a slight decrease in maximal bite force compared with a low alveolar process. In the Fd/Pd group, patients with a mandibular alveolar process that was defined as negative had a smaller bite force than others ($P < 0.001$), but there were no differences between low and high alveolar processes.

The periodontal changes of inflammation and mobility in the abutment teeth in the partial-denture group had in this study no clear connection with bite force.

Discussion

With regard to age and sex bite force was divided, so that the force can be expected to be connected with general muscle force, as has been observed in previous investigations (5, 7), although muscle force was not separately recorded in this study. As was to be expected, the bite force was clearly greater when there were natural teeth in the maxilla. The bite force of complete-dentures patients seemed to be fairly satisfactory, although in some studies (1, 2, 4) complete dentures have been found to be poor substitutes for natural teeth with regard to bite force. The greater bite force was in the molar and premolar regions, both in the complete-dentures group and in the partial-denture group in whom the opposing dentition was formed by full denture. The biting area was thus located further posteriorly compared with the Nd, Pd/Pd group. The contralateral stabilization of occlusion during the recording had a considerable effect. Values that were reached by this method were clearly greater than without stabilization, and the following measurement was more reliable. Biting by the method used usually did not hurt, although the force sometimes was rather great also in the areas of artificial teeth.

In partial-denture groups the patients with fractured and repaired dentures had high bite force. The fracture of denture is possible if the force that is directed towards some particular point of denture is too high. In the complete-dentures group the circumstances differ from the above, because the bite force is balanced by the resilience of the denture-bearing mucosa.

In this study the satisfaction with denture indicated that the maximal bite force correlated with biting ability (4, 19). Although satisfaction can have an emotional basis, such as an esthetic one, occlusion does, however, have an essential importance in the question of satisfaction.

The positive effect of a stable occlusion on the bite force was also clearly evident in this study (9, 11). The importance of a stable occlusion increased as the number of natural teeth decreased.

The state of the mucosa is important for the biting ability in patients with dentures (23). Changes in mucosa seemed to correlate

with bite force most easily in the complete-dentures group, which seems natural because of the gingival support of the structure.

The positive correlation between the bite force and the height of the alveolar process could be most easily seen in the Fd/Pd group, in which all the degrees of reduction could be seen. However, differences between alveolar processes that had been estimated as low or high were not large. The decrease in bite force was considerable only in the areas of negative alveolar processes. Thus both the bite force and the chewing efficiency are significantly decreased (3, 4, 10).

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