Diagnosing increased muscle activity and occlusal stress in temporo mandibular joint syndrome with Periotest

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Abstract

Periotest measurements were carried out not in occlusal contact to the antagonist tooth and under maximum habitual occlusion in 38 patients with functional temporo mandibular joint syndrome and in a control group of 25 test subjects with periodontally sound dentition. A comparison between the patients with temporo mandibular joint syndrome and test subjects without muscle findings showed significant (1%) variations both for Periotest measurements not in occlusal contact and particularly for Periotest value differences of the measurement carried out under maximum habitual occlusion and the measurement not in occlusal contact. This was especially true for the premolars and the first molars. In the test subjects without muscle findings, Periotest value differences were between -2.0 and -3.4 (confidence intervals). In patients with muscle findings, the Periotest value differences of -5.4 to -7.9 were greater.

Point-biserial correlation coefficients showed a particularly pronounced correlation between Periotest value differences and sensitivity to pressure in the aductory masticatory muscles.

Zusammenfassung

Bei 38 Patienten mit funktioneller Myoarthropathie und 25 Probanden einer Kontrollgruppe mit parodontal gesundem Gebiß wurden Periotestwerte bestimmt. Die Periotestmessungen wurden sowohl ohne Okklusalkontakt als auch in maximaler Interkuspidation durchgeführt. Der

Vergleich der Patienten mit Myoarthropathie und der Probanden ohne Muskelbefund ergab signifikante Unterschiede auf dem 1 %.Niveau sowohl bei Periotestwerten ohne Okklusalkontakt als auch vor allem bei den Differenzen der Periotestwerte ohne Okklusalkontakt und der Periotestwerte in maximaler Interkuspidation. Dies betraf vor allem die Prämolaren und die ersten Molaren. Bei Probanden ohne Muskelbefund ergaben sich Periotestwertdifferenzen zwischen -2,0 und -3,4 (Vertrauensbereiche). Bei Patienten mit Muskelbefund waren die Periotestwerte mit -5,4 ··· -7,9 ausgeprägter negativ.

Punktbiserielle Korrelationskoeffizienten ergaben einen besonders ausgeprägten Zusammenhang zwischen Periotestwertdifferenzen und der Aktivität der aduktorischen Kaumuskulatur.

Introduction

The Periotest measurement [1] represents an independent biophysical dimension. It reflects not only tooth mobility but also the visco-elastic characteristics of the periodontium. The Periotest measurement can be made freely by hand - no rigid fixtures are required. The Periotest method measures the deceleration of a rod which taps against the tooth under examination at a constant speed [2]. The greater the degree of periodontal structural change, the longer the time required for deceleration of the rod. The Periotest value not in occlusal contact to the antagonist tooth (PTV) reveals information about the unstressed periodontium of an individual tooth or about the implant bed of a single implant [3]. In contrast, the Periotest measurement carried out under maximum habitual occlusion gives information when the periodontal fibres are taut, thus allowing conclusions to be made about the occlusal stressing situation [4].

TMJ syndrome of functional and psychosomatic origin represents the third most common disease in dentistry after caries and periodontopathies [5].

Extensive investigations have been carried out among others by SHORE [6], LASKIN [7] and SCHULTE [5,8]. The disease focuses on muscle hypertonicity and excessive muscle activity which in turn damage the tissues and structures of the stomatognatic system by parafunctioning. In addition to occlusal factors, it is above all muscular hyperactivity of purely psychic origin which plays an important etiologic role. A relaxation therapy for patients aims amongst other things to curb excessive muscle activity and avoid parafunctioning. In addition to occlusal equilibration, relief can also be obtained in self-observation by the patient, muscle exercises, muscle massages and the application of splints [9-11].

One way of directly measuring muscle activity involves carrying out an electromyogram with surface electrodes. These measurements show that muscular activity during swallowing depends on what substance is being swallowed. When nothing is actually swallowed, there is little muscular activity [12]. Comparative investigations in patients with functional TMJ syndrome and healthy test persons show significant differences in the electromyogram, above all when at rest. The muscle activity required to hold the lower jaw at rest with the head held erect is increased in patients with functional TMJ syndrome [13-15]. In contrast, the fixing activity of a healthy, normally-innervated muscle shows no or only slight activity on a surface EMG.

Significant differences in the electromyogram can also be seen during swallowing in patients with functional TMJ syndrome before and after the introduction of splints [9], and before and after milling therapy [16].

The following report is designed to investigate the influence of increased muscle activity on occlusal-periodontal stressing and to correlate with Periotest measurement.

Material and methods

Investigations were carried out on 38 patients with functional TMJ syndrome and a control group of 25 test persons without TMJ syndrome. The control group consisted of dental students and assistant dentists of our dental school and was split into two sub-groups: those with palpable myogeloses or pressure sensitivity in the area of the aductory masticatory muscles and those without any muscle findings (Fig. 1). The test persons in the control group were aged between 20 and 30 years.

The patients with TMJ syndrome were all periodontally healthy. 28 of the 38 patients were female, 10 were male. Fig. 2 shows the frequency distribution according to age and sex. The frequency peak falls in the middle of the third decade. The female sex is 3 times more frequently represented than the male. Teeth in the maxilla were not blocked by prosthetic work in order not to influence the Periotest measurement. Patients were split into those with discoordination with and without lateral deflection [17].

Apart from the lateral pterygoid muscles, palpation of the musculature was carried out bimanually. The following muscles were included in the investigation: superficial part of the masseter muscle, temporal muscle, posterior venter of the digastric muscle, lateral pterygoid muscle, medial pterygoid muscle, sternocleidomastoid muscle and the suboccipital muscle. Palpation of the temporomandibular joint was carried out bimanually from the side, in front of the tragus and from dorsally in the external auditory canal. The distance between the two incisor edges was measured during maximum mouth opening. Thereafter, the deviations during the opening movement were registered.

Prior to the Periotest measurement, patients and test persons were all asked to take up their habitual intercuspidation position and swallow several times. For this Periotest measurement under maximum habitual

occlusion they were asked to hold the same mandible position and bite as far as possible. Measurements began on the second upper molar on the right (FDI designation 17) and continued along the anterior teeth up to the second upper molar on the left (27). At each tooth location the Periotest value not in occlusal contact was first determined, followed by the Periotest value in maximum intercuspidation without removing the handpiece. The guidelines for measurements given by the manufacturer (Ing. Peter Gulden, Medizintechnik, Bensheim, Germany) were followed [18]. Due to the stressed masseter muscles, however, measurements under maximum habitual occlusion could not be carried out on the second molars in the midbuccal/lingual percussing direction. For this reason, a mesial-eccentric percussing direction was used instead at these tooth sites, both for measurements not in occlusal contact as well as under maximum habitual occlusion (Fig. 3).

Statistical evaluation was carried out according to SACHS [19] on a PC using a standard spreadsheet program (123 from Lotus Development Corporation).

Results

Table 1 and Fig. 4 show the results of the control group with and without muscle findings, distributed according to tooth locations. Test persons with muscle findings exhibit Periotest values (PTV) elevated by 1 to 2 in the posterior tooth region compared to those without muscle findings.

Table 2 and Fig. 5 show the Periotest values differences of the measurement under maximum habitual occlusion and the measurement not in occlusal contact (DIFF). For test persons without muscle findings the Periotest value differences are in the range of -1.3 to -4.1; for those with muscle findings, more negative Periotest value differences of -2.6 to -7.2

were found. The differences in the premolars and first molars were especially pronounced, as can be seen from Fig. 5.

The variations in the Periotest values not in occlusion (PTV) and the variations in the Periotest value differences (DIFF) caused by the muscle finding were checked with the U-test according to Wilcoxon, Mann and Whitney. The result can be seen in Table 3. The test was carried out two-sided at the 1% significance level. The Periotest values not in occlusal contact are greater and the Periotest value differences are more pronounced negative in test persons with muscle findings. In the posterior tooth area these variations are significant.

In order to attain a measure of the stochastic dependency of the Periotest results on muscle findings, a point-biserial correlation analysis was carried out. Table 4 shows the correlation coefficients for the various tooth locations. The highest correlation can be seen in the posterior tooth area for Periotest value differences. The point-biserial correlation coefficient has values in this area of more than 0.70. Thus, the Periotest value differences are strongly correlated to the muscle finding. A less strong correlation with the muscle finding is shown by the Periotest values not in occlusion. In the posterior tooth area the values are in the range of 0.50 to 0.63. The negligible correlation coefficients of the second molars are striking. Here, there is only a slight correlation with the muscle finding.

The 38 patients with discoordination split up into 18 without lateral deviation, 5 with lateral deviation to the right and 15 with lateral deviation to the left (cf. Fig. 6).

Table 5 shows the evaluation of the Periotest values not in occlusion (PTV) for female and male patients with discoordination. All 95% confidence intervals fall within the Periotest value normal range [2]. The mean Periotest values of the female patients are approximately 1.5 to 2.5 higher than the mean Periotest values of the male patients. This is more or less in

accordance with the difference of Periotest values of healthy male and female adults, which according to D'HOEDT [18] is 1.4 (cf. Fig. 7).

Table 6 shows the Periotest value differences (DIFF) of patients with discoordination. The Periotest value differences in female patients are on average -0.1 to -1.6 more negative than in male patients. The same variation was found by SCHULTE and WAGNER [20]. However, this difference is not statistically significant (cf. Fig. 8).

Fig. 9 shows a comparison of the Periotest value differences between the patient group with discoordination and the control group with muscle findings. The latter was not subdivided according to sex.

Since all confidence intervals overlap, there are no significant differences. This was checked with the Wilcoxon, Mann and Whitney U-Test at the 1% significance level. Neither the Periotest value differences of the female nor the male patient group vary significantly from the control group with muscle findings.

Discussion

The mean Periotest values (PTV) of the test persons are approximately 2 to 3 below the Periotest normal values [2,18]; they do, however, fall within the normal Periotest ranges. This could be explained by the predominant youthfulness of the control group.

The Periotest values differences in maximum intercuspidation and not in occlusal contact (DIFF) show a statistically highly significant variation for control test persons with and without muscle findings (aductorial musculature with myogeloses and sensitivity to pressure). With the help of the U-Test at the 1% level, a significant difference could be found in the posterior tooth area. This applies to the premolars and first molars. Test

persons without muscle findings have Periotest value differences between -2.0 and -3.4 (confidence intervals), whereas test persons with muscle findings have Periotest value differences of between -5.4 and -7.9. This is caused by the increased muscular activity of the test persons and is consistent with electromyographic studies about the correlation between functional TMJ syndrome and increased muscle activity [1,14,15]; it also provides additional proof of increased occlusal-periodontal stress. The high resolution capability of the Periotest device enables it to differentiate between the varying degrees of tooth stress in test persons without and with muscle findings. The determination of the point-biserial correlation coefficients also confirms this capability. Periotest value differences are correlated most strongly with a muscle finding in the aductory masticatory muscles.

A comparison of the two control groups in the area of the second molars did not show any significant variation in the Periotest value differences. This could be due to the difficult access to this tooth region, making it impossible to use the standard percussion technique in midbuccal/lingual direction, thus possibly lessening the sensitivity of the Periotest method. On the other hand, the cause could also be that the second molars do not fall within the central masticatory range.

Test persons without muscle findings had smaller Periotest values not in occlusion (PTV) than test persons with muscle findings. This was statistically significant in the premolars and the first molars. This result leads us to conclude that the periodontal damping capability is altered under increased stressing. Various authors point out that non-physiological tooth stressing - caused, for example, by parafunctioning - leads to increased tooth mobility. This in turn alters the visco-elastic characteristics of the periodontium, as manifested in increased Periotest values [21-23].

Periotest values not in occlusion for female patients with TMJ syndrome are higher than the Periotest values of male patients. This confirms the findings of D'HOEDT [18] and LUKAS [2]. The Periotest value differences (DIFF) in male patients are between -5 and -6, those of female patients between -6 and -7. These differences are not, however, statistically significant.

A comparison between the test person group with muscle findings and the patient group with discoordination shows that the 95% confidence intervals of the Periotest values not in occlusion largely overlap. The U-Test according to Wilcoxon, Mann and Whitney shows no significant variations at the 1% significance level.

The Periotest value differences (DIFF) reflect the increased muscle activity of patients with discoordination. The supposition that measuring Periotest value differences enables statements to be made about aductory muscular activity is thus confirmed. A subdivision of patients with discoordination into sub-groups with and without lateral deviation did not reflect any significant correlation with the Periotest value differences. One tendency, was, however, revealed: patients with lateral deviation to the left had more negative Periotest value differences in the left lateral range, and patients with lateral deviation to the right had more negative Periotest value differences in the right lateral tooth range. These variations are not significant, however. A possible cause could be the unequal muscular activity of the right-hand or left-hand aductory masticatory muscles.

Conclusions

Measurement of the Periotest value differences in maximum intercuspidation and not in occlusion (DIFF) facilitates determination of the increased muscular activity of the aductory masticatory muscles, as can be found in patients with functional TMJ syndrome, as well as increased occlusal-periodontal stressing.

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Table 1 Evaluation of Periotest measurements not in occlusal contact (PTV) for test persons without TMJ without and with muscle findings according to tooth locations. (go back)

without muscle findings and without TMJ:	Incisor		Canine	Bicuspid		Molar	
	Central	Lateral		First	Second	First	Second
Mean PTV	2.1	1.0	-2.5	0.0	-0.3	-0.6	1.0
confidence interval	1.5...2.7	0.5...1.5	-3.0...-	-0.4...0.5	-0.8...0.2	-1.3...0.0	0.4...1.6
number of measurements	30	30	30	30	30	30	30
standard deviation	1.6	1.3	1.5	1.4	1.5	1.8	1.7

with muscle findings and without TMJ:	Incisor		Canine	Bicuspid		Molar	
	Central	Lateral		First	Second	First	Second
Mean PTV	2.3	2.8	-2.1	2.0	2.4	1.4	2.3
confidence interval	1.4...3.2	2.0...3.6	-2.5...-	1.4...2.6	1.5...3.2	0.6...2.1	1.3...3.2
number of measurements	20	20	20	20	20	20	20
standard deviation	1.9	1.7	1.0	1.4	1.8	1.7	1.9

Table 2 Evaluations of Periotest value differences yielded of the measurement carried out under maximum habitual occlusion and the measurement not in occlusal contact (DIFF).) Test persons without TMJ without and with muscle findings according to tooth locations. (go back)

without muscle findings and without TMJ:	Incisor		Canine	Bicuspid		Molar	
	Central	Lateral		First	Second	First	Second
Mean DIFF	-2.9	-2.4	-1.3	-2.7	-2.7	-2.7	-4.1
confidence interval	-4.3...-1.6	-3.4...-1.3	-1.9...-0.8	-3.4...-2.0	-3.2...-2.2	-3.3...-2.2	-5.0...-3.2
number of measurements	30	30	30	30	30	30	30
standard deviation	3.5	2.8	1.5	1.9	1.5	1.5	2.5

with muscle findings and without TMJ:	Incisor		Canine	Bicuspid		Molar	
	Central	Lateral		First	Second	First	Second
Mean DIFF	-2.6	-4.0	-2.7	-7.2	-6.9	-6.1	-6.0
confidence interval	-3.9...-1.3	-5.4...-2.6	-3.4...-2.0	-7.8...-6.5	-7.9...-5.9	-6.8...-5.4	-7.2...-4.7
number of measurements	20	20	20	20	20	20	20
standard deviation	2.9	3.0	1.4	1.5	2.1	1.5	2.7

Table 3 Comparison of Periotest values not in occlusion (PTV) and the Periotest value differences not in occlusion and in maximum intercuspidation (DIFF). Test persons without TMJ. With U-test according to Wilcoxon, Mann and Whitney was checked if the mean values without and with muscle findings are distinct. (go back)

	Statistical significance ascertainable:						
	Incisor		Canine	Bicuspid		Molar	
	Central	Lateral		First	Second	First	Second
Mean PTV	*no*	*no*	*no*	* YES *	* YES *	* YES *	*no*
Mean DIFF	*no*	*no*	* YES *	* YES *	* YES *	* YES *	*no*

Table 4 Point-biserial correlation between test persons with and without muscle findings and Periotest values not in occlusion (PTV) and the Periotest value differences not in occlusion and in maximum intercuspidation (DIFF). Test persons without TMJ. (go back)

	Point-biserial correlation coefficient						
	Incisor		Canine	Bicuspid		Molar	
	Central	Lateral		First	Second	First	Second
Mean PTV	0.05	0.52	0.15	0.58	0.63	0.50	0.32
Mean DIFF	0.00	0.27	0.42	0.79	0.77	0.74	0.34

Table 5 Periotest values not in occlusion (PTV) in patients with TMJ and discoordination. No distinction is made between discoordination with and without lateral deviation of the mandible. (go back)

female patients:	Incisor		Canine	Bicuspid		Molar	
	Central	Lateral		First	Second	First	Second
Mean PTV	6.4	5.6	1.6	6.3	6.5	5.7	8.3
confidence interval	5.4...7.5	4.7...6.5	0.8...2.4	5.4...7.2	5.5...7.6	4.7...6.7	7.0...9.7
number of measurements	52	52	51	46	50	51	51
standard deviation	3.7	3.	02.9	3.1	3.8	3.6	4.7

male patients:	Incisor		Canine	Bicuspid		Molar	
	Central	Lateral		First	Second	First	Second
Mean PTV	4.4	4.1	0.3	3.3	4.0	1.8	4.6
confidence interval	2.6...6.1	2.2...5.9	-1.6...2.2	2.2...4.3	2.9...5.1	0.5...3.1	3.5...5.8
number of measurements	20	20	20	18	17	17	19
standard deviation	3.7	4.0	4.1	2.2	2.4	2.7	2.5

Table 6 Periotest value differences (DIFF) in patients with TMJ and discoordination. No distinction is made between discoordination with and without lateral deviation of the mandible. (go back)

female patients:	Incisor		Canine	Bicuspid		Molar	
	Central	Lateral		First	Second	First	Second
Mean DIFF	-3.9	-3.7	-3.4	-6.3	-6.1	-6.7	-10.3
confidence interval	-5.0...-2.7	-4.8...-2.5	-4.2...-2.5	-7.7...-5.0	-7.4...-4.8	-7.8...-5.5	-11.8...-
number of measurements	52	52	51	46	50	51	51
standard deviation	4.1	4.0	3.0	4.8	4.6	4.1	5.2

male patients:	Incisor		Canine	Bicuspid		Molar	
	Central	Lateral		First	Second	First	Second
Mean DIFF	-3.8	-3.5	-2.9	-5.3	-5.7	-5.2	-8.7
confidence interval	-5.3...-2.2	-5.3...-1.6	-3.9...-1.9	-6.6...-4.0	-7.3...-4.2	-6.7...-3.7	-10.5...-6.9
number of measurements	20	20	20	18	17	17	19
standard deviation	3.4	3.9	2.2	2.9	3.3	3.2	3.8

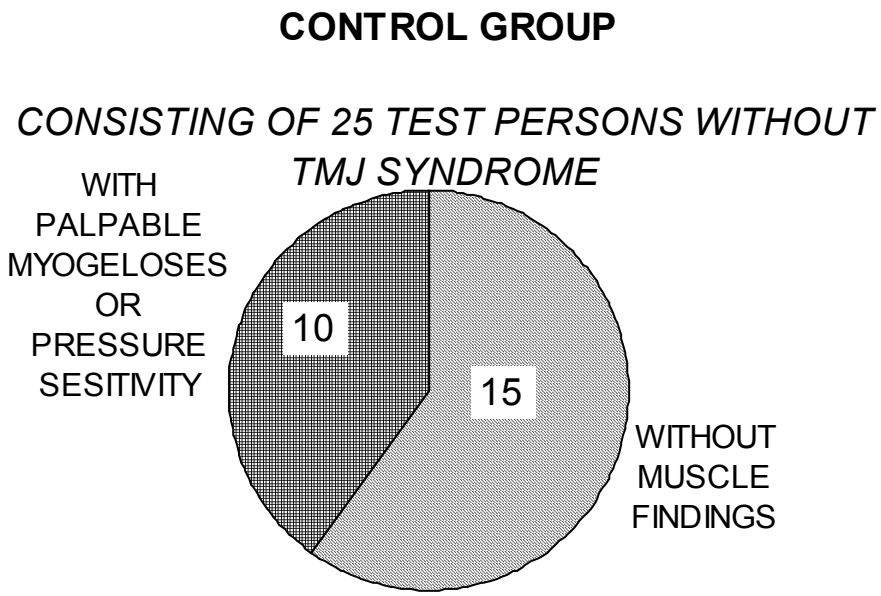

Fig. 1. Subdivision of the control group according to muscle findings. (**go back**)

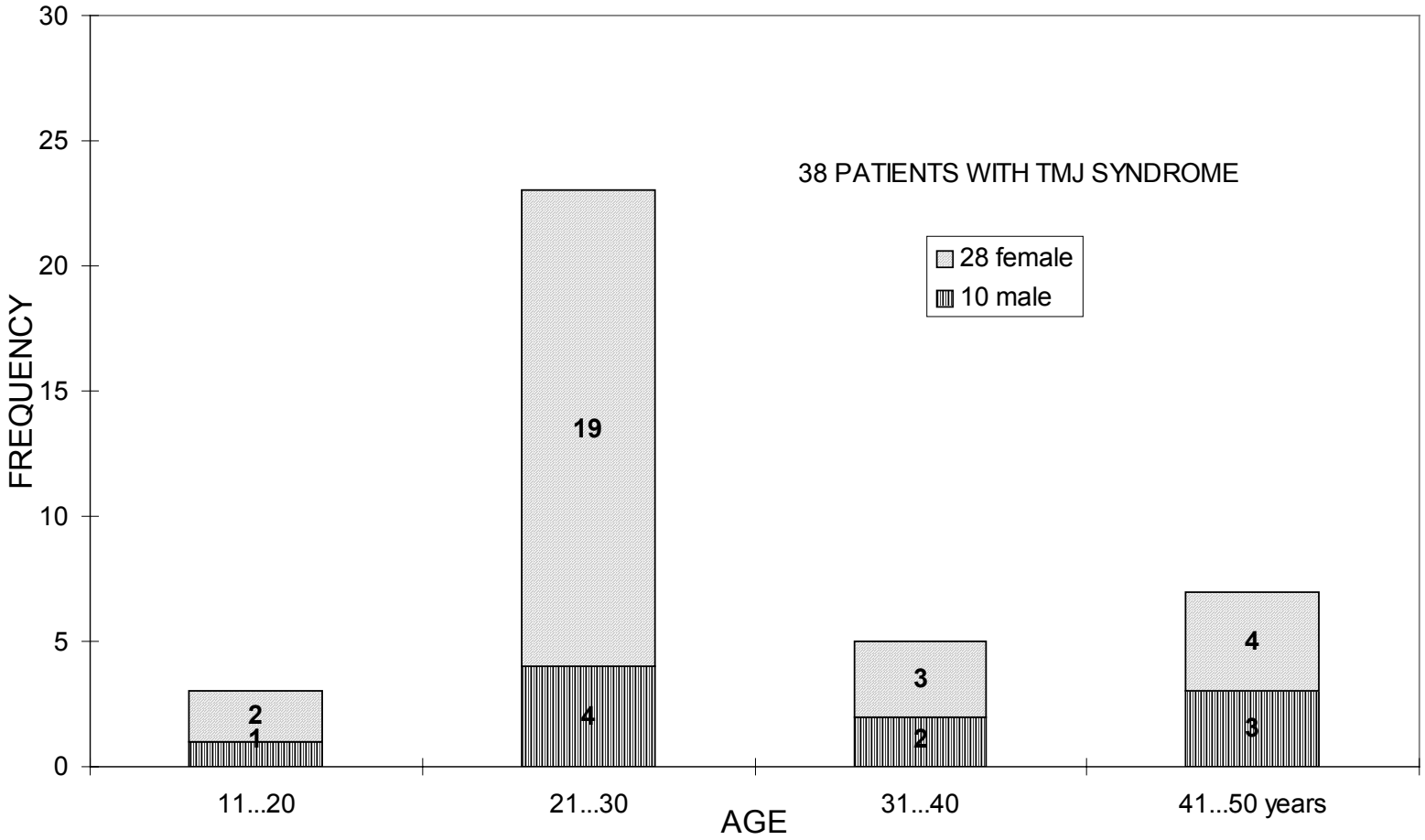

Fig. 2. Age distribution of the patient group, subdivided according to sex. (**go back**)

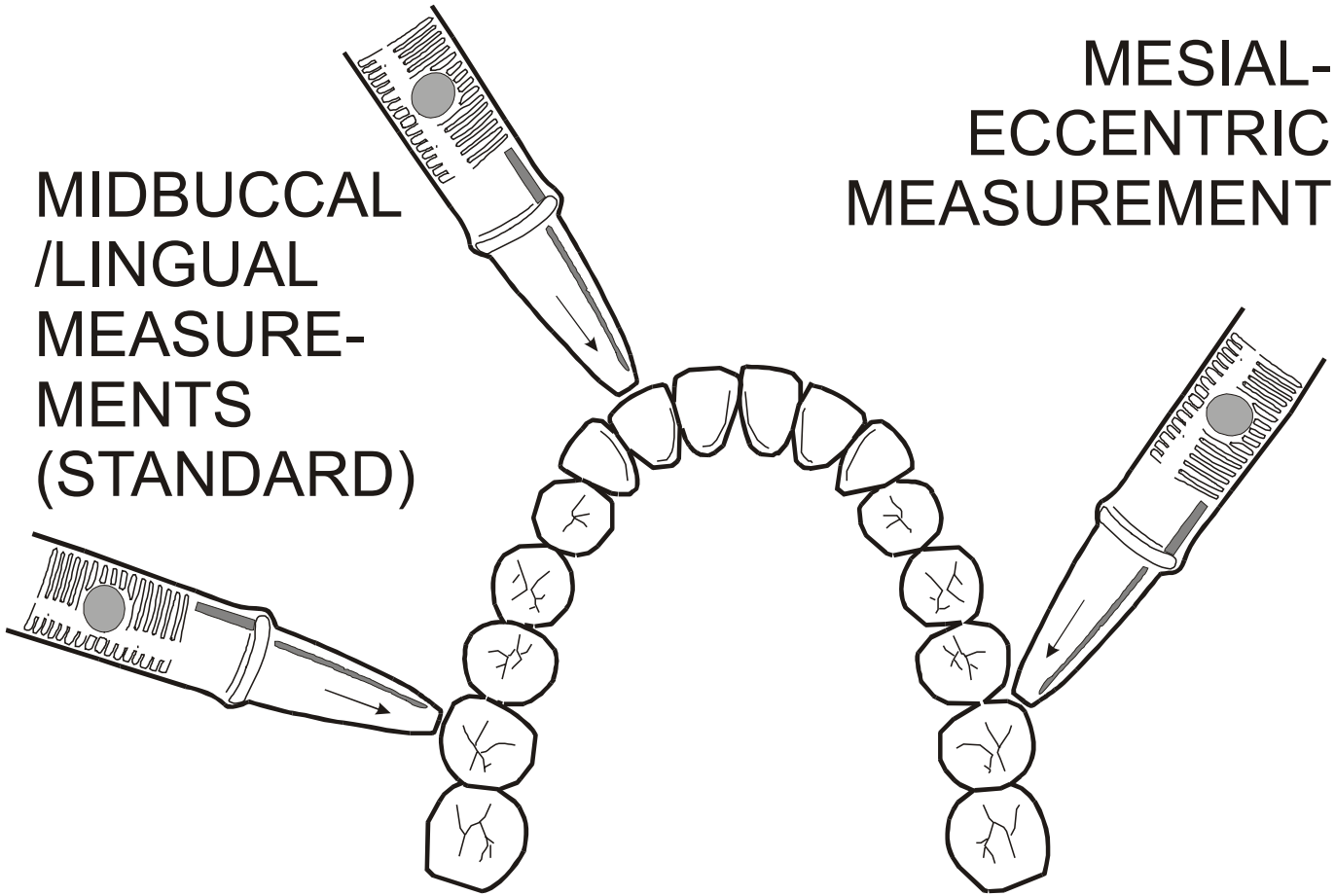

Fig. 3. The mesial-eccentric percussing direction on the second molar (right) as opposed to the standard midbuccal/lingual direction (left) as recommended in the operating instructions. (go back)

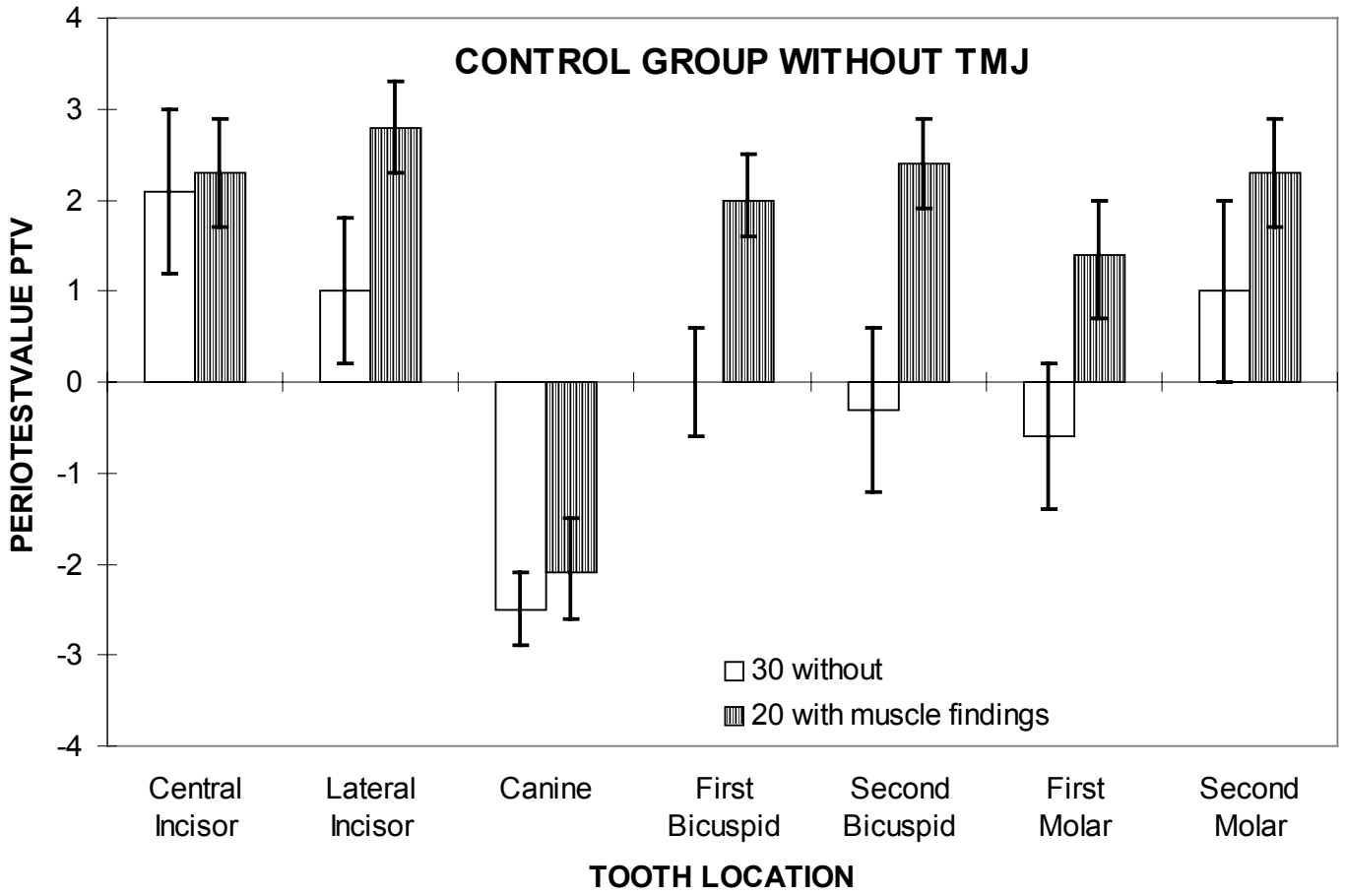

Fig. 4. Comparison of mean Periotest values (PTV) and corresponding 95% confidence intervals in test persons with and without muscle findings. (go back)

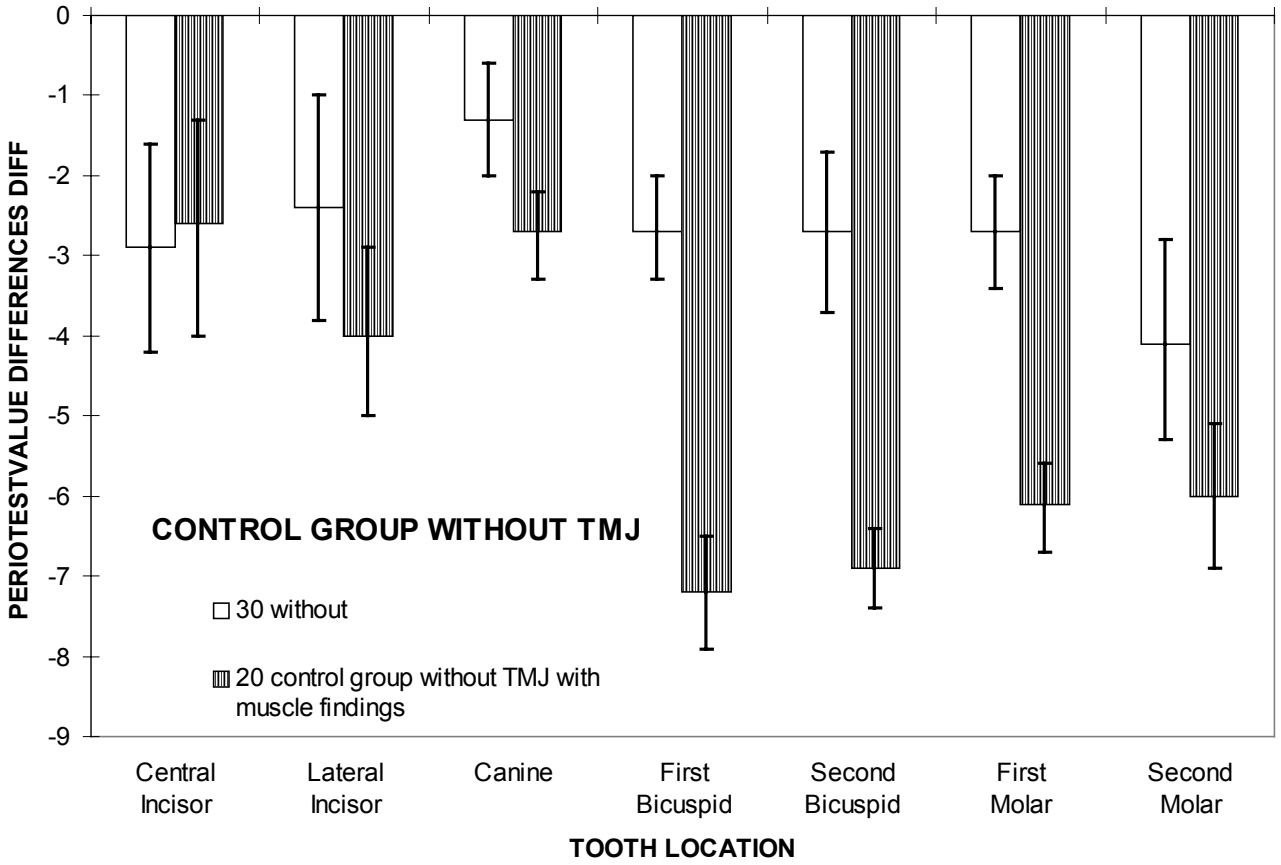

Fig. 5. Comparison of Periotest value differences (DIFF). Subdivided into test persons with and without muscle findings. (**go back**)

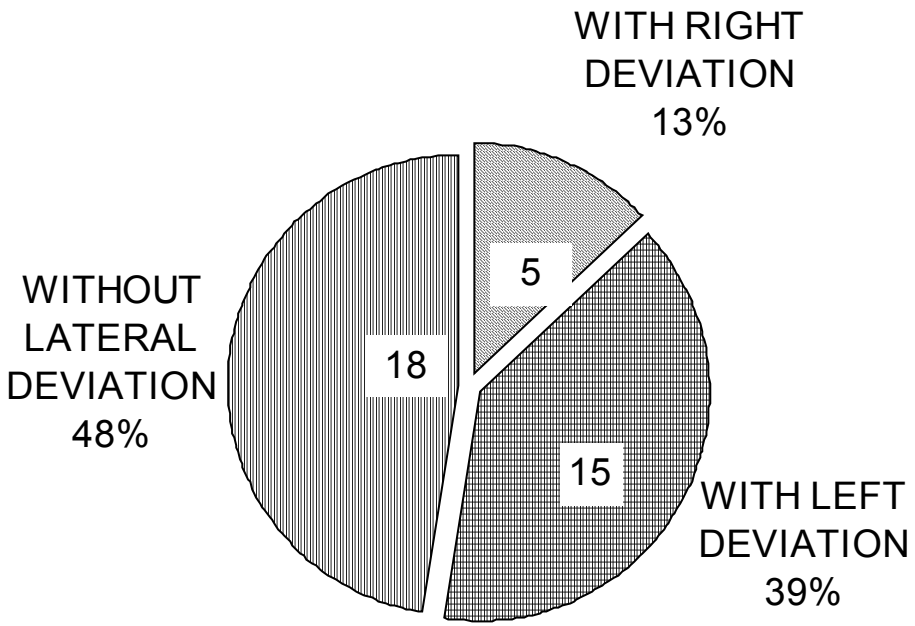

Fig. 6. Subdivision of patients with discoordination. (go back)

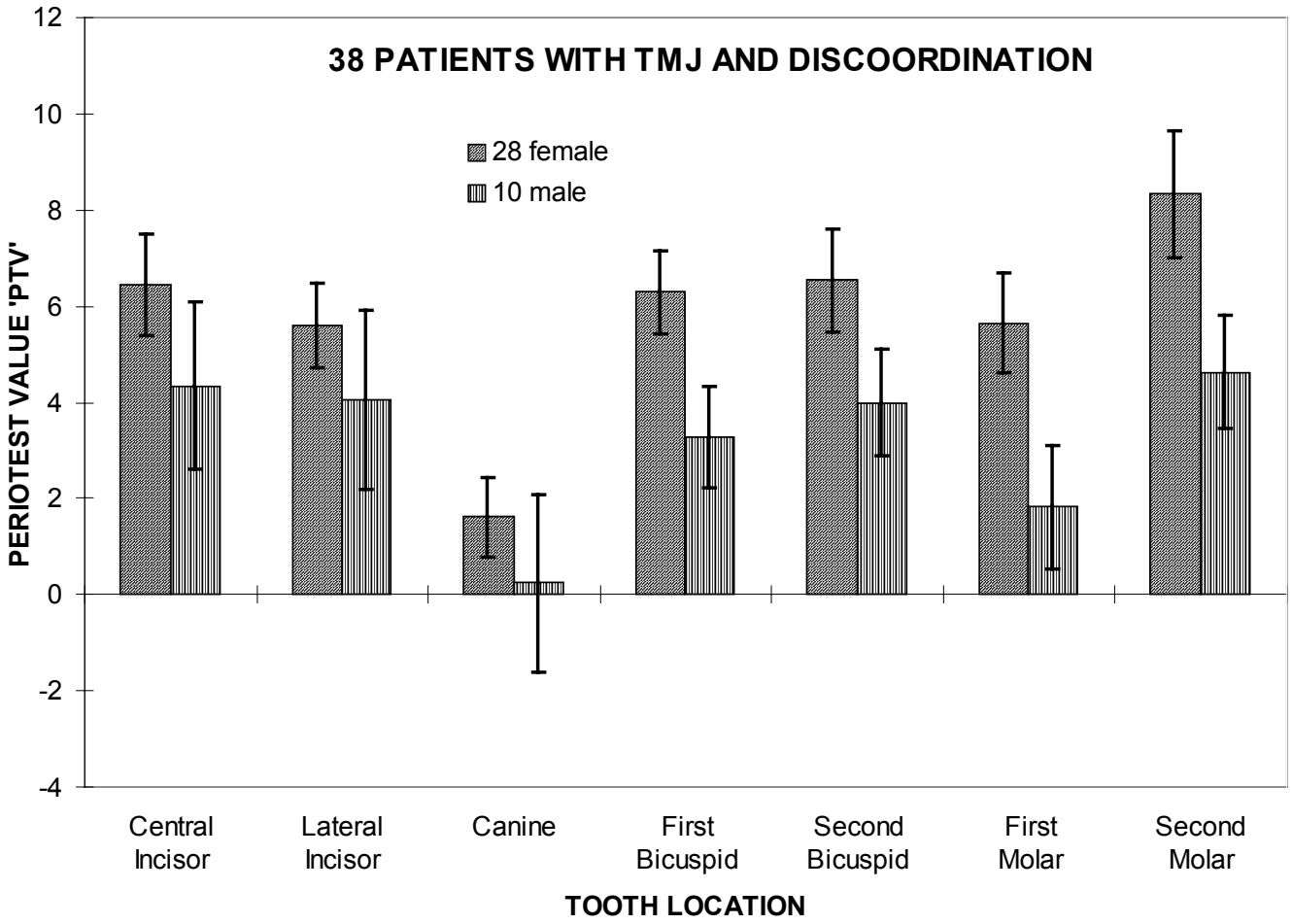

Fig. 7. Mean Periotest values and 95% confidence intervals of female and male patients with discoordination.

(go back)

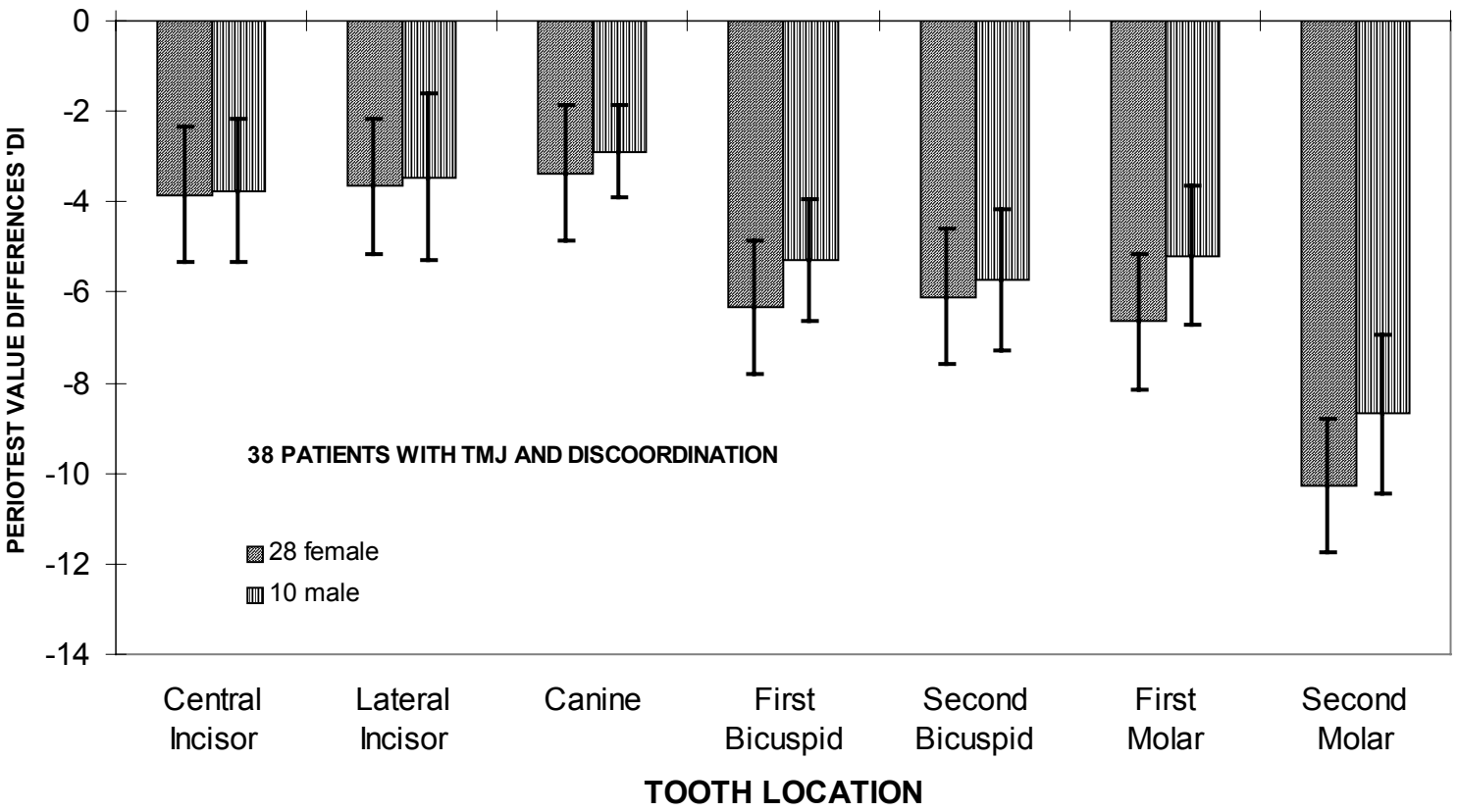

Fig. 8. Periotest value differences in maximum intercuspidation and not in occlusion (DIFF) in patients with discoordination. (**go back**)

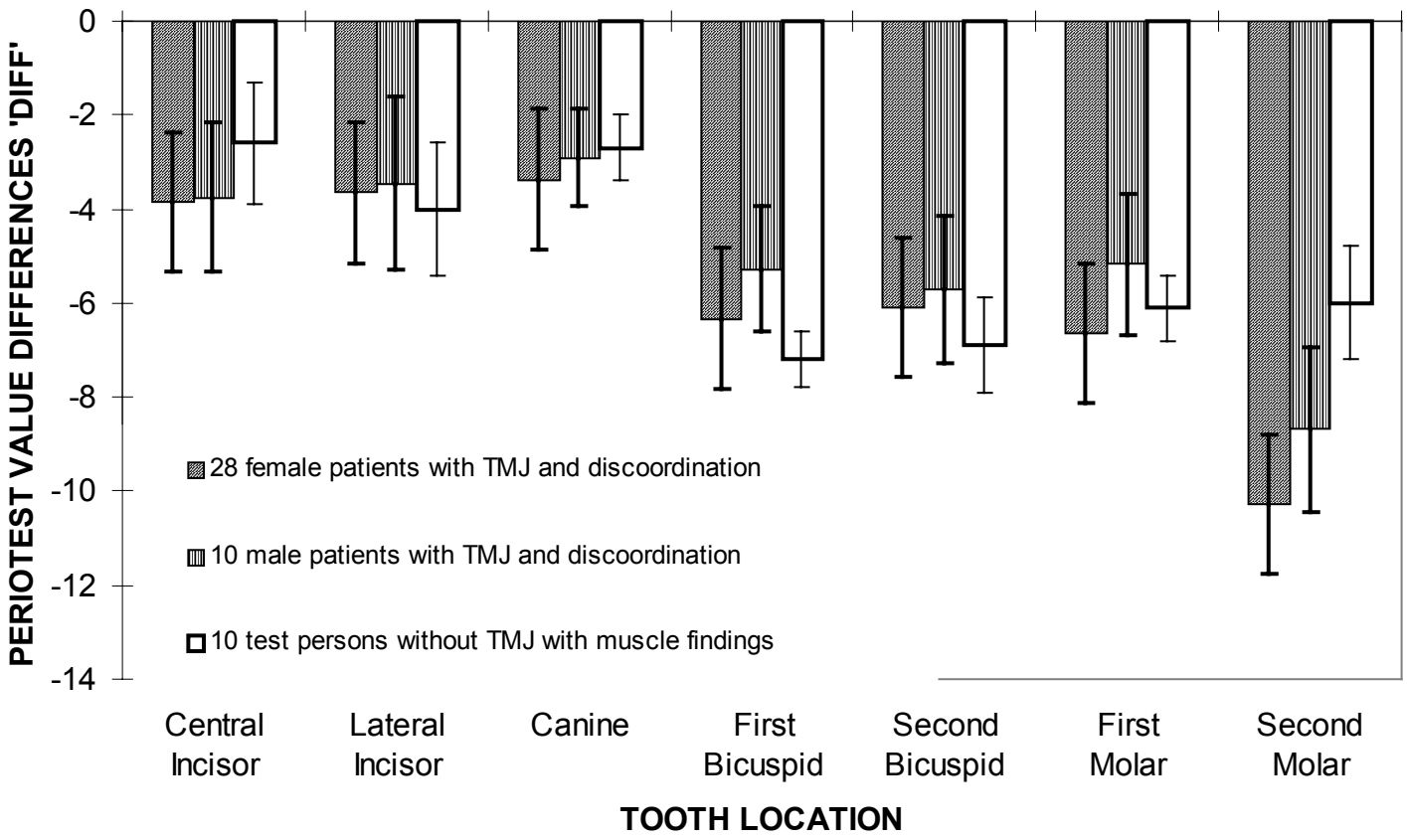

Fig. 9. Comparison of mean values and 95% confidence intervals between the control test persons with muscle findings and patients with discoordination. (**go back**)