Electromyographic studies of pelvic floor and abdominal musculature in normal women performing various exercises

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Summary: **Utilising EMG the study was conducted on normal healthy women, to assess the strength/tension characteristics of pelvic floor musculature during certain unconventional as compared to the classical exercises used for pelvic floor strengthening and re-education. Further, the correlation of pelvic floor and abdominal muscle activity during these exercises was worked out. Baseline activity to maximum build up of EMG and consequent relaxation was recorded for various exercises.**

On comparing individual exercises, the order of the positions of exercise progression for pelvic floor strengthening was found to be crooklying, supine, prone, Buddha, high sitting, standing, knee to chest, quadruped and finally squatting. In all these positions a better perineal contraction was achieved with the lower limbs in abduction, contrary to what is conventionally advised. The abdominals showed a minimal level of activity during pelvic floor exercises and vice-versa.

Introduction

Pelvic floor exercises are generally recommended in early cases of genital prolapse, stress urinary incontinence and other pelvic floor dysfunctions. Kegel (1948), was the first to stress on perineal exercises for these disorders, though many questions were left un-answered relating to methodology and only anecdotal information was quoted. Later reports (Godec et al, 1978; Tchou et al, 1988; Montgomery et al, 1983; McQuire, 1975; Harris, 1983; Laycock, 1987; Santiesteban 1988), mainly demonstrate the utility of pelvic floor exercises and electrical stimulations of perineal muscles in the management of stress urinary incontinence only. In these studies, the criteria for selection of exercise positions are not clear and also there is a wide variability in the recommended type, duration and progression of exercises. Additionally, there is no comment whether abdominal muscles could be strengthened simultaneously with pelvic floor muscles.

A clinical study on the effect of perineal exercises in genital prolapse conducted at our institute did reveal that patients with early genital prolapse benefit from these exercises (Shandilya et al, 1993). However, the questions related to selection of postures, exercises and their progression etc. could not be well defined.

The present study was undertaken to assess with the help of EMG, the strength/tension characteristics of pelvic floor musculature during certain unconventional as compared to the classical exercises used for pelvic floor strengthening and re-education and to evaluate the relationship of pelvic floor and abdominal muscle activity simultaneously during various exercises in normal women.

Material and methods

A total of 20 normal healthy non-obese women (average age: 26.15 years, range 19 - 41 years) having good tone and control of perineal and abdominal muscles having power of grade 3 or more were selected for the study. The procedure and its significance were explained to each

subject and a written consent obtained.

The subjects were examined in one sitting during the post-menstrual period. The examination included gynaecological, physiotherapy and EMG recordings. The methodology was as follows:

Gynaecological examination

Routine gynaecological examination of the subjects was done including per vagina examination to rule out clinically any obvious gynaecological pathology.

Physiotherapy assessment included

Digital evaluation of pelvic floor muscles to assess (i) tone and (ii) control in the lithotomy position (Graber, 1982). Abdominal muscle power was graded by the standard manual muscle testing criteria (Daniels et al, 1977)

The electromyographic recording

The EMG was recorded on a single channel student's physiograph (INCO) with a biopotential coupler. Two such instruments were used, one for recording abdominal muscle activity and the other for perineal muscles. During the entire recording session the subject was kept in a shielded cabin. Silver chloride disc electrodes (diameter 4mm approx.) were used. The electrodes were sterilised in Cydex and were smeared with electrode jelly (Elefix Nihon Kohden Co. Ltd.) which was non-acidic. There were no complaints of irritated vaginal mucosa from our subjects on subsequent visits to the gynaecology OPD.

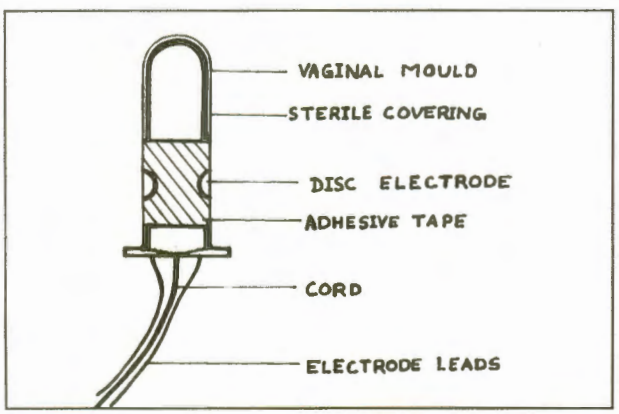

Fig I. Vaginal Electrode Assembly for Recording EMG

The vaginal electrode assembly (Fig. I) consisted basically of the vaginal mould modified so as to fix disc electrodes on it. The vaginal moulds were made of varying sizes (maximum length = 5 cm and diameter = 2 cm) to ensure proper tissue electrode contact. They were made of plaster of Paris bandages and are hollow from inside (weight = 10 grams each). The moulds were covered with a fresh condom for each patient. A plastic stop ensured that no upward or downward movement of electrodes occurred during contraction/recordings. The ground electrode was attached to the leg on the anteromedial surface. The abdominal electrodes were placed on the anterior aspect of the abdomen mainly in the region of the rectus abdominis. The bipolar electrode configuration was used for both muscle groups.

Each recording was made starting with a basic level record to the maximum build up of the electrical activity during voluntary contraction of pelvic floor muscles. No recording was taken during change of posture.

Exercises assessed

The subjects were asked to perform the group maximal contraction which is a strong pelvic floor contraction in a cephaled direction (Santiesteban, 1988). The contraction was held for a maximum of 3 seconds followed by a rest period of 10 seconds. An additional rest period of 2 minutes was given after 3 such contractions. EMG was recorded for both the muscle groups (perineal and abdominal) for these exercises in various new (position nos.: 1,2,3,4,5,6,9,10,11,15) as well as conventional positions (position nos.: 7,8,12,13,14,16,18,19,20) listed in Table I.

The abdominal exercises assessed were the ones which are commonly used for strengthening these muscles, namely the posterior pelvic tilt, curl-up and the reverse curl (Gardiner, 1981).

Data analysis

The method of analysis (Kelly; 1971) of the electromyograms was partially subjective, i.e. by visual analysis, and partially objective, i.e. measurement of am-

Table I

EMG of Perineal Muscles During Group Maximal Contraction in Various Positions

S. No.	Positions	Group Maximal Contraction (mean ± S.D.)
1.	Crook Ly -L.L. abd.	50.50 ± 28.92
2.	Supine - L.L. abd.	46.57 ± 26.82
3	Prone - L.L. abd.	46.05 ± 28.36
4.	Buddha Position	43.94 ± 28.99
5.	High Sitt- L. L. abd.	43.68 ± 23.56
6.	Resisted abd in crook ly.	43.46 ± 15.19
7.	Crook ly - L.L. add.	39.25 ± 24.56
8.	Prone - L.L. abd.	38.75 ± 22.64
9.	Standing - L.L. add.	38.68 ± 21.78
10.	Knee to chest position	38.23 ± 21.13
11.	Camel and cat	37.89 ± 22.62
12.	Supine - L.L. add.	37.57 ± 20.61
13.	Squatting	33.05 ± 18.48
14.	High Sitt- L.L. add.	32.63 ± 17.82
15.	Leg lift ly. -limbs overlap	31.75 ± 20.47
16.	Standing - L.L. add.	30.26 ± 13.69
17.	Resisted add. in crook ly.	28.92 ± 10.95
18.	Standing (legs crossed)	27.66 ± 15.68
19.	Bridging	22.69 ± 9.91
20.	Legs overlap in long sitt.	21.42 ± 11.67

plitude for constant time duration. Peak to peak amplitudes were measured. A 3-second period record was selected during which maximum activity was seen. For example, in 3 seconds, 38 peaks of 3 mm amplitude (i.e. 114 mm), 14 peaks of 4 mm amplitude (56 mm) and 8 peaks of 5 mm amplitude (40 mm) were present. Therefore the average amplitude per peak in 3 seconds was equal to 3.5 mm. The sensitivity of the recorder was 200 μV.

The Kruskal Wallis one way ANOVA technique i.e. analysis of variance has been applied for analysis of the data.

Results

Perineal exercises

A considerable individual variability in absolute values of EMG activity of perineal muscles was observed. Table-I shows EMG of perineal muscles during group maximal contraction in various positions in descending order. Perineal muscles showed maximum activity on voluntary contraction in crooklying with lower limbs abducted (LL abd) which was found to be significantly different from that obtained during the conventionally recommended exercises, i.e. bridging, inclined long sitting (legs crossed) and standing with legs crossed.

Table II

EMG of Perineal Muscles in Various Abdominal Exercises

S.No.	Posterior Pelvic Tilt	Curl Up	Reverse Curl	P Value	
1.	Crook Ly. with L.L. Abd.	38.08	70.20	66.25	<0.0001**
2.	Crook Ly. with L.L. Add.	43.50	66.96	63.92	0.0028*
3.	Supine with L.L. Abd.	37.53	70.78	64.92	<0.001 **
4.	Supine with L.L. Add.	36.79	69.07	67.45	<0.001 **

* Significant

** Highly significant

Abbreviations :

L.L. - Lower Limbs
Ly. - Lying
Add. - Adduction
Abd. - Abduction
Res. - Resisted
Sitt. - Sitting

Abdominal exercises

On analysis of the data it was observed that, during the posterior pelvic tilt, minimal level of activity occurred both in the perineals and abdominals as compared to the other two abdominal exercises. When the three were compared, they were significantly different (Table-II). The reverse curl showed a much better perineal and abdominal muscle activity but lesser than the curl-up which showed the maximum. During all the three abdominal exercises, both the muscle groups, i.e. the perineal and the abdominals were found to be active synchronously (fig-II).

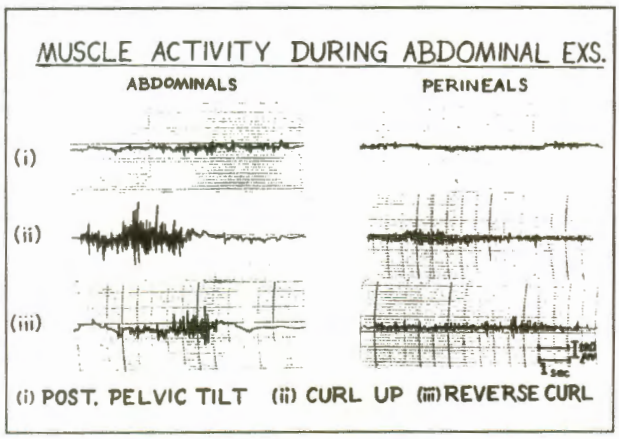

Fig II. Muscle activity during abdominal exercises

Discussion

The present study has revealed that a better perineal contraction could be achieved with the lower limbs in abduction which is contrary to the commonly recommended position of adduction (Tchou et al, 1988; Gardiner, 1981).

The order of preference for positions of exercise progression for pelvic floor strengthening and re-education as revealed by the present study is crook-lying followed by supine, prone, Buddha position, high sitting, standing, knee to chest, quadruped and finally squatting (Table I). In all these, the preferred position of lower limbs is that of abduction. These positions are not just quantitatively proceeding from the most easy to the most difficult (strength of contraction decreases as position becomes more difficult), but they are also in order of increasing resistance for the perineal muscles which is in accordance with the norms of re-education and strengthening.

Presently, the norm in general is to strengthen the perineals first and then the abdominals in patients who have weakness of both groups of muscles. As our study reveals that the perineals and abdominals are active synchronously during abdominal exercises, this, therapeutically implies that perineals and abdominals can be strengthened simultaneously. One can further hypothesize that patients having weakness of pelvic floor as well as backache and / or weak abdominals, should be therapeutically given exercises for both groups simultaneously to strengthen not only the pelvic floor but also the abdominal muscles.

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