

Impaired Function of the Levator Ani Muscle in the Grand Multipara and Great Grand Multipara

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KISLI, E., KISLI, M., AGARGUN, H., ALTINOKYIGIT, F., KAMACI, M., OZMAN, E. and KOTAN, C. *Impaired Function of the Levator Ani Muscle in the Grand Multipara and Great Grand Multipara*. Tohoku J. Exp. Med., 2006, **210** (4), 365-372 — Repeated deliveries might disturb the levator function and increase defecation disorders. In this prospective study, we determined the electric activity of the levator ani muscle (LAM) in nullipara, multipara, grand multipara, and great grand multipara (20 subjects for each group). Multiparity, grand multiparity, and great grand multiparity were defined as women having 2 - 5, 6 - 9, and 10 and over deliveries, respectively. The number of deliveries of multipara, grand multipara and great grand multipara were 4.05 ± 1.14 (2 - 5), 7.55 ± 1.23 (6 - 9) and 12.2 ± 2.16 (10 - 17), respectively. All women were asked whether they had experienced constipation, fecal or urinary incontinence, and/or pelvic pain. All women were also evaluated for pelvic organ prolapse. Electromyography (EMG) of the LAM at rest and on contraction was recorded. EMG is an electrical recording of muscle activity. Constipation, incontinence and pelvic organ prolapse were encountered in multipara, grandmultipara and great grand multipara women. The LAM EMG at rest and on contraction in the nullipara was accepted as control. Both the resting and contractile activities of the LAM were as follows: nullipara > multipara > grand multipara > great grand multipara. These findings indicate that levator dysfunction and defecation disorders are increased with repeated deliveries because of pudendal and/or levator ani nerve injury and traumatic injury to the LAM occurred with the mechanical stresses of vaginal deliveries. ——— electric activity; levator ani muscle; multipara; grand multipara; great grand multipara
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There are several causes of levator ani muscle (LAM) dysfunction, such as conditions of chronic straining and increased intraabdominal

pressure, senility, debility and obesity due to fat-laden viscera, which lead to increase in the intraabdominal pressure (Shafik 1983). One of

Received May 8, 2006; revision accepted for publication October 20, 2006.

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the common causes of levator dysfunction seems to be gestation and delivery. The gravid uterus enlarges progressively during gestation. It induces its effect on the LAM probably through: (a) increase of the uterine weight, (b) elevation of the intraabdominal pressure and (c) mechanical interference with its functional activity. These effects might disturb the levator function and also it is postulated that these effects are augmented with repeated pregnancies. The continuously increasing size of the gravid uterus presumably affects the levator function, particularly in women with repeated deliveries (Shafik and El-Sibai 2002).

Previous studies have shown that multiparity, forceps delivery, increased duration of the second stage of labour and high birth weight may lead to anal sphincter injury (Beevors et al. 1991; Cornes et al. 1991; Sultan et al. 1993; Ryhammer et al. 1995). While most injuries to the anal sphincter following delivery are recognised and repaired, an injury to the LAM may occur and remain undiagnosed (Shafik and El-Sibai 2002). The LAM is a muscle of evacuation. Its contraction at defecation or urination helps to evacuate the rectum or urinary bladder (Shafik 1991, 1992a). Preceding studies have demonstrated that a derangement of the LAM would lead to a levator dysfunction syndrome which comprises defecation and urinary disorders as well as perineal descent, anorectal intussusception and rectal prolapse (Shafik 1983).

Grand multiparity and great grand multiparity are not uncommon in Van, the east of Turkey (Gurel 1999). The aim of the current study is to investigate the electric activity of LAM in nullipara, multipara, grand multipara and great grand multipara and to determine LAM dysfunction in grand multipara and great grand multipara.

MATERIALS AND METHODS

The study was approved by the ethics committee of Yuzuncu Yil University and patients had given informed consent to the investigation. Eighty women were included in this prospective study. Twenty nullipara, 20 multipara, 20 grand multipara and 20 great grand multipara women who were come in to the clinic for routine examination were chosen for the study. These women were asked to participate in the study. Women who had

accepted to participate were included in the study. The mean age of nullipara women were 42.15 ± 9.39 s.d. years (range 32 - 58). They had no history of deliveries or abortions. These women were considered as controls. The mean age of the multipara women were 45.9 ± 9.48 s.d. years (range 33 - 63). The mean number of full term deliveries was 4.05 ± 1.14 s.d. (range 2 - 5). The grand multipara women had a mean age of 45.2 ± 7.69 s.d. years (range 33 - 62). The mean number of full term deliveries was 7.55 ± 1.23 s.d. (range 6 - 9). The great grand multipara women had a mean age of 45.15 ± 6.13 s.d. years (range 39 - 59). The mean number of full term deliveries was 12.2 ± 2.16 s.d. (range 10 - 17) (Table 1).

Multipara, grand multipara and great grand multipara women who had only some prolonged second stage of labour as determined by medical records are included. The second stage was considered prolonged if it lasted more than 1 hr. Woman who had obesity, caesarean section delivery, forceps delivery, history of abortions, chronic cough or smoking was not included. Women who were over 65 years of ages excluding from the study. Parous women, who had detected sphincter injuries and perineal lacerations at the time of delivery, clinically were also excluded from the study.

The initial assessment of the patients in our unit is made by anamnesis and physical examination. Urogynecologic histories were taken and physical examinations were performed. All women were asked whether they had experienced constipation, fecal or urinary incontinence, and/or pelvic pain in the form of proctalgia or vulvodinia.

Electromyography (EMG)

The LAM EMG at rest and on contraction by straining was recorded using the method described previously (Shafik 1998). Briefly, a concentric needle electromyographic electrode (Type 151T, Nihon Kohden, Tokyo) was introduced into the LAM 2 cm lateral to the anal orifice and 2 cm deep. A ground electrode was applied to the thigh and a standard electromyographic apparatus (Type MEP-9104K, Nihon Kohden) was used to amplify and display the potentials recorded.

Statistical analysis

The results were analysed statistically using ANOVA test. Scheffe test was used for post-hoc comparisons. Pearson correlation analysis was used for correlations. Significance was described to $p < 0.05$, and values were given as the mean \pm s.d.

RESULTS

There was no statistical difference in aspect of ages among groups ($p > 0.05$). Mean birthweight in multipara, grand multipara and great grand multipara women were $3,085.88 \pm 232.15$ g, $3,133.15 \pm 146.22$ g, and $3,065.83 \pm 70.79$ g, respectively. Mean body mass index (BMI) in nullipara, multipara, grand multipara and great grand multipara women were 23.54 ± 1.62 , 23.81

± 1.07 , 23.38 ± 0.91 , and 23.66 ± 0.70 , respectively. There are no significant differences in aspect of mean birthweight (other than the nulliparous group) and mean BMI in groups, statistically ($p > 0.05$) (Table 1). All parous (multipara, grand multipara and great grand multipara) women had episiotomy. Five of nullipara, 6 of multipara, 5 of grand multipara and 5 of great grand multipara women are in menopause.

TABLE 1. Clinical features of the studied subjects.

| | | Nullipara (n = 20) | Multipara (n = 20) | Grand multipara (n = 20) | Great grand multipara (n = 20) |
|-------------------------------|-----------------|-----------------------|-----------------------|-----------------------------|--------------------------------------|
| Years of age | Mean \pm S.D. | 42.15 \pm 9.39 | 45.9 \pm 9.48 | 45.2 \pm 7.69 | 45.15 \pm 6.13 |
| | Range | 32 - 58 | 33 - 63 | 33 - 62 | 39 - 59 |
| Number of deliveries | Mean \pm S.D. | – | 4.05 \pm 1.14 | 7.55 \pm 1.23 | 12.2 \pm 2.16 |
| | Range | – | 2 - 5 | 6 - 9 | 10 - 17 |
| Mean birthweight (g) | – | – | 3,085.88 \pm 232.15 | 3,133.15 \pm 146.22 | 3,065.83 \pm 70.79 |
| Mean BMI (kg/m ²) | – | 23.54 \pm 1.62 | 23.81 \pm 1.07 | 23.38 \pm 0.91 | 23.66 \pm 0.70 |

Values were given as the mean \pm S.D. BMI, body mass index.

TABLE 2. Defecation disorders, pelvic organ prolapse and pelvic pain in the studied subjects.

| | Constipation | Incontinence | | Pelvic pain | | Pelvic organ prolapse |
|------------------------------|--------------|-------------------------|------------------------|-------------|------------------|--------------------------|
| | | Fecal | Urinary | Proctalgia | Vulvodinia | |
| Nullipara | – | – | – | – | – | – |
| Cystocele | | | | | | – |
| Rectocele | | | | | | – |
| Uterine prolapse | | | | | | – |
| Multipara | 2 | 1 | 2 | – | – | |
| Cystocele | | | | | | 1 |
| Rectocele | | | | | | – |
| Uterine prolapse | | | | | | – |
| Grand multipara | 5 | 3 (α) | 4 (β) | 1 | – | |
| Cystocele | | | | | | 2 (α) |
| Rectocele | | | | | | 1 |
| Uterine prolapse | | | | | | 1 (β) |
| Great grand multipara | 4 | 5 (γ, λ) | 7 (ω, δ) | 2 | 1 (ϵ) | |
| Cystocele | | | | | | 2 (γ, λ) |
| Rectocele | | | | | | 1 (ω) |
| Uterine prolapse | | | | | | 2 (δ, ϵ) |

Each of $\alpha, \beta, \gamma, \lambda, \omega, \delta$ and ϵ indicates the same subject.

Clinical findings

Table 2 exhibits the defecation, urinary disorders, pelvic pain as well as the pelvic organ prolapse of the studied groups. Nullipara women had no constipation, fecal or urinary incontinence or pelvic organ prolapse. Constipation, incontinence and pelvic organ prolapse were encountered in multipara, grand multipara and great grand multipara women (Table 2). Constipation took the form of excessive straining at defecation although the stools were soft and bulky. Meanwhile, one woman in grand multipara and 2 women in great grand multipara complained of pelvic pain in the form of proctalgia. One woman (subject ε) complained of vulvodynia in great grand multipara. None of the nullipara women

had pelvic organ prolapse. One of multipara, 2 of grand multipara and 2 of great grand multipara women had cystocele. One of grand multipara and 1 of great grand multipara (subject ω) had rectocele. One of grand multipara (subject β) and 2 of great grand multipara (subjects δ , ε) had uterine prolapse (Table 2). One woman (subject α) with cystocele had also fecal incontinence, and one woman (β) with uterine prolapse had also urinary incontinence in grand multipara. Two women (γ , λ) with cystocele had also fecal incontinence, one woman (ω) with rectocele had also urinary incontinence, one woman (δ) with uterine prolapse had also urinary incontinence, and one woman (ε) with uterine prolapse had also vulvodynia in great grand multipara.

TABLE 3. The LAM EMG at rest and on contraction in the studied subjects *Potentials (mV)*.

| EMG | Nullipara (control) | | Multipara | | Grandmultipara | | Great grandmultipara | |
|----------------|----------------------|---------|-----------------------|---------|-----------------------------------|---------|-----------------------------------|--------|
| | Mean \pm S.D. | Range | Mean | Range | Mean | Range | Mean | Range |
| At rest | 102.4 \pm 13.62 | 80-120 | 85.15 \pm 9.77* | 70-105 | 70.1 \pm 13.66 [§] | 50-87 | 45.8 \pm 5.09 ^Ω | 39-55 |
| On contraction | 670.45 \pm 80.4 | 510-770 | 321.9 \pm 43.94* | 290-426 | 188.5 \pm 38.33 [¥] | 130-260 | 130.8 \pm 25.49 ^Ω | 95-170 |

Values were given as the mean \pm S.D.

Post – hoc Scheffe test:

* $p < 0.001$ with respect to control.

[§] $p < 0.01$ with respect to multipara.

[¥] $p < 0.001$ with respect to multipara.

^Ω $p < 0.001$ with respect to grand multipara.

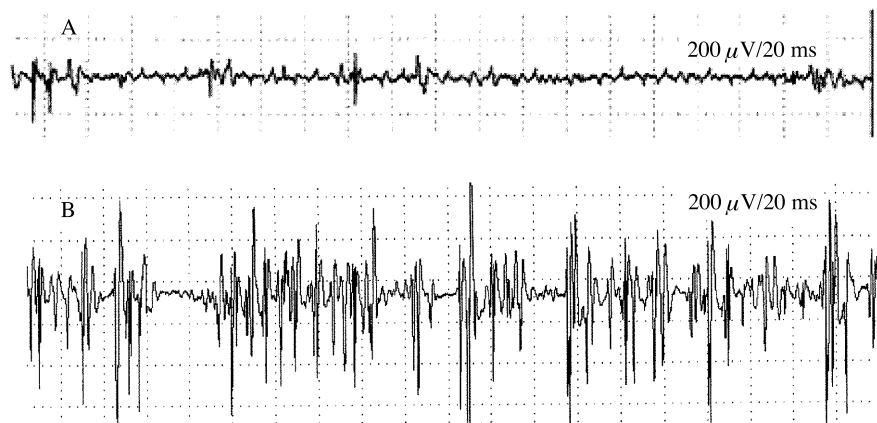


Fig. 1. EMG of the levator ani muscle in a nulliparous woman. Resting activity (A); on contraction (B).

EMG findings

The LAM EMG at rest and on contraction in the nullipara was accepted as control (Table 3 and Fig. 1). In the multiparous women, resting and contraction EMG of the LAM differed significantly from that of the controls with a mean potential of 85.15 ± 9.77 mV and 321.9 ± 43.9 mV, respectively ($p < 0.001$, $p < 0.001$) (Table 3 and Fig. 2). In the grand multiparous women, the

mean of both the resting and contractile activity of the LAM was significantly lower than that of the multipara with a mean potential of 70.1 ± 13.66 mV and 188.5 ± 38.33 mV, respectively ($p < 0.01$, $p < 0.001$) (Table 3 and Fig. 3). In the great grand multipara, the mean of both the resting and contractile activity of the LAM was significantly lower than that of the grand multipara with a mean potential of 45.8 ± 5.09 mV and

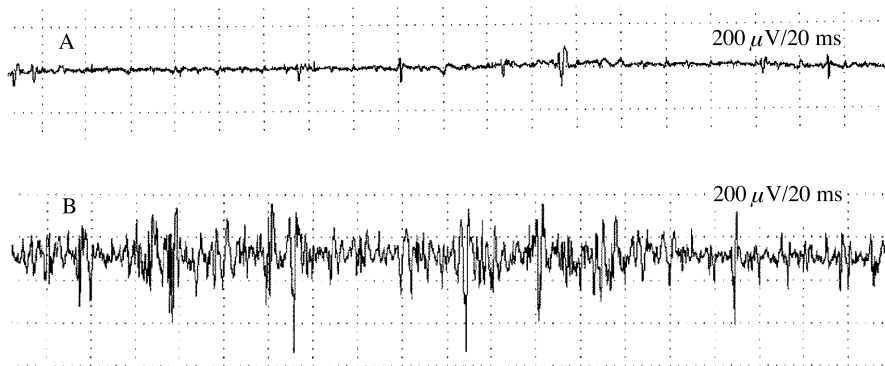


Fig. 2. EMG of the levator ani muscle in a multiparous woman. Resting activity (A); on contraction (B).

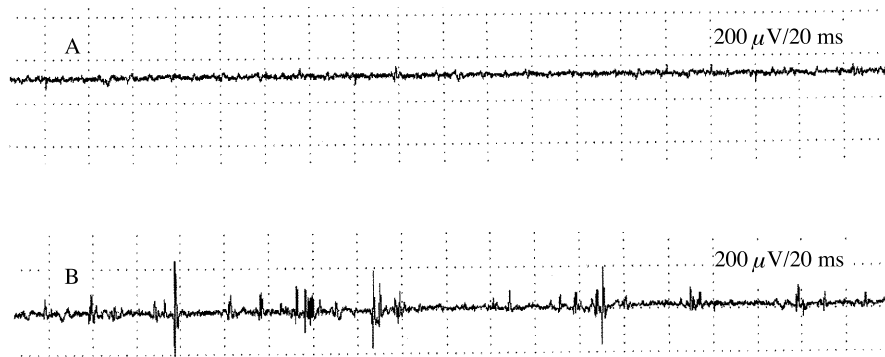


Fig. 3. EMG of the levator ani muscle in a grand multiparous woman. Resting activity (A); on contraction (B).

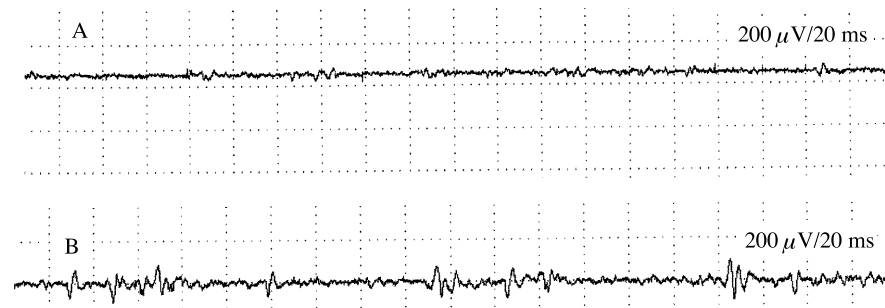


Fig. 4. EMG of the levator ani muscle in a great grand multiparous woman. Resting activity (A); on contraction (B).

130.8 ± 25.49 mV, respectively ($p < 0.001$, $p < 0.001$) (Table 3 and Fig. 4). A negative correlation was found among labour number and both resting ($r = -0.73$, $p < 0.001$) and contraction potentials ($r = -0.85$, $p < 0.001$) (Pearson correlation analysis).

DISCUSSION

The cause of levator dysfunction in the parous women needs to be discussed. Studies have shown that the gravid uterus, by virtue of its weight and associated increased intraabdominal pressure, might disturb the levator function. It is postulated that this effect is augmented with repeated pregnancies (Shafik and El-Sibai 2002). However, Lien et al. (2005) reported that the pudendal nerve is injured during vaginal delivery but not during pregnancy. Animal models simulating the childbirth trauma with vaginal distension in rat support this hypothesis (Lin et al. 1998; Damaser et al. 2003). Heit et al. (2001) reported that elective cesarean section is the only true primary prevention strategy for childbirth injuries to the pelvic floor. The function of the LAM as a muscle of evacuation for rectum and urinary bladder is disturbed with repeated pregnancies and delivery. The derangement of LAM may lead to fecal and urinary disorders in the form of incontinence or retention (Shafik and El-Sibai 2002).

Shafik and El-Sibai (2002) reported that the LAM EMG in multipara women with a prolonged 2nd stage of labour exhibited a lower activity than controls at rest and on contraction. They also reported that primipara women showed diminished activity in both conditions, which was significantly higher than that of multipara. In the present study, it was found that grand multiparous women showed diminished both the resting and contractile activity of the LAM significantly, lower than that of the multipara and nullipara. It was also found that great grand multiparous women showed diminished both the resting and contractile activity of the LAM significantly, lower than that of the grand multipara and multipara.

Shafik and El-Sibai (2002) reported that 16.6% of primipara and 31.8% of multipara with prolonged 2nd stage of labour had constipation.

Shafik (1988) reported that they experienced excessive straining at stool (strainodynia) although the stools were soft and bulky. They explained that this strainodynia is probably due to the levator sagging, which exposes the anal canal to the direct effect of the increased intra-abdominal pressure. On straining at stool, the anal canal is occluded rather than opened, as would occur under normal physiological conditions (Shafik and El-Sibai 2002). In the present study, 10% of multipara, 25% of grand multipara and 20% of great grand multipara women had constipation. Shafik and El-Sibai (2002) reported that 8.3% of prolonged 2nd stage of labour in the primiparous women and 22.7% of prolonged 2nd stage of labour in the multiparous women occurred fecal incontinence. They also reported that 8.3% of prolonged 2nd stage of labour in the primiparous women and 36.3% of prolonged 2nd stage of labour in the multiparous women occurred stress urinary incontinence. They explained that incontinence whether fecal or urinary is due most probably to pudendal neuropathy because of sagging of the LAM. The type of incontinence would depend on the branch of pudendal nerve most involved: in fecal incontinence it is related to the inferior rectal nerve and in urinary incontinence to the perineal branch (Shafik 1992b, 1994; Shafik and El-Sibai 2002). However, no contribution of the pudendal nerves to levator ani innervation was noted. Additionally, many electrophysiologic studies have demonstrated that the levator ani muscles and the external anal sphincter have physiologically distinct innervations and that the pudendal nerve does not appear to innervate the iliococcygeal, pubococcygeal, or puborectalis muscles (Percy et al. 1981; Swash et al. 1985; Snooks and Swash 1986). Pierce et al. (2005) studied in the female squirrel monkey to characterize the spinal distribution of afferent and efferent pathways that innervate the levator ani muscle and they concluded that the levator ani muscle has a distinct innervation with very little or no contribution from the pudendal nerve. Barber et al. (2002) studied on 12 fresh-frozen female cadavers and reported that the female levator ani muscle is not innervated by the pudendal nerve, but rather

by innervation that originates from the S3-5 nerve roots that travel on the superior surface of the pelvic floor. They also reported that the distinct innervation of the levator ani muscles by the levator ani nerve and the external anal and urethral sphincters by the pudendal nerve provide a mechanism to explain the varying types of pelvic floor disorders that can occur in women after childbirth. For instance, it may explain the reason that some women experience urinary incontinence or fecal incontinence and that other women experience pelvic organ prolapse.

In the current investigation, fecal incontinence occurred in both multiparous, grandmultiparous and great grand multiparous women 5%, 15% and 25%, respectively and urinary incontinence occurred in both multiparous, grandmultiparous and great grand multiparous women 10%, 20% and 35%, respectively. The incidence of incontinence (fecal and urinary) was higher in the great grand multipara than the grand multipara and multipara women, due apparently to a greater extent of traumatization to the LAM in the great grand multipara than the grand multipara and multipara women. Although constipation, fecal or urinary incontinence occurred with multiparous, grandmultiparous and great grand multiparous women, did not occur with control (nullipara women) groups probably because levator dysfunction did not occur. None of the nullipara women had pelvic organ prolapse. Five percent of multipara, 10% of grand multipara and 10% of great grand multipara women had cystocele. Five percent of grand multipara and 5% of great grand multipara women had rectocele. Five percent of grand multipara and 10% of great grand multipara women had uterine prolapse. Pelvic organ prolapse occurred with parous women due probably to levator dysfunction. One woman in grand multipara and 2 women in great grand multipara women studied complain of pelvic pain in the form of proctalgia and one woman complain of vulvodynia in great grand multipara women, due probably to involvement of the sensory fibres of the pudendal nerve and or levator ani nerve.

Sometimes even after menopause, when loss of estrogen support to the pelvic floor had led to

deterioration in fecal control (Donnelly et al. 1997). Most cases of stress urinary incontinence occur years after menopause. It has been postulated that many women with a slightly weakened urethra and levator from birth injury remain asymptomatic until menopause and aging further impair the continence mechanism (Lin et al. 1998). In our study, one of multipara woman who was in menopause had urinary incontinence. Two of grand multipara women who were in menopause had urinary incontinence. One of grand multipara woman who was in menopause had fecal incontinence. Two of great grand multipara women who were in menopause had urinary incontinence. One of great grand multipara women who were in menopause had fecal incontinence. One of great grand multipara woman who was in menopause had rectocele and urinary incontinence. One of great grand multipara woman who was in menopause had cystocele. For these patients menopause may have a contributory role for the disorders.

The present study is the first, to our knowledge, that compares the EMG findings and LAM dysfunction in multipara and grand multipara with great grand multipara. In conclusion, these findings suggest that levator dysfunction may occur in the parous women due to pudendal and/or levator ani nerve injury and traumatic injury to the levator ani muscle occur with the mechanical stresses of vaginal delivery. LAM dysfunction is most common in the great grand multipara.

CONCLUSION

The EMG findings as well as the clinical manifestations of the population in the current study have shown that repeated deliveries may affect the electric activity of the LAM. The insult to the LAM is maximum in the great grand multipara women. In conclusion, defecation disorders are increased with repeated deliveries.

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