UROGYNECOLOGY

Levator ani denervation and reinnervation 6 months after childbirth

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OBJECTIVE: The objective of the study was to assess the prevalence of levator ani denervation and reinnervation 6 months after the first delivery.

STUDY DESIGN: Ninety-six primigravida women underwent quantitative electromyography of the levator ani during the third trimester and twice postpartum. A 95% confidence interval for normal function was created using interference pattern analysis. Fifty-seven who completed the study are presented in this secondary data analysis. Postpartum muscle sites outside the normal range were considered abnormal. Obstetric and demographic characteristics were assessed.

RESULTS: Of 57 subjects, 70% had no denervation. Of the 30% with denervation at 6 weeks, 35% recovered by 6 months. Obstetric or maternal characteristics were not predictive of denervation or reinnervation, except subjects with persistent denervation tended toward lower body mass index (BMI) independent of mode of delivery.

CONCLUSION: Nearly one-third of women have levator ani denervation after first delivery, but many recover by 6 months. Denervation is not clearly associated with mode of delivery, but higher maternal BMI may be protective.

Key words: Delivery, levator ani, neuromuscular function, pelvic floor, quantitative electromyography

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Injury to the pelvic floor at the time of childbirth and its role in the pathophysiology of pelvic floor dysfunction is a contemporary issue of interest in women's health.[1,2] The National Institute of Child Health and Development funds the Pelvic Floor Disorders Network, which was formed in 2001 to conduct research that would ultimately improve the care and quality of life for women with pelvic organ prolapse and bowel and bladder dysfunction. In March 2006, a National Institutes of Health State-of-the-Science Conference statement was published on cesarean delivery on maternal request.[3]

This has been an area of heated debate over the past several years with the increased attention and focus on the rising US cesarean delivery rates, which includes a rise in cesarean request to approximately 4-18% of all cesarean deliveries.[3]

Urinary and fecal incontinence as well as pelvic organ prolapse may be associated with vaginal birth. Patient satisfaction with the birth process and quality of life postpartum are important factors to consider when determining the mode of delivery. However, support for or against cesarean delivery on maternal request for the aforementioned outcomes and others is based on weak quality data, necessitating further research.[3]

Multiple studies have supported an association between vaginal parity and neuromuscular abnormalities in the levator ani and external anal sphincter.[1,4-8] Morphologic abnormalities in the levator ani are consistently observed in vaginally parous women as shown by magnetic resonance[2] and ultrasound studies,[4] and muscle loss in these women is associated with an increased risk of pelvic organ prolapse.[9,10]

Other recent investigations have shown a connection between levator ani muscle denervation and prolapse using both magnetic resonance imaging and quantitative analysis of needle electromyography (QEMG).[7,10] However, the prevalence and specific mechanism of permanent pelvic floor denervation injury after a single typical obstetrical delivery as well as the nature and extent of any resulting dysfunction are not clear. Others have used techniques such as surface electromyography (EMG), which is of limited precision and localization for the levator ani, a muscle directly palpated only on internal pelvic examination.[11]

Ideally, providers of health care to women would like to be able to predict which patient was at greatest risk of significant pelvic floor injury were she to undergo vaginal delivery. Such knowledge would possibly help us counsel patients about defined risks of different modes of delivery. We undertook this research to obtain pilot data toward an ultimate goal of defining those risk factors. We applied a fairly invasive examination technique to measure levator ani neuromuscular function in a cohort of primiparous women. We previously reported an approach to analyzing this data set.[12]

Our goal with this report is to simplify the statistical approach with an ultimate future goal of maximizing clinical appli-

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cation of the technique. We applied this analysis method to identify the type and prevalence of levator denervation and reinnervation and the obstetrical and demographic characteristics of women with such changes.

MATERIALS AND METHODS

Primigravid women who presented to the Duke obstetrical clinics from 2001 to 2004 were approached to participate in this study after receipt of full institutional review board approval. We recruited singleton primigravidas less than 34 weeks' gestational age who denied a history of pelvic surgery, prepregnancy pelvic floor symptoms, diabetes, or neuromuscular disorder. Because we wanted to study the effects of a trial of labor in as many subjects as possible, we excluded women who planned a cesarean delivery in advance of delivery (eg, a woman with maternal cardiac contraindication to labor).

EMG acquisition and analysis

At 28-34 weeks' gestation, subjects underwent baseline concentric needle EMG assessment of the levator ani muscles and analysis of the resulting digital EMG data as previously described.[12,13] Briefly, the levator ani were palpated transvaginally at 2 defined points on each side intended to correspond to the puboviceralis and iliococcygeous portions of the muscle. EMG signals were recorded from these sites using a concentric needle electrode with the recording territory of the muscle at rest and with moderate and maximal activity using a Synergy 2-channel electromyograph (Oxford Instruments Medical Systems, Hawthorne, NY). This same EMG assessment was performed again at 6 weeks and 6 months postpartum. A pelvic organ prolapse quantitation (POPQ)[14] and a clinical assessment of voluntary pelvic floor contraction was also performed.[15]

We used interference pattern analysis to analyze the EMG data. This is a widely accepted method for testing neuromuscular integrity that can used when the load against which the muscle is contracting is not measurable.[16-18] For each subject, we sampled the digitally recorded signals at each muscle site during six 50 millisecond epochs of representative muscle activity to obtain the number of turns per second and mean turns amplitude at rest and during moderate and maximal contraction effort as previously reported.[12]

We pooled all QEMG data from the baseline antepartum visit in 70 subjects (those in the final analysis group) and confirmed that the data were normally distributed. We simplified the data by taking the ratio of the 2 main QEMG variables[16] as follows: (number of turns per second)/(amplitude in microvolts), abbreviated here as (T/A). In these 70 subjects, the normal range of T/A (including 95% of all observations) was 0.46-1.2, inclusive of both extremes. We applied this normal range in the same group after delivery. We excluded those subjects who did not have resting and contracting T/A within the normal range in at least 3 of 4 muscle sites at the antepartum visit.

At the subsequent 6 week and 6 month postpartum visits, we calculated the mean and the 95% confidence intervals for T/A for each subject at each muscle site. Each site was assessed to determine whether it was judged normal or abnormal at either postpartum visit. A site was considered to be abnormal if the entire 95% confidence interval of T/A was outside the normal range. Muscle site data that were even partially within the normal range were considered normal for that site. Furthermore, any subject with missing or uninterpretable data postpartum at any site was excluded. This ensured that to be characterized as abnormal, a subject's levator muscle EMG was clearly abnormal compared with antepartum values.

We further characterized muscle sites postpartum as having a low T/A if the 95% confidence interval of the value was less than the lower limit of normal and a high T/A if the 95% confidence interval value exceeded the upper limit of normal. If any of the 4 levator muscle sites were determined to have a low or high T/A, the subject was declared abnormal at that visit. If the levator EMG was determined to be abnormal at both the 6 week and 6 month visits, the denervation change was characterized as persistent. If neuromuscular function was abnormal at 6 weeks but normal at 6 months, the injury was considered recovered and consistent with reinnervation.

Obstetrical measures

Each subject's labor and delivery were managed by her obstetrician, following a protocol conforming to accepted practices of active management of labor.[19] The decision of whether to use regional anesthetic was left to the subject and her physician, although once placed, epidurals were managed using a standard protocol of ropivicaine/fentanyl-loading dose and a subject-controlled analgesic pump. Routine episiotomy was not performed.

Statistical analysis

The frequency of levator muscle EMG abnormalities was computed for both the 6 week and 6 month visits. The odds ratios of abnormal levator EMG by race (African American vs white) adjusted for age, along with the 95% confidence intervals, were computed. For subjects at the 6 month visit, any abnormality was determined to be either reinnervated or persistent denervation and the frequency of types of denervation/reinnervation computed. Obstetrical, neonatal, or maternal characteristics for the normal, reinnervated, or persistent denervation groups were computed.

We used the Wilcoxon rank sum test or Fisher's exact test to compare groups. Because there appeared to be a trend in higher body mass index (BMI; in kilograms per square meter) for postpartum subjects with normal or recovered levators, we performed logistic regression to assess the effect of BMI on levator status by combining subjects into 3 groups with similar mode of delivery.

RESULTS

Ninety-six primigravidas were enrolled. Enrollment and analysis of the 96 are summarized in Figure 1. Eleven subjects did not meet the inclusion criterion of having resting and maximum contraction T/A values within the normal range for at least 3 of 4 muscle sites at the antepartum visit. Fifty-seven subjects com-