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Paraspinal Electromyography: Age-Correlated Normative Values in Asymptomatic Subjects

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Study Design. Cross-sectional study.

Objectives. To determine if the amount of lumbar paraspinal denervation increases with age and present normative data on the amount of denervation present in asymptomatic subjects.

Summary of Background Data. To our knowledge, there are no data on the relationship of paraspinal denervation with age or normative data on the amount of denervation expected in asymptomatic older adults.

Methods. We combined the data from our current study of asymptomatic adults, age 55–79 years, and a previous study of asymptomatic adults, age 18–58 years, who underwent lumbar paraspinal muscle needle electromyography using a validated needle electromyography (MiniPM) technique. We then compared the results of the age group 55–79 to that of the age group 18–54.

Results. The older group scored significantly higher than the younger group by 1.7 ($P = 0.008$, 95% confidence interval 0.5–3.0). Linear regression showed that age was a significant predictor of the MiniPM score ($\beta = 0.04$, and $P = 0.04$). For subjects 55 years and older, mean MiniPM score on one side was 2.3 (standard deviation 3.6). The upper range of the 95th percentile was 10.

Conclusions. The amount of lumbar paraspinal muscle denervation does increase with age. Understanding the range of findings in asymptomatic subjects will help us interpret lumbar paraspinal needle electromyography findings in patients with spinal disorders.

Key words: electromyography, muscles, spine, normality. **Spine 2005;30:E499–E502**

Our understanding of the electrodiagnostic evaluation of the lumbar paraspinal muscles has improved over the last decade. Dissection studies have shown that the iliocostalis and longissimus muscles receive polysegmental innervations, but the most medial lumbar multifidus muscle fibers at one lumbar level received innervation from only one root level.[1–4] This finding is unique because all the other lumbosacral muscles are innervated by at least 2 root levels.[5,6]

Two researchers have described standardized needle electromyogram (EMG) techniques to evaluate the lumbar paraspinal muscles.[1,7,8] One of these techniques has been validated with cadaver studies, showing that the lumbar multifidus muscles can be consistently evaluated using the MiniPM technique.[8–10] This technique has also had good inter-examiner reliability.[11] However, there is still some debate regarding the usefulness of evaluating the lumbar multifidus muscles with a standardized EMG technique. One argument is that some asymptomatic subjects will have abnormal spontaneous activity in the lumbar multifidus muscles.[12,13] This effect would decrease the specificity of the EMG study.[14] A later study showed that the amount of abnormal spontaneous activity was fairly low and concluded previous reports may have misreported insertional activity or endplate spikes as abnormal spontaneous activity.[15] Given these findings, normative values similar to what has already been performed with nerve conduction studies should be determined to help clinicians interpret lumbar multifidus EMG findings.

We previously evaluated a population of normal asymptomatic subjects with the MiniPM technique and reported that 95% of subjects have values of ≤ 2.[1] Thus, having a score >2 (from a possible score of 0–96) would be abnormal. The primary limitation of this sample was that the average age of the subjects was 32.6 years (standard deviation [SD] 10). Because it is believed that the amount of abnormal EMG findings increase with age,[13] the results of this study may not be applicable to people older than 50 years. However, other researchers have not replicated the study by Nardin *et al*[13] to verify their conclusions.

The first purpose of this study was to determine if there is an association between age and the amount of EMG findings present in the lumbar paraspinal muscles. The second purpose was to determine the normative value of lumbar multifidus muscle EMG study in asymptomatic subjects through a wide age spectrum. This process will help electrodiagnostic clinicians interpret results of the lumbar paraspinal portion of EMG studies.

Methods

The data for this study were gathered from 2 groups. For the first group, electrodiagnostic clinicians evaluated subjects, who were recruited by flyers posted in the community, using a standard EMG protocol. The clinicians were blinded to the status

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of the subjects because this study was performed as part of a larger study that also included subjects with low back pain as well as subjects with lumbosacral spinal stenosis. The subjects included in this study were age 55–79 years without any back or leg pain. Potential subjects were excluded if they had diabetes, disease of the nerves in the arms and legs, drank more than 10 alcoholic drinks per week, had undergone low back surgery, or had medical problems an electromyography technician avoid (*e.g.,* mainly persons who have an active infection or are taking blood thinners other than aspirin). Institutional review board approval was obtained before starting the study, and all patients gave signed informed consent. Initially, 36 normal subjects were tested for this portion of the study. Of the normal subjects, 2 were excluded after testing as a result of a diagnosis of myopathy or polyneuropathy. This left 34 subjects, with a mean age of 64.8 years (SD 7.8, range 55–79), of which 21 (62%) were female. One subject was Hispanic (3%), and 33 were white (97%). Mean height was 1.7 m (SD 0.1), mean weight was 81.8 kg (SD 21.3), and mean body mass index was 28.9 (SD 6.4).

For the second group, we used data from a previous study of 35 asymptomatic adults (mean age 32.7 years, SD 10.1, range 18–58).[1] The mean age of this group was 32.6 years (SD 10.0, range 18–58), and 29 (83%) were female. A separate institutional review board approval was obtained to use this previously collected dataset.

Both groups were evaluated with the same EMG tests, including paraspinal EMG with the MiniPM technique. The MiniPM technique is described in detail elsewhere but is briefly reviewed here for reference.[1] Figure 1 illustrates how to locate the needle insertion sites. The protocol entails palpation of 4 needle insertion sites that are 2.5 cm lateral to midline at the levels: between the posterior superior iliac spine, as well as 1 cm cranial to the inferior tip of the L3, L4, and L5 spinous processes. At each insertion site, a 50-mm monopolar needle is directed at a 45° angle toward the midline and is inserted in approximately 5-mm intervals until it contacts the spinous process.

The abnormal spontaneous activity (positive sharp waves or fibrillation potentials only) must be reproduced (the needle can be withdrawn slightly and the area reexplored if there are abnormalities), but, if found, it is scored as 0–4+. This procedure has been previously described in an earlier article but has been reproduced here for reference in Table 1.[8] The most medial 1 cm of the insertion is scored in the "S" (for root specific) column and the more lateral 4 cm in the "M" (for mixed innervation) column.

The needle is withdrawn and directed cranially 45°, and the procedure is repeated. Again, it is withdrawn and redirected caudally 45° until contact with midline. The procedure is scored by calculating the total number of "+'s" at each "S" and "M" column at each level (a total of 24 numbers added), for a possible total score of 0–96 on each side. Normal values established in 35 asymptomatic subjects are 0–2 (95% scored <2), with a mean of 0.5.

Statistical Analysis. To determine the expected normal range of values seen with the MiniPM technique in older adults, the mean, SD, and upper range of the 95th percentile were calculated for subjects older than 54 years. To determine if paraspinal EMG findings were related to age, a linear regression analysis was performed using the MiniPM score as the dependent variable and age as the independent variable.

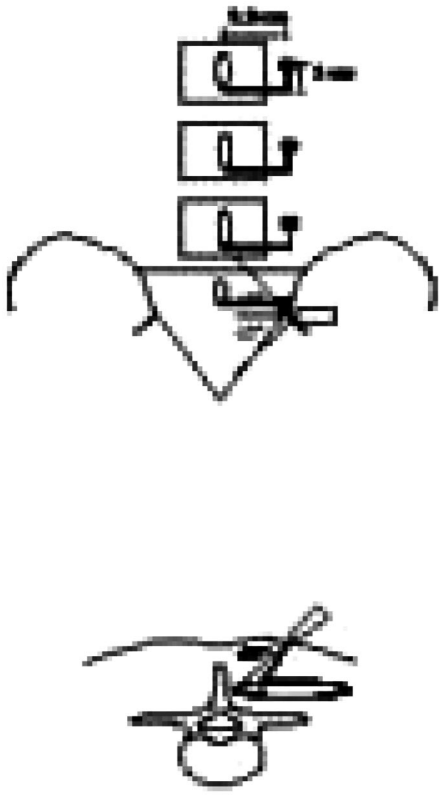

Figure 1. Localizing the four insertion sites for the MiniPM technique. The top three sites are 2.5 cm lateral and 1 cm superior to that inferior aspect of the 1.2–4 spinous process The fourth site is between the posterior superior iliac spine, 2.5 cm lateral to the S1 spinous process. Reprinted with permission from *Am J Phys Med Rehabil.*[11]

■ Results

Mean MiniPM score for subjects younger than 55 years was 0.5 (SD 0.7) and for subjects 55 years and older was 2.3 (SD 3.6), as shown in Figure 2. The mean difference of 1.7 was significant at $P = 0.008$ (95% confidence interval [CI] 0.5, 3.0). Figure 3 shows a scatterplot of the MiniPM score of each subject *versus* age, as well as the linear regression line and 95% mean prediction interval. Linear regression analysis showed that age was a significant predictor of the MiniPM score ($\beta = 0.04$, $P = 0.04$). There appears to be an outlier with a MiniPM score of 16. Repeated linear regression analysis excluding that subject was still significant ($\beta = 0.03$, $P = 0.02$).

Table 1. Paraspinal Mapping Scoring System Used at Individual Points of Insertion*

Score	Meaning
0	No reliable data obtained (*e.g.,* due to adipose tissue or inability to relax muscles)
–	No reproducible spontaneous activity
+	A single, reproducible train of fibrillation potentials
++	More than one train of fibrillation potentials
+++	Numerous fibrillation potentials at more than one depth
++++	Fibrillation potentials fill screen

*Reprinted with permission from Haig *et al.*[8]

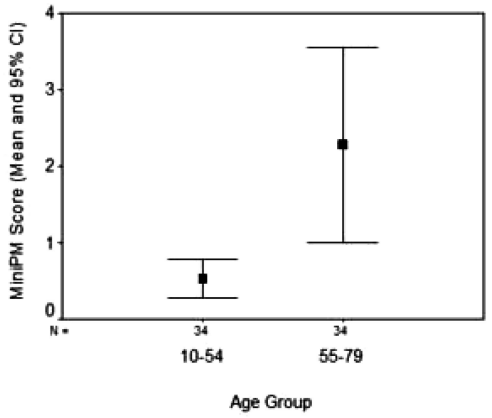

Figure 2. Mean MiniPM score of older subjects versus younger subjects.

For the subjects 55 years and older, the mean MiniPM score of 2.2 (SD 4.0) on the left was not different from the score of 2.5 (SD 3.8) on the right side, with a *t*-test *P* value of 0.7 (mean difference = 0.3: 95% CI 2.1, −1.5). Combining the results of the left and right side, mean MiniPM score was 2.3 (SD 3.6). The upper range of the 95th percentile of this value is 10.0.

■ Discussion

The *t* test showed that the MiniPM scores of the older adults were significantly higher than the scores of the younger adults. Linear regression analysis showed that the amount of lumbar paraspinal muscle denervation in asymptomatic subjects did slowly increase with age. The normative value of the lumbar spine EMG study was small, with a mean total score of 2.4. The upper threshold that included the upper 95th percentile was 10. This value is higher than the normative value of <3 we obtained for the previous group of subjects with a mean age of 30 years. This result is consistent with the theory that the amount of abnormal EMG findings increases with age.[13] However, we do not agree with the conclusion of Nardin *et al*[13] that "isolated fibrillations and positive sharp waves in lumbosacral paraspinal muscles, especially of older subjects, are nonspecific findings." Because our technique is more quantitative, we were able to determine a cutoff value of 10 using our technique would give us a 95% specificity. Thus, despite the fairly common findings of abnormal spontaneous activity in the lumbar paraspinal muscles, we assert that isolated needle findings in the lumbar paraspinal muscles that yield a MiniPM score >10 may still be considered abnormal. This cutoff is most meaningful if the codified paraspinal needle evaluation is presented.

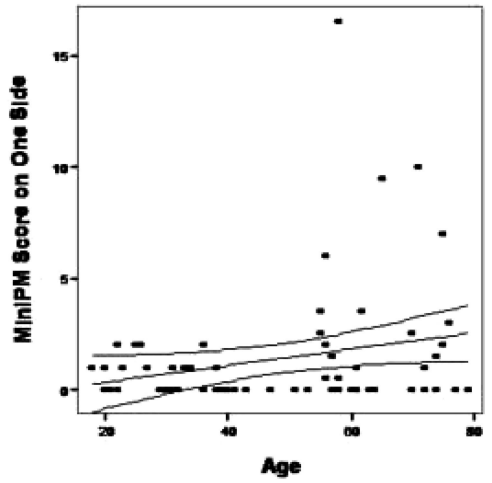

Figure 3. Scatterplot of MiniPM score on one side versus age of subject with superimposed linear regression line and 95% mean prediction interval.

This study has several strengths. The subjects were interspersed with symptomatic individuals, and the electromyography technicians were blinded to decrease examiner bias. This study also examined the paraspinal muscles with a codified technique that has had good inter-examiner reliability.[11] Finally, the paraspinal examination technique was quantitative, so we were able to set a cutoff value that will give us a 95% specificity. Because the technique used in the study by Nardin *et al*[13] only recorded when abnormal spontaneous activity was present, their interpretation was limited to stating "in older subjects such findings need to be interpreted cautiously, and in isolation may not indicate clinically significant disease."

Because this study is limited to asymptomatic subjects, we cannot determine the sensitivity of the EMG study for different disease conditions. Similarly, because only one subject had an abnormal score, we could not see if paraspinal abnormalities were associated with limb abnormalities. In conclusion, the amount of abnormal spontaneous activity in the lumbosacral paraspinal muscles does increase with age. Understanding the range of findings in asymptomatic subjects will help us interpret lumbar paraspinal EMG activities in patients with spinal disorders.

■ Key Points

- The amount of lumbar paraspinal muscle denervation does increase with age.
- Understanding the range of findings in asymptomatic subjects will help us interpret lumbar paraspinal needle electromyography findings in patients with spinal disorders.

References

1. Haig AJ. Clinical experience with paraspinal mapping. II: A simplified technique that eliminates three-fourths of needle insertions. *Arch Phys Med Rehabil* 1997;78:1185–90.
2. Macintosh JE, Valencia F, Bogduk N, et al. The morphology of the human lumbar multifidus. *Clin Biomech (Bristol, Avon)* 1986;1.
3. Bogduk N, Twomey LT. *Clinical Anatomy of the Lumbar Spine and Sacrum*. 3rd ed. New York, NY: Churchill Livingstone; 1997.
4. Bogduk N, Wilson AS, Tynan W. The human lumbar dorsal rami. *J Anat* 1982;134:383–97.
5. Geiringer SR. *Anatomic Localization for Needle Electromyography*. 2nd ed. Philadelphia, PA: Hanley & Belfus; 1999.
6. Kimura J. *Electrodiagnosis in Diseases of Nerve and Muscle: Principles and Practice*. 3rd ed. New York, NY: Oxford University Press; 2001.

7. Stein J, Baker E, Pine ZM. Medial paraspinal muscle electromyography: Techniques of examination. *Arch Phys Med Rehabil* 1993;74:497–500.
8. Haig AJ, LeBreck DB, Powley SG. Paraspinal mapping. Quantified needle electromyography of the paraspinal muscles in persons without low back pain. *Spine* 1995;20:715–21.
9. Haig AJ, Moffroid M, Henry S, et al. A technique for needle localization in paraspinal muscles with cadaveric confirmation. *Muscle Nerve* 1991;14:521–6.
10. Chinsethagij K, Wongphaet P, Su-archawaratana S, et al. Precision of a needle localization technic in the lumbosacral multifidus muscles for segmental specific needle electromyographic study: A cadaveric study. *J Med Assoc Thai* 2003;86:722–6.
11. Tong HC, Young IA, Koch J, et al. Paraspinal electromyography that compares concentric with monopolar needles: A blinded study. *Am J Phys Med Rehabil* 2003;82:917–24.
12. Date ES, Mar EY, Bugola MR, et al. The prevalence of lumbar paraspinal spontaneous activity in asymptomatic subjects. *Muscle Nerve* 1996;19:350–4.
13. Nardin RA, Raynor EM, Rutkove SB. Fibrillations in lumbosacral paraspinal muscles of normal subjects. *Muscle Nerve* 1998;21:1347–9.
14. Dawson B, Trapp RG. *Basic & Clinical Biostatistics*. 3rd ed. New York, NY: Lange Medical Books-McGraw-Hill; 2001.
15. Dumitru D, Diaz CA, King JC. Prevalence of denervation in paraspinal and foot intrinsic musculature. *Am J Phys Med Rehabil* 2001;80:482–90.