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Spring balance evaluation of the ischiocavernosus muscle

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We studied the voluntary contractile activity of the ischiocavernosus muscle (ICM) in 21 sexually potent and 97 erectile dysfunction (ED) subjects using a spring balance. A strap was placed around the coronal grove of the glans penis and tensioned with the spring balance. Subjects were asked and encouraged to contract the ICM against the spring balance. We evaluated the length of stroke, duration of contraction, and maximum contractile force. The length of stroke, duration of contraction, and maximum contractile force showed statistically significant differences between potent and ED subjects. Diagnosed psychogenic ED and arteriogenic ED showed higher contractile activity than cavernous ED and neurogenic ED. Our results corresponded to those of previous studies that have urged consideration of the role of the ICM during the process of erection in animal experiments and in human electrophysiological studies. The spring balance evaluation is a useful, inexpensive method for evaluating the ICM. *International Journal of Impotence Research* (2001) **13,** 294–297.

Keywords: ischiocavernosus muscle; spring balance; erectile dysfunction; impotence

Introduction

Some authors[1,2] have denied the involvement of the ischiocavernosus muscle (ICM) in erection, saying only hemodynamic changes and the tunica albuginea are sufficient to achieve rigid erection. On the other hand, there is a lot of evidence that demonstrates an important role for the ICM in erection in humans.[3,4] While the roles of pelvic floor muscles such as the ICM, bulbocavernosus muscle, and transverse perineal muscle during the process of erection are still controversial, animal studies and human studies indicate that the ICM is activated during sexual intercourse and contributes to the increase in intracavernous pressure.

We compared the ICM contraction measured by a spring balance in potent men as compared with men with erectile dysfunction (ED), and among subgroups of ED, to investigate whether there is a role for the ICM or not.

Materials and methods

The control group consisted of 20 males. With informed consent, 10 patients who have visited our andrology clinic for problems unrelated to ED, and 11 other healthy volunteers underwent the ICM examination as a control group. The mean age of the control group was 48.6 y (range: 28 to 73-y-old). Also with informed consent, 97 ED patients (17 to 80-y-old, mean 53.8 y) entered the study. There was no statistical significant difference in age distribution of each group (Student's *t*-test, Welch's *t*-test).

Investigations included two or more intracavernous injection tests (prostaglandin: 10 μg, 20 μg, papaverine hydrochloride: 60 mg) and a color Doppler examination (Hitachi EUB515). In cases requiring further examination to establish ED subgroup classification, nocturnal penile tumescence (NPT) recording and dynamic infusion cavernosometry and cavernosography (DICC) were also performed.

According to the results of these investigations, we classified patients into five subgroups; psychogenic ED, arteriogenic ED, cavernous ED, neurogenic ED and others. Psychogenic ED was diagnosed when the patients responded to a low dose of PGE_1 and showed normal Doppler examination results, and when they had psychogenic factors but no history of neurological disorders. Arteriogenic ED was diagnosed when the peak systolic velocity of both cavernous arteries was less than 25 cm/s. Cavernous ED was diagnosed when the patients did not respond to both 20 μg of PGE_1 and 60 mg of papaverine, and whose flow rate to maintain erection was more than 30 ml/min at pharmaco DICC. Neurogenic ED was diagnosed when the patients had a history of spinal injury or pelvic surgery,

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showed a complete response to 10 μg of PGE_1 and had abnormal NPT patterns. Among patients with an incomplete response to an intracavernous injection of vasoactive drugs, some patients did not correspond to our criterion and some patients were diagnosed as having multiple causes of ED. These patients were classified as 'other'.

To evaluate the ICM we measured voluntary contraction of this muscle using a spring balance. Patients were asked to lie on the examination table on their backs. A strap was placed around the coronal groove of the glans penis and connected to the spring balance (Figure 1). The corpus cavernosum, and ICM were aligned along the same axis for an accurate measurement. Usually the angle between the body and penis is about 30°, although this should be adjusted according to the angle between the ischiopubic bone and the table in each case. Patients underwent practice in contracting the ICM before the measurement. Practice was performed under a tension of about 100 g, which makes it relatively easy for the patients to understand the manner of the ICM contraction.

After reaching a complete understanding of how to contract the ICM, the examination was performed. Three parameters were evaluated (Table 1). According to the results of the preliminary test performed previously with nine other normal volunteers, reproducibility of these three parameters was statistically significant (repeated measure ANOVA). In particular, reproducibility of the maximum force was good. Based on these results it was decided to repeat three sessions for maximum force and five sessions for stroke and endurance. The first parameter was the length of stroke in millimeters of the ICM contraction against a tension of 100 g. The best ICM contraction achieved out of five attempts was recorded. The second parameter was endurance. We measured duration in seconds of a voluntary contraction against a constant tension of 500 g. Because endurance is influenced by patient tension, encouragement is important. Patients repeated this session three times with a rest interval between each, and the longest duration was recorded. The third parameter was the maximum contractile force against incremental increase in tension. The greatest tension against which the patient could produce a contraction was recorded in grams. This session was also repeated three times with rest intervals and the highest tension recorded.

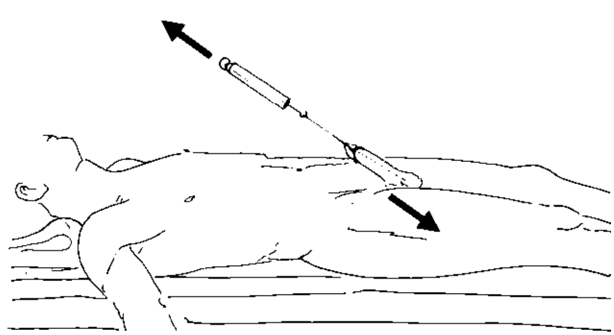

Figure 1 Spring balance method for ICM testing. A strap was placed around the coronal groove of the glans penis and tensioned with the spring balance. The corpus cavernosum and ICM were aligned along the same axis for an accurate measurement.

Table 1 Parameters of ICM tests

Stroke	Length of stroke in millimeters of the ICM contraction against a tension of 100 g
Endurance	Duration in seconds of voluntary contraction against a constant tension of 500 g
Max	Maximum contractile force against incremental increase in tension

Statistical analysis

We used the Student's *t*-test and Welch's *t*-test for parametric data and the Mann-Whitney U-test and Kruskal-Wallis test for nonparametric data. The Pearson's correlation coefficient test, and the Spearman's correlation coefficient by rank test to analyse any eventual correlation between ICM parameters and subgroup of ED.

Results

According to our criteria, 22 patients were diagnosed as psychogenic ED, 33 patients were arteriogenic ED, 24 patients were cavernogenic ED, six patients were neurogenic ED, and 12 patients were classified as other. There was no statistical significant difference in age distribution of each group (Student's *t*-test, Welch's *t*-test). There was no correlation between age and ICM parameters in both potent and ED subjects (Pearson's correlation coefficient test, Spearman's correlation coefficient by rank test). All ICM parameters were significantly higher in sexually potent controls than ED (Figure 2). If the 10 percentile value is determined as the threshold level for each parameter, the normal threshold value of stroke length was 2 mm, that of duration was 3 s, and that for maximum contractile force was 950 g. Table 2 summarizes the percentage of the patients who met or exceeded each threshold level of the ICM parameters.

We compared the three ICM parameters among the four subgroups; psychogenic, arteriogenic, cavernous and neurogenic EDs. The median values of stroke length were larger in arteriogenic and psychogenic EDs than in cavernous and neurogenic EDs (Figure 3). The difference was statistically significant (Kruskal-Wallis test, Scheffe's F-test,

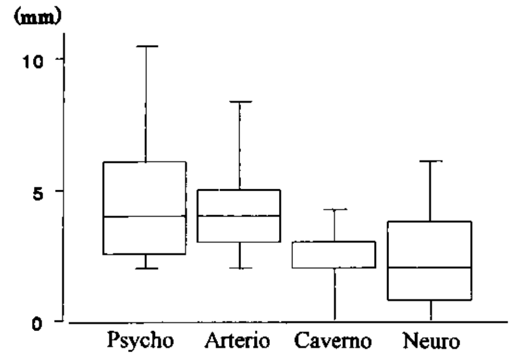

Figure 2 ICM parameters of normal controls and ED patients. There are statistically significant differences between normal controls and ED patients in each ICM parameter (Mann-Whitney's U test, $*P<0.05$, $**P<0.01$).

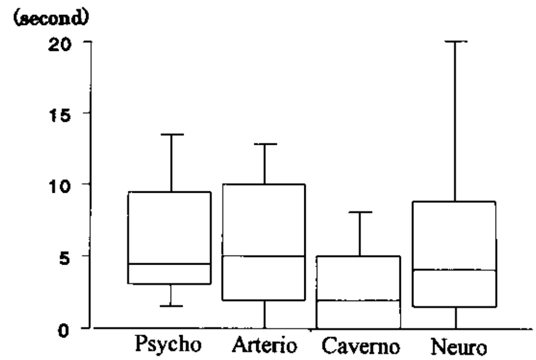

Figure 3 Stroke length achieved. The H-value of the Kruskal-Wallis test was 16.76 and P was $P<0.01$.

H-value = 16.76, $P<0.01$). For duration, the order of median value was arteriogenic ED, psychogenic ED, neurogenic ED, and cavernous ED (Figure 4), again with the difference statistically significant (Kruskal-Wallis test, Scheffe's F-test, H-value = 9.74, $P<0.01$). The maximum contraction showed the largest differences among subgroups (Figure 5). The median value of maximum contraction of arteriogenic ED was 1160 g, psychogenic ED was 1080 g, cavernous ED was 610 g, and neurogenic ED was 330 g with the overall difference (Kruskal-Wallis test, Scheffe's F-test, H-value = 32.80, $P<0.01$).

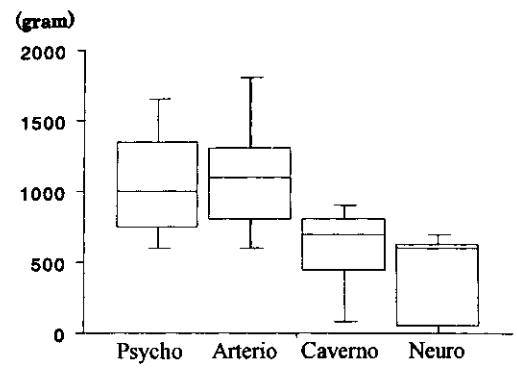

Figure 4 Contraction endurance. The H-value of the Kruskal-Wallis test was 9.74 and P was $P<0.01$.

Discussion

While it is widely accepted that hemodynamic change in the corpus cavernosum is necessary for production and maintenance of erection, the mechanism of venous outflow regulation is still subject to controversy. Involvement of the ICM in the process of penile rigidity was suggested as long as a hundred years ago. Some researchers[1,2] have emphasized the vascular system as a unique mechanism capable of producing outflow resistance, while others[3–5] say that contraction of the ICM is necessary to attain enough outflow resistance. In animal experiments[6,7] intracavernous pressure exceeded systolic blood pressure in rigid erection, but this high pressure was decreased by anesthesia of the muscles. Therefore, although the hemodynamic mechanism was essential for erection, it seems the ICM was also important. Our data showed that the contractile capacity of the ICM in ED patients is significantly lower than that of potent controls, thus supporting the involvement of the ICM in the process of erection.

Electro myogram (EMG) recording of the ICM using a needle electrode[8] or anal plug electrode[9] has been performed to evaluate the activity of this muscle. However, although application of an anal plug electrode is less invasive than a needle electrode, EMG recordings require expensive instruments and are not easy to perform at outpatients clinics. The amplitude is used as a parameter in EMG, but we think this parameter is questionable. If surface electrodes are used, the amplitude may be influenced by the electrical resistance of the skin and also obesity. If needle electrodes are used, muscular contraction may move the tip of the needle electrode and, furthermore, it is very painful.

Table 2 Threshold levels of the ICM parameters and the percentage of patients at or above threshold

Parameter	*Threshold level*	*Control*	*Psychogenic*	*Arteriogenic*	*Cavernous*	*Neurogenic*
Stroke	2 mm	100	100	100	79.2	66.7
Endurance	3 s	100	72.7	81.8	45.8	66.7
Max	950 g	90.5	50.0	81.8	4.2	0

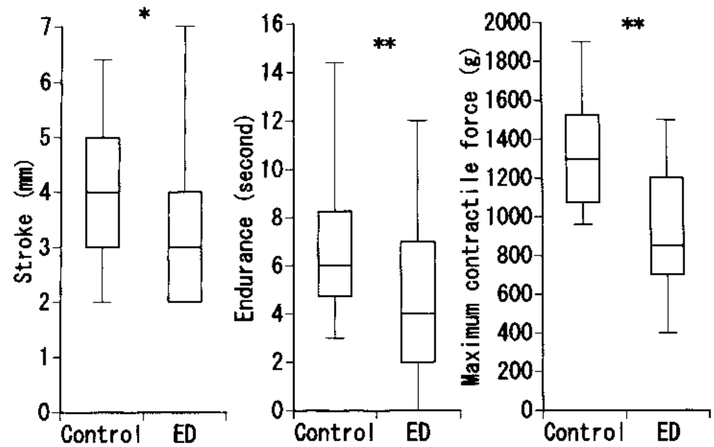

Figure 5 Maximum contractile force. The H-value of the Kruskal-Wallis test was 32.80 and *P* was $P < 0.01$.

Ultimately, what we must evaluate is not electrical activity but the contractile activity of the ICM. Our spring balance requires no special instruments, and is easy to perform. Published results from anal plug electrode EMG recordings[9] found there was no difference among the subgroups of ED subjects, yet through the spring balance evaluation we found significant differences in ICM activity. This may be due to the anal plug electrode reflecting the electrical activity of all the pelvic floor muscles, whereas the spring balance method can focus directly on the actual contractile activity of the ICM itself.

Conclusion

The spring balance method is a useful examination for directly evaluating the contractile capacity of the ICM and our results support the active involvement of the ICM in the erectile function.

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