Morphological examination of pelvic floor muscles in a simulated childbirth trauma model of rats: pelvic nerve somatomotor branch transection model

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INTRODUCTION

It is particularly well-known that the childbirths lead to the weakening of pelvic floor muscles (PFM) and pelvic nerve to the onset of stress urinary incontinence (SUI)[1)].

A previous study demonstrated that simulated birth trauma with vaginal distention (VD) in rats induces urethral dysfunction and SUI[2)]. In addition, lower urethral resistance was obtained in the rats whose pelvic nerve somatomotor branch (Smb) to pubococcygeus muscles (Pcm) were transected bilaterally[3)].

Thus, PFM play important roles in lower urinary tract functions[4)]. Peripheral nerve injury causes denervation and causes a great variety of muscle changes such as atrophy[5)].

In the skeletal muscle, it is reported that a change in morphology and fiber type distributions occurs after nerve transection[6)].

However, it is unknown that nerve injury after childbirth occurs PFM compositions change. From the above, it is expected that nerve injury after childbirth can cause muscle atrophy of the PFM and change muscle fiber type distributions.

The aim of this study was that morphological examination of PFM in the rat model of childbirth trauma in transection of Smb.

METHODS

Study design

Seventeen female Sprague-Dawley rats (210-330g)

- (1) a control group (n=5)
- (2) 4-week after transected the Smb (1M group, n=6)
- (3) 12-week after transected the Smb (3M group, n=6)

Smb: pelvic nerve somatomotor branch

Surgery

In the1M and 3M groups, Smb transection was carried out under sodium pentobarbital anesthesia.

The nerve branch was located in the pelvic area, after a ventral abdominal incision, where it crosses the internal iliac vessel (Fig.1).

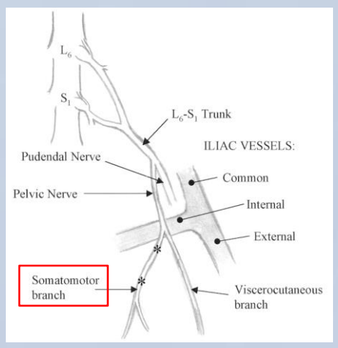


Fig.1. Drawing of the pelvic nerve somatomotor branch
(Manzo J et al: Physiol Behav. 2000.)

Tissue harvesting

A midline incision was made from the abdomen to the perineal vagina and harvest Pcm (Fig. 2). For morphological examination, Pcm were frozen in liquid nitrogen and stored at –80°C.

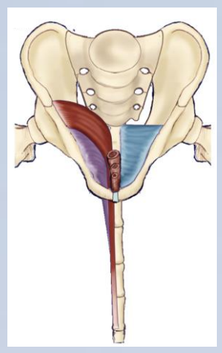


Fig. 2. Drawing of the pubococcygeus muscle (purple)
(Thor KB et al: Am J Physiol Regul Integr Comp Physiol. 2010.)

Morphological examination

We used the adenosinetriphosphatas (pH10.2) and succinate dehydrogenase (SDH) activity to identify muscle fiber type (type Ⅰ, type Ⅱa, type Ⅱb) distribution.

Parameters

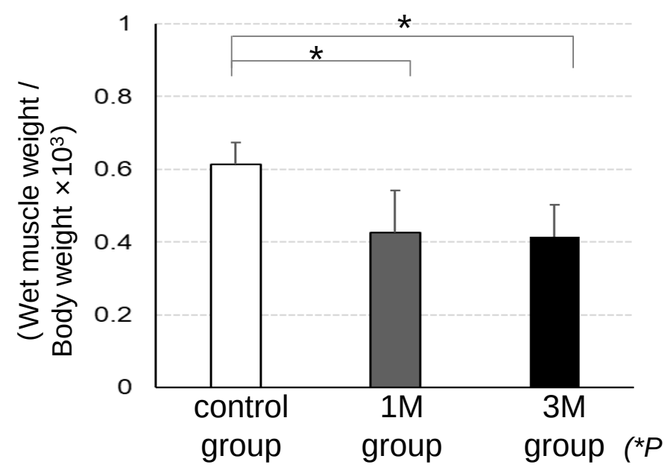
1) Pcm wet weight
2) Distribution of type Ⅰ, Ⅱa, Ⅱb fibers

Statistical analysis

One-way analysis of variance was performed to compare the data among 3 groups. P value of less than 0.05 was regarded to be statistically significant.

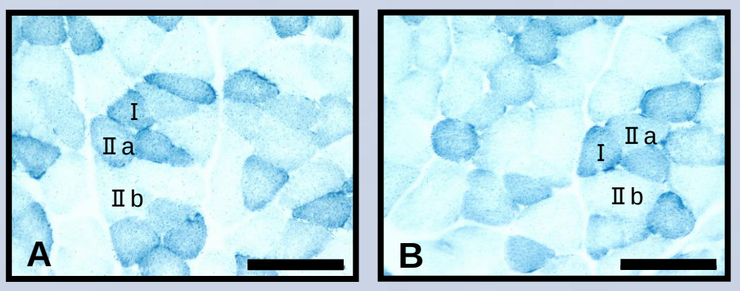
The present study was conducted after being approved by Animal Study Facility Ethics Committee in our institute (No. 19-0062).

RESULTS



- **The Pcm wet weight was significantly lower in 1M group (p = 0.022) and 3M group (p = 0.015) than in control group (Fig. 3).**

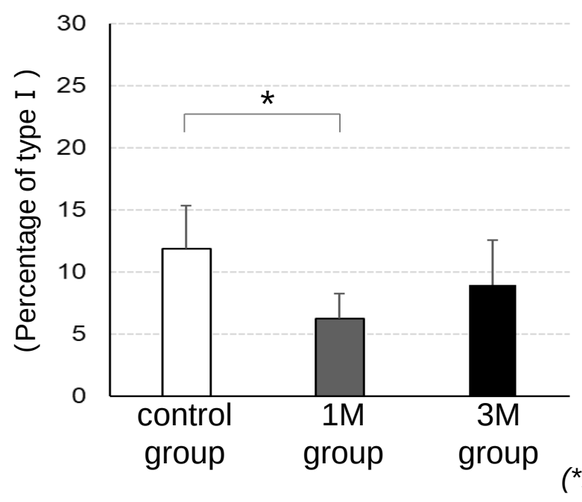
Fig. 3. Comparison of wet muscle weight



A: control group
B: 1M group

- Type Ⅰ (dark blue)
- Type Ⅱa (neutral blue)
- Type Ⅱb (pale blue)

Fig. 4. Cross sections of the Pcm, stained with SDH activity. Bar = 100 μm.



- **After 1 month of transection, the percentage of type Ⅰ fibers showed significantly decreased compared to the control group (Fig. 4, 5).**
- The percentage of type Ⅰ fibers decreased from 11.9 ± 3.4 % to 6.2 ± 2.0% (p = 0.022) (Fig. 4, 5).

Fig. 5. Distribution of type Ⅰ fiber

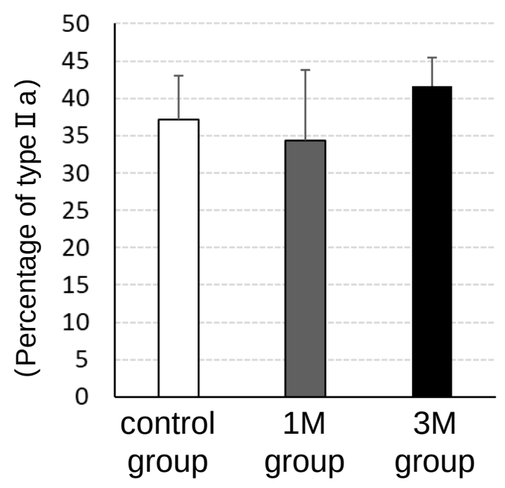


Fig. 6. Distribution of type Ⅱa fiber

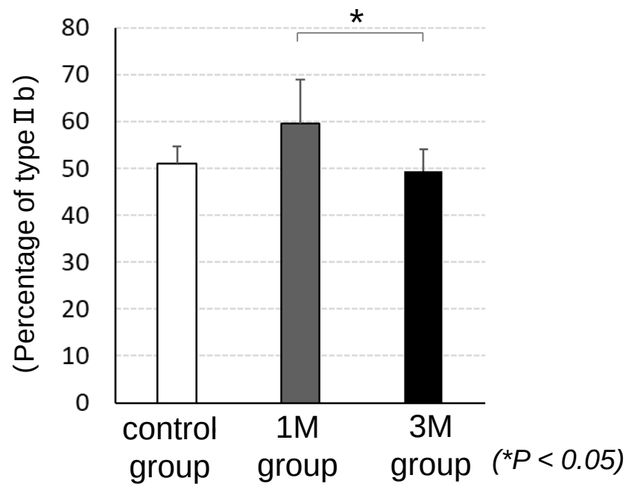


Fig. 7. Distribution of type Ⅱb fiber

- Type Ⅱa was not significantly different among groups (Fig. 6).
- Type Ⅱb in 3M group showed significantly lower than in 1M group (Fig. 7).

DISCUSSION

We showed that Pcm weight was decreased significantly in 1 month after transection as compared to the control group. The previous study reported that skeletal muscle atrophy after denervation was considered to occur in 1 month[7)]. In our results revealed that the PFM atrophy was also observed at least 1 month after nerve damage.

We found that the percentage of Pcm type I fibers significantly reduced 1month after nerve transection. The previous study investigating histological changes in lower extremity muscles have been shown that type I fibers decreased 1 month after nerve transection[8)]. This change could lead to reduced sustained muscle strength.

PFM is known to be damaged due to pudendal nerve injury induced by vaginal delivery. The previous study[3)] showed that the Smb transection model induced SUI. It rational because it mimics what happen clinically. Also, we confirmed the PFM compositions change of Smb transection model. From our results, it is thought that the PFM compositions change is related to the cause of impaired PFM function.

CONCLUSIONS

The vaginal delivery can be involved in PFM atrophy due to denervation, and contribute to the elucidation of the mechanisms of SUI.

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DISCLOSURE STATEMENT

Conflict of Interest (COI) of the principal presenter: No potential COI to disclose

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