《論　文》

Muscle strains diagnosed using ultrasound after a 10-km run: its incidence and type of injuries

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Abstract

Purpose: The purpose of this study was to evaluate muscle injuries using ultrasound (US) after assessing lower limb muscle pain occurring after a 10-km run in young non-athletes, and to reveal the rate of muscle injury and type of muscle strain.

Subjects: The subjects included 72 young, non-athletes who participated in a 10-km run. The mean age was 20.6 ± 0.6 years.

Methods: The subjects were immediately evaluated through physical examination for regarding the pain sites in their lower limbs. Subsequently, B-mode US was evaluated for diagnosis of muscle injuries. Chi-square tests were used for analysis of rate at muscle strain and muscle strain type.

Results: Sixty-three participants complained of one or more of these pain regions (87.5%). Forty-two muscle injuries detected using US were observed mostly in the medial–gastrocnemius and the vastus lateralis muscle, with a rate of 40.3% for participants. Muscle strain was classified into three types in this study.

Conclusion: We investigated muscle injuries in runners after a 10-km run using US, and consequently, the incidence proved substantially high. Clinicians should pay close attention to the high injury incidence in amateur runners, and should exploit US for runners to promptly diagnose those who have any symptoms.

Introduction

Running is considered to be one of the easiest recreational activities that achieves various benefits, including general health condition improvement. However, running-related musculoskeletal injuries are common in both elite athletes and amateur runners, with lower extremity injury incidence rates ranging from 19.4% to 92.4%[1-5]. This large variation may be attributable to differences in subject characteristics, observation period, or injury definitions[6].

The most frequent musculoskeletal running-related injuries in elite runners are Achilles tendinopathy, anterior knee pain, shin splints, and plantar fasciitis[7-10]. These injuries are predominantly caused by overuse of muscles or tendons, and result from repetitive loading on the lower limbs and unusual running styles.

Muscle strains occur when part of the fascia or muscle fiber is damaged by overuse. Although several studies have investigated running injuries in athletes and trained runners, injury incidence in amateur or untrained runners has rarely been considered[1,2,4]. Many studies on sports-induced muscle injuries are based on clinical findings, whereas There is not the report including the imaging. Medical history and physical examination are not usually sufficient to diagnose an overuse injury due to running, and an objective imaging technique for the assessment of injuries after running is required.

Magnetic resonance imaging (MRI) has been commonly used to investigate pathological changes in muscles and tendons caused by sports injuries[11-15]. MRI is certainly useful to diagnose these injuries accurately, but is difficult to use widely in epidemiological research because of long measurement time, increased cost, and limited applicability in obtaining immediate results after sports activities. Otherwise, US using high-frequency transducers is an excellent, rapid, non-invasive alternative method to diagnose sports-related musculoskeletal injuries and provides useful information for arriving at a differential diagnosis of acute pain[8,16-18]. In this study, the authors use US to evaluate muscle strains because of its precision and portability, over and above the same advantages as those of MRI. To the best of our knowledge, there are no studies evaluating muscle strains using US immediately after a run.

The purpose of this study is first to assess lower limb muscle pain occurring after a 10-km run in healthy young novice runners and to evaluate diagnosed muscle injuries using US for assessing the incidence, and to clarify the type of these injuries.

Methods

Subjects

Seventy-two healthy university students (51 men, 21 women) were recruited as participants, who completed a 10-km run held in Tokai City, Japan, in December of 2010, 2011, and 2012.

The subjects did not practice sports regularly and voluntarily agreed to participate in a 10-km run for three consecutive years, The number of participants was 32, 18, 22, respectively. Mean age, height, weight, and BMI were 20.7 ± 0.6 years, 166.7 ± 7.8 cm, 60.1 ± 8.3 kg, and 21.3 ± 2.1 kg / m^2, respectively. This study was approved by the Ethics Committee at the Seijoh University, and written informed consent was obtained from all subjects (approval number, 2011C0024, 2012C0020).

Procedures

After the 10-km run, the subjects were immediately transferred to our laboratory for this study, and physical examinations were assessed. US was used to promptly diagnose runners who had pain or any symptoms after the run. US was performed a using Xario SSA-660A ultrasound (Toshiba Medical Systems, Japan), equipped with a 12-MHz transducer. US examinations were performed with the transducer aligned with the transverse and longitudinal sections of the given pain site. Muscle strains were also examined for abnormalities, which led to the diagnosis of the observed type of muscle strain according to the clinical grades of Lee et al[19]. Muscle strain levels I, II, and III are described. The US images were evaluated and double-checked by two experienced sonographers (M.A. and B.M.).

Statistical analysis

A Chi-square test, performed in SPSS v.17 for Windows was conducted to test for significant relations between the rate of muscle strain of gastrocnemius quadriceps, and hamstrings, and relations between the type of muscle strain. The level of significance was set at $P<0.01$.

Results

Sixty-three subjects experienced pain in one or more sites, mainly in the calf (n = 40), followed by the anterior (n = 33) and posterior (n = 17) thigh region. These sites also often overlapped, with 63 out of the 72 subjects (87.5%) complaining of pain in one or more sites (Table 1).

Table 1. Pain location and frequency after 10-km run

Pain	locations	%
Lumbar	3	4.2
Hip	9	12.5
Thigh/front	33	45.8
Thigh/back	17	23.6
Knee	12	16.7
Shin	5	6.9
Calf	40	55.6
Ankle	12	16.7
Foot	8	11.1

Values are expressed as numbers and percentages of pain location as determined using the questionnaire and physical examination. Overlapped pain is included in the numbers. The overall prevalence of pain in the 72 participants was 87.5%. (n=72 participants)

A total of 42 muscle strains were detected in the medial gastrocnemius muscle (21 sites) and vastus lateralis muscle (14 sites) (Table 2). Other muscle injuries were present in a lower frequency. Twenty-nine participants (40.3%) had muscle injuries. The incidence of hamstring muscles was significantly fewer than other muscles ($P<0.01$).

Table 2. Muscle strains detected using ultrasound after 10-km run

Muscle group	Muscle	Injuries (bilateral injuries)
Gastrocnemius	Medial gastrocnemius	21 (5)
	Lateral gastrocnemius	3
Quadriceps	Vastus medialis	1
	Vastus lateralis	14 (1)
	Rectus femoris	1
Hamstrings*	Semitendinosus	1
	Biceps femoris	1
Total		42 (6)

Overlapped injuries are included in the numbers.
*: P<0.01, Chi-square test. (n=144 limbs)

Table 3. Classification of muscle strain

Muscle group	Muscle	Grade Ⅰ	Grade Ⅱ	Grade Ⅲ
Gastrocnemius	Medial gastrocnemius	7	14	
	Lateral gastrocnemius		3	
Quadriceps	Vastus medialis			1
	Vastus lateralis		13	1
	Rectus femoris			1
Hamstrings	Semitendinosus			1
	Biceps femoris			1
Total		7 (4.9 %)	30 (20.8%)*	5 (3.5%)

Two subjects had both Grade Ⅰ and Grade Ⅱ in the medial gastrocnemius muscles.
*: P<0.01, Chi-square test. (n=144 limbs)
Grade Ⅰ: Normal appearance or focal or general areas of increased echogenicity with or without perifascial fluid.
Grade Ⅱ: Discontinuity in muscle fibers in echogenic perimysial striae.
Grade Ⅲ: Complete discontinuity of muscle fibers and associated hematoma.

The type of the muscle strain is shown in Table 3. These were classified as Grade Ⅰ strains, observed only in the inferior portion of the medial gastrocnemius muscle, with hypo-echogenicity in seven of the 42 sites. Grade Ⅱ strains were detected at the discontinuity of muscle fibers as hypo-echogenecity in the myotendinous junction of the gastrocnemius and vastus lateralis muscles, and was observed in 30 of the 42 sites.

Grade Ⅲ strains were observed at the intramuscular hematoma as hyper-echogenicity in the quadriceps muscles and hamstring muscles, which was found in five of the 42 sites. Two subjects had both Grade Ⅰ and Grade Ⅱ strains in the medial gastrocnemius muscle. The incidence of Grade Ⅱ strains was significantly higher than the other Grades ($P<0.01$).

Discussion

In this study, we investigated pain and muscle injury sites in the lower limbs of young amateur runners immediately after participating in a 10-km run. The incidence of muscle injury was higher than expected, revealing many Quadriceps and Hamstring muscle strains, most of which were Grade Ⅱ. To the best of our knowledge, this is the first report using US to systematically investigate muscle injuries in the lower limb muscles of amateur participants.

Although previous studies have examined the incidence of running-related injuries in athletes, few studies have investigated injury incidence in amateur or recreational runners[1,2,4]. Our results show a pain incidence of 87.5%, which is high–frequency result compared to other reports ranging from 19.4 % to 92.4 %[1-5]. These results were reasonably explained through the evaluation for pain according to questionnaires, whereas we performed physical examination for pain sites for all participants just after the run. In addition, in the results of previous studies, research on the incidence of injury in various definitions and observation periods has understandably yielded different results. As to the pain sites occurring from frequency, our results were very similar when compared to the results of recreational runners by a study of Taunton et al[2]. They investigated recreational runners who finished a 10-km run, and the sites most prone to injury were in order of the knee, the calf and the foot, with an overall pain incidence of 29.5%.

The subjects in this study experienced pain mainly in two locations, the calf (n=40) and thigh/front (n=33). Furthermore, we detected muscle injuries using US in the gastrocnemius (24/40, 60%) and quadriceps (16/33, 48.5%), respectively. Its rate was high. Thereby, we gave more attention to the high incidence of muscle injuries in subjects with pain or symptoms after the run.

A previous study classified acute muscle injuries by sonographical grading: Grade Ⅰ, normal appearance, focal, or general areas of increased echogenicity with or without perifascial fluid; Grade Ⅱ, discontinuity of muscle fibers in echogenic perimysial striae; Grade Ⅲ, complete discontinuity of muscle fibers and associated hematoma[19]. In the present study, all muscle strain grades were observed. We classified acute muscle injuries into three main categories identified using US imaging, as mentioned above. Hypo-echogenic findings around the fascia of the medial head of the gastrocnemius muscle were observed in seven of 42 sites, and these were determined to be Grade Ⅰ cases. The fascia surrounding the muscle fiber bundles can also become swollen, leading to a Grade Ⅰ strain. Previous studies on Grade Ⅰ strains reported US evidence of muscle strains in the gastrocnemius muscle as tennis leg[20]. Grade Ⅱ strains in the gastrocnemius muscle or vastus lateralis muscle in contact with the myotendinous junction has been diagnosed as the discontinuity of fiber tissue, with fluid accumulation at the site of disruption. This type was the most frequent injury observed in our study. This suggests that plantar flexion of the foot, and coincident extension of the knee, resulted in simultaneous contraction and stretching of the vastus lateralis muscles and gastrocnemius muscles. We believe this may be due to a lesser capacity of the joint's ability to absorb energy compared to other muscles. Small hematomas of the quadriceps and hamstring muscles were observed in five sites as Grade Ⅲ, and were considered to be the result of repetitive high force eccentric muscle contractions associated with structural damage of the contractile apparatus. US showed the presence of acute hematoma along with a diagnosis of Grade Ⅲ. For patients with Grade Ⅲ, it is necessary to refrain from physical activity until the hematoma is resolved, and discontinuity of muscle fibers is repaired. All muscles strains observed were partial, with functional recovery occurring within a week during follow up. The high frequency of lower limb muscle injuries, and the regional sonographic characteristics observed in our study, may be relevant to sports-related clinical practice. Combinations of physical examination and US are essential to detect pathological changes in muscles after a distance run in runners complaining of focal pain.

Conclusions

We have assessed the incidence of muscle injuries in healthy, young amateur runners who participated in a 10-km run, and diagnosed the injuries using US immediately after the run. The incidence of muscle injuries in amateur runners was observed to be relatively higher than predicted. Therefore, clinicians should pay close attention to the high incidence of injuries in amateur runners, and should use US to diagnose these injuries promptly in subjects with pain or symptoms after a run.

Conflict of interest

The authors declare that they have no conflict of interest.

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