A case of limited knee joint flexion improved by a sliding treatment of the quadriceps femoris after femoral shortening surgery

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Key Words: femoral shortening surgery, sliding treatment, limited knee joint flexion

Absutract:
[Purpose] The purpose of this report was to determine whether the sliding treatment of the quadriceps femoris is effective for increasing the range of motion in knee joint flexion in patient with limited knee flexion after femoral shortening surgery.
[Method] The subject was a 2-year-old girl. The diagnosis was bilateral congenital knee dislocation (tibial anterior dislocation of the tibia). Left and right femoral shortening surgeries were performed at 509 and 551 days after birth, respectively, and each leg was immobilized for 6 weeks after surgery. In the femoral shortening surgery, the skin was incised 10 cm around the knee joint, and the quadriceps femoris was shortened by 2 cm in the longitudinal direction and fixed with a metal plate insertion. Restorative positioning was also performed at the tibiofemoral joint. Physical therapy was started on day 636 after birth. The intervention was performed twice a week, for approximately 20 minutes. At the time of postoperative intervention, the palpation test revealed the extensibility limitation of both the left and right quadriceps femoris in the longitudinal direction and decreased sliding between the quadriceps femoris (particularly the rectus femoris) and adjacent soft tissues. The range of flexion of both knees was 60° on the right and 80° on the left, and the end feel at the time was more elastic. In this study, we focused on the longitudinal direction extensibility and sliding treatment with the surrounding tissues of the quadriceps femoris to expand the range of motion in knee joint flexion.
[Result] The range of motion in knee joint flexion was improved by 30° on day 818 (at the last intervention before metal plate removal) and by 90° on the right side. The range of motion of the left side was 100°, which improved by 20°.
[Conclusion] Results suggested that sliding treatment of the quadriceps femoris was effective at increasing the angle of knee flexion.

Introduction

Congenital knee dislocation occurs in 1 in 100,000 live births and is a rare condition that results in tibiofemoral joint dislocation (anterior dislocation of the tibia in relation to the femoris) [1]. It often causes problems with limited knee joint flexion, which can interfere with various activities such as walking and climbing stairs [2]. Tibiofemoral joint dislocation due to congenital knee dislocation is said to be caused by shortening of the quadriceps femoris muscle [3][4], and quadriceps femoris prolongation has traditionally been performed as a treatment method [3][5]. However, because the prolonged quadriceps femoris muscle does not function sufficiently as a knee joint extension owing to scarring of the quadriceps femoris, femoral shortening surgery, in which the quadriceps femoris muscle is relatively extended, has been used in recent years [6][7]. Femoral shortening surgery is a technique that is often performed to correct leg length differences in adults, with the leg length difference being shortened in the middle one-third of the femoris [8]. The advantages of femoral shortening surgery for congenital knee dislocations are that it minimizes the invasion of the quadriceps muscle and avoids scarring of the quadriceps femoris, thus preserving the function of the muscle as an extension of the knee joint [7]. However, limited knee joint flexion has been reported to occur after femoral shortening surgery [7].

Recently, interventions that focus on the sliding of the quadriceps femoris have been reported to be effective for limited knee joint flexion [9]. The sliding of a muscle with respect to adjacent tissues is the extent to which the superficial muscle moves passively with respect to adjacent deep muscles and other soft tissues [10]. In addition, the reduction in sliding between adjacent tissues of the muscle has been shown to be largely influenced by myofascia [11]. Myofascia dysfunctions show the following three signs: densification of the collagen and elastin fibers that form the epimysium, gelatinization of the intercellular substrate, and aggregation of hyaluronic acid [12][13]. As the epimysium is continuous with the perimysium and endomysium [14], the high density of the epimysium is said to impair its sliding throughout the myofascia [15]. Myofascia is said to cause a thickened perimysium and endomysium due to immobility [16] and a decrease in extensibility and inter-tissue sliding due to inflammation [17]. Therefore, one reason for the limited knee joint flexion despite the relative quadriceps femoris prolongation caused by femoral shortening surgery may be the reduction in sliding between the quadriceps femoris and the surrounding soft tissue due to the inflammation and immobility caused by the surgery. Therefore, to improve the limited knee joint flexion after femoral shortening surgery for congenital knee dislocations, not only the expansibility but also the sliding with the surrounding tissues of the

quadriceps femoris is necessary. However, no reports have described interventions that focus on the sliding of the quadriceps femoris and surrounding tissues in cases of limited knee joint flexion after femoral shortening surgery for congenital knee dislocations.

Therefore, the purpose of this report was to determine whether the sliding treatment of the quadriceps femoris is effective for increasing the range of motion in knee joint flexion in patient with limited knee flexion after femoral shortening surgery.

Subject and Methods

1. Subject

The subject was a 2-year-old girl (weight: 8100 g). The diagnosis was bilateral congenital knee dislocation (tibial anterior dislocation of the tibia; Fig. 1).

Right Left

Fig 1. X-ray image of the knee joint at birth

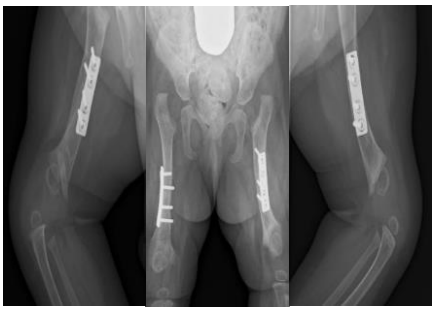
At birth, the subject weighed 755 g and had an intraventricular hemorrhage and progressive intraventricular enlargement, which were treated with a subgaleal shunt surgery 22 days after birth. On the 69th day after birth, a ventriculoperitoneal shunt surgery was performed. The subject also had a bilateral congenital hip dislocation (backward dislocation of the hip joint), and both joints were immobilized with braces since birth to prevent the progressions of the hip and knee joint dislocations. The extent of the dislocation was grade 3 (dislocated type) according to the Drehmann classification [18].

2. Ethical considerations

This study was conducted in accordance with the Declaration of Helsinki, and the patient's family's consent was obtained in writing before the start of the study, explaining the purpose and methods of the study, that the data would not be used for any purpose other than the present study, and that the data would be strictly controlled to prevent personal information from being disclosed. The study was also conducted with the approval of the Nanto Visiting Nursing Station's Ethics Review Committee (No. 2019.NHS.2).

3. Progress

Left and right femoral shortening surgeries were performed at 509 and 551 days after birth, respectively (Fig. 2).



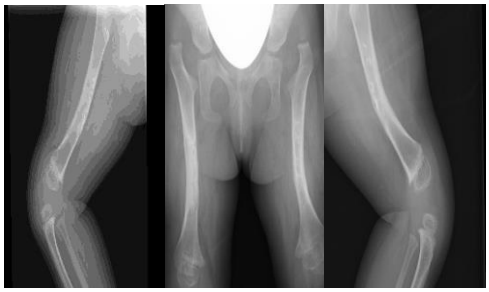
Right Front Left

Fig 2. X-ray image of Knee joint after femoral shortening surgery

※The image of the right side was

obtained 551 days after birth, that of the left side was taken 509 days after birth, and that of the front was obtained after femoral shortening surgery on the right side.

In the femoral shortening surgery, the skin was incised 10 cm around the knee joint, and the quadriceps femoris was shortened by 2 cm in the longitudinal direction and fixed with a metal plate insertion. Restorative positioning was also performed at the tibiofemoral joint. Both sides were immobilized with casts from the trunk to the lower extremities for 6 weeks after the surgery. Physical therapy was started on day 636 after birth. The intervention was performed twice a week, for approximately 20 minutes. In addition to sliding treatment of the quadriceps femoris, standing and walking exercises were also performed. On day 876 after birth, the metal plate was removed (Fig. 3).



Right Front Left

Fig 3. X-ray image of Knee joint after removal of the metal plate (876 days after birth)

4. Physical therapy assessment during intervention after femoral shortening surgery (636 days after birth)

The palpation test revealed the extensibility limitation of both the left and right quadriceps femoris in the longitudinal direction and decreased sliding between the quadriceps femoris (particularly the rectus femoris) and adjacent soft tissues. The flexion range of motion of both knee joints was 60° on the right side and 80° on the left side, and the end feel was “more elastic.” Ventral displacement of the tibia from the femur was observed in the full range of motion in knee joint flexion.

5. Focus of the intervention

The tibiofemoral joint motion in knee joint flexion requires the tibia to move dorsally in relation to the femoris, according to the concave convex rule [19]. In the present case, a decrease in sliding was observed between each myofascia surrounding the quadriceps femoris and between the quadriceps femoris and the adjacent soft tissues. We hypothesized that this caused excessive ventral displacement of the tibia and restricted the dorsal motion of the tibia during knee joint flexion. In this study, we focused on the longitudinal direction extensibility and sliding treatment with the surrounding tissues of the quadriceps femoris to expand the range of motion in knee joint flexion. The sliding treatment was performed by grasping the muscle with the therapist’s thumb, index finger, and middle finger in the position of full knee extension, moving it perpendicular to the course of the muscle and extending the movement between the tissues [10].

Results

The range of motion in knee joint flexion was improved by 30° on day 818

(at the last intervention before metal plate removal) and by 90° on the right side (Table 1). The range of motion of the left side was 100°, which improved by 20° (Table 1). The ventral displacement of the tibia relative to the femur in the total range of motion during knee joint flexion was reduced compared with that on day 636 after the intervention.

Table 1. Flexion angle of the knee joint

	At first intervention after femoral shortening surgery (636 days after birth)	At the time of intervention before metal plate removal (818 days after birth)
Right (°)	60	90
Left (°)	80	100

Discussion

This study investigated whether the sliding treatment of the quadriceps femoris is effective for increasing the range of motion in knee joint flexion in cases with limited knee joint flexion after femoral shortening surgery. Children with underdeveloped cognitive and verbal skills, such as our patient, have difficulty with verbal instructions and intervention to increase the range of motion of the knee joint with automatic movements. Therefore, intervention in passive movements is necessary, and evaluation of the effects of interventions that focus on sliding rather than extensibility movements is important.

Congenital knee dislocation is caused not only by the shortening of the quadriceps femoris [3)4)] but also by defects or dysplasia of the anterior cruciate ligament [20)]. In the present case, after the femoral shortening surgery, the end feel during knee joint flexion was “more elastic,” which suggests a muscle-derived loss of mobility. Therefore, we determined that the ventral displacement of the tibia in this case was of muscular origin rather than due to dysplasia or a defect in the anterior cruciate ligament. We hypothesized that in this case, inflammation of the soft tissues, including the quadriceps femoris, due to the femoral shortening surgery and immobility due to the cast fixation caused adhesions and reduced the sliding between the myofascial tissues, which resulted in limited range of motion in knee flexion. By contrast, the range of motion in knee joint flexion improved as a result of the intervention with the quadriceps femoris sliding treatment. Horiguchi et al. [9)] reported that the quadriceps femoris sliding treatment improved the sliding of the myofascia. Therefore, in this case, the sliding treatment of the quadriceps femoris may have improved the sliding between the myofascia surrounding the quadriceps femoris and the soft tissues adjacent to the quadriceps femoris, and improved the flexion angle of the knee joint by making it easier for the tibia to move dorsally during knee flexion.

The limitation of this study is that we

did not objectively assess the degree of sliding in the quadriceps femoris and adjacent soft tissues. Therefore, the degree of sliding of the myofascia of the quadriceps femoris and the soft tissues adjacent to the quadriceps femoris during flexion of the knee joint must be evaluated using ultrasonographic diagnostic equipment and other objective indicators.

Conclusions

We examined whether the sliding treatment of the quadriceps femoris is effective for increasing the flexion angle of the knee joint in subject with limited knee joint flexion after femoral shortening surgery. The results showed that it was effective for the restriction of knee joint flexion after femoral shortening surgery. In future studies, we would like to increase the number of cases and further examine the effect of the sliding treatment of the quadriceps femoris.

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