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An Improved Surgical Method for Treating Knee Flexion Contractures in Children with Cerebral Palsy

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Abstract This article analyzes a new anatomically-based and minimally invasive surgical method for treating knee flexion contractures in children with cerebral palsy (CP). The study included 122 patients divided into two groups according to the treatment method: traditional and newly proposed. The method based on aponeurosis dissection, used in the main group, demonstrated superior clinical and functional outcomes, preserved muscle function, reduced spasticity, and accelerated rehabilitation. This technique is recommended as an effective and modern surgical approach.

Keywords Cerebral palsy, Knee joint contracture, Aponeurosis dissection method

1. Introduction

Cerebral palsy (CP) is one of the leading neurological conditions causing disability in children. In particular, knee flexion contractures resulting from the spastic form of CP limit independent walking, complicate rehabilitation, and place a heavy burden on both families and medical staff [1,5,6].

Conservative treatments (casting, orthoses, botulinum toxin injections) may provide temporary relief, but surgery is often necessary in severe and persistent cases [2,3,4]. Traditional surgical methods often involve muscle and tendon lengthening or cutting, which can sometimes lead to overcorrection, loss of balance, or reduced function. Therefore, a new anatomically and physiologically sound method involving aponeurosis dissection is being developed as a relevant direction in modern traumatology and orthopedics.

2. Materials and Methods

The study involved 122 children with spastic CP and knee flexion contractures. They were divided into two clinical groups based on the surgical method. In the control group (n = 68), traditional methods involving muscle cutting and stretching were used. In the main group (n = 54), patients underwent a newly proposed minimally invasive surgical method based on aponeurosis dissection.

All patients were evaluated preoperatively and at 3, 6, and 12 months postoperatively. Assessment included clinical examination and gait analysis (mobility, balance, knee flexion angle, muscle tone and activity, contracture characteristics). Knee joint deformities, flexion angles, bone structure, and growth points were evaluated radiographically. Electroneuromyography (ENMG) was used to assess the activity, conductivity, and spasticity of rectus femoris and hamstring muscles preoperatively and 6 months postoperatively. Spasticity was evaluated using the Modified Ashworth Scale at 3, 6, and 12 months postoperatively. Knee flexion angles were measured with a goniometer, and all data were statistically analyzed using t-tests and chi-square (χ^2) tests. Results were presented as mean ± standard deviation, with $p<0.05$ considered statistically significant.

3. Results and Discussion

The study confirmed that the newly developed, minimally invasive surgical method involving aponeurosis dissection provided superior clinical and functional results in children with CP and knee flexion contractures. Of 122 patients, 68 in the control group underwent traditional methods, while 54 in the main group received surgery based on the patented method "Surgical correction method for knee flexion contracture" (FAP № 02190, 17.03.2022) (see Figure 1).

All patients were evaluated with X-ray, ENMG, and the Modified Ashworth Scale before and after surgery. ENMG results showed better motor activity and conduction velocity in the rectus femoris and hamstring groups in the main group compared to the control group ($p<0.01$), indicating preserved anatomical structure and restored function due to aponeurosis dissection. Radiological analysis showed that the average

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preoperative knee flexion angle was ~35° in both groups. Six months post-op, this angle decreased to 16° in the main group and to 12° at 12 months. In the control group, the angle remained around 21°, confirming that the new method ensures more direct functional correction.

Postoperative spasticity measured by the Ashworth scale averaged 2.04 ± 0.6 in the main group, compared to 2.50 ± 0.7 in the control group ($p<0.05$). The new method reduced tension in the aponeurotic structure without increasing muscle tone, indicating muscle preservation. Overall, the aponeurosis dissection method is less invasive than traditional tendon and muscle cutting, helps preserve anatomical function, speeds up rehabilitation, and improves clinical outcomes (see Diagram 1).

This method effectively reduces the aponeurotic structure that is the source of spasticity, restores balance between antagonist muscles, and reduces the scope of pathological reflexes. It minimizes negative effects on the flexor-extensor system and improves functional gait patterns.

4. Conclusions

The proposed method can be considered one of the pathogenetically justified, highly effective techniques for treating knee flexion contractures in children with cerebral palsy. By selectively dissecting the aponeurosis, preserving antagonist muscles, and applying minimally invasive techniques, this method ensures quicker recovery and improved gait. This individualized approach meets modern orthopedic and neurosurgical standards, enhances treatment outcomes, and reduces the risk of recurrent contractures.

Figure 1. Surgical correction of knee flexion contracture

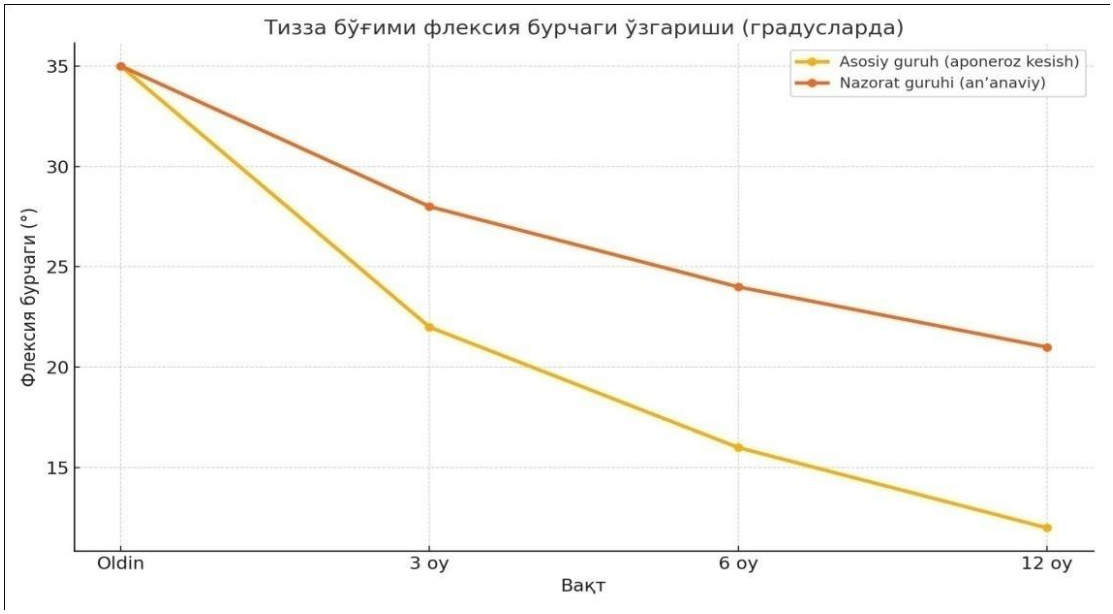

Diagram 1. Changes in knee flexion angle post-surgery in control and main groups

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