

## KYPHOSIS IN PATIENTS WITH CEREBRAL PALSY: CAUSES OF ITS DEVELOPMENT AND CORRECTIONAL POSSIBILITIES (LITERATURE REVIEW)

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In this article, the literature pertaining to the treatment of kyphosis in patients with cerebral palsy was reviewed. Among the most common causes of kyphosis is the connection with pathological reflexes of newborns and infants with cerebral palsy, the presence of a hamstring syndrome, as well as weaknesses of the extensor muscles of the trunk. Attention is paid to a fundamental decrease in the quality of life of patients if they have pronounced kyphosis.

Among the treatments, different variants of corsets are used, but the effectiveness of this method of treatment is low. It is notable that in some adolescent patients, they develop a fixed deformity that was successfully corrected and stabilized with spinal surgery. Therefore, a variety of techniques and devices for fixation have been used.

**Keywords:** cerebral palsy, kyphosis, contracture.

The issue of orthopedic treatment of patients with cerebral palsy is traditionally focused on the elimination of contractures and limb deformities. Many of these patients also have curvature of the spine, which results in difficulties in walking and sitting. The most common deformities are scoliosis and kyphosis. The pathogenesis and treatment of scoliosis has been given significant attention in the recent literature. However, the current literature fails to adequately consider the etiology, development, and possible treatments for kyphosis in patients with cerebral palsy. The frequency of kyphosis in patients with cerebral palsy is not reported by researchers. This may be because of the lack of clear criteria for the diagnosis of this condition. According to the literature, the value of physiological kyphosis of the spine in healthy individuals significantly varies between authors (from 15° to 50°) [1]. These significant differences in standards make it difficult to define the pathology. An additional reason for this is that kyphosis in patients with cerebral palsy is, first of all, a non-fixed condition when the deformation can be completely and actively corrected by a patient for a short time. The deformation in some of these patients becomes

gradually fixed during adolescence, and the surgical correction methods conform to those for fixed kyphosis of other etiologies [2]. Therefore, it appears particularly relevant to study the formation of non-fixed kyphosis in order to develop treatments and prevent the development of its fixed form.

According to the literature, kyphosis begins in infancy, often as part of a labyrinth tonic reflex in newborns. This is characterized by the patient's posture and reflex, and formation of kyphosis in the prone position in the newborn, and subsequently, when a child learns to walk [3, 4]. The immediate cause of its development in patients with cerebral palsy is considered by most studies as the existence of the so-called hamstring syndrome. This involves a heightening of the flexor tibia tonus with or without contracture, resulting in a posterior pelvic tilt, smoothing compensatory lumbar lordosis, and kyphosis of thoracolumbar spine [5, 6, 7, 8]. When the patient tries to straighten the knee joints in a seated position, kyphosis sharply increases, leading to an inability to maintain this position. Knee flexion increases the lumbar lordosis with a corresponding decrease in the severity of kyphosis [2]. The implementation of this syndrome is domi-

nated by hypertonicity of the medial group of tibia flexors. The degree of shortening can be judged by a possible extension of the knee joint during flexion of the hip to 90° (normally this angle is not less than 110°) [5]. The researchers found a relationship between the severity of flexion contracture of the knee joint and the smoothness of the lumbar lordosis (with respective increase of kyphosis), which confirms its pathogenic interdependence [7]. Moreover, some studies found a relationship between the change in the sagittal profile of the spine and pelvis tilt in the formation of kyphosis [9]. The possibility of lumbar hyperlordosis as a compensatory response to an existing thoracic kyphosis in adolescent patients and the opposite interdependence were noted. The latter is associated with primary hyperlordosis as a consequence of lumbar flexion contracture of the hip joints. At the same time, the pelvis anteriorly tilts, causing the development of hyperlordosis [8]. On the basis of a survey of 184 patients with cerebral palsy with different degrees of motor abilities, a study reported the progression of kyphosis to 2.2° within 1 year in patients with VI-V impaired motor capabilities as classified by the Gross Motor Function Classification System. In patients with the best development of motor skills, this did not occur [10].

Studies have reported the weakness of the extensor muscles of the back as a characteristic feature of kyphosis in patients with cerebral palsy. At the same time, some authors identified this condition as a separate form of kyphosis, which is characterized by a more uniform curvature of the spine during extension [2, 8]. Furthermore, patients have hypertonicity of the body muscles, making it difficult to correct kyphosis.

In addition to these common causes of kyphosis, there are several other rare ones. For example, a front dislocation of the hip joint, which severely limits hip flexion and smoothes out the seat of the lumbar lordosis and increases compensatory thoracic kyphosis when seated, is another cause. The development of kyphosis after laminectomy and selective dorsal rhizotomy was described [2]. However, these forms of kyphosis have a different pathogenesis, and methods of correction also distinguish them from the “usual kyphosis;” therefore, they should be separately considered.

Thus, the formation of pathological kyphosis in patients with cerebral palsy is generally regarded

not as an isolated distortion of sagittal profile but as a compensatory response to the imbalance of the body due to the presence of contractures in the joints of lower extremities.

The main problems that arise in patients with kyphosis are difficulties in sitting and holding the head in an upright position, and these difficulties mainly increase in adolescence. Pain is typically absent; however, patients quickly tire when in a seated position with a pronounced inclination of the head in front, resulting in the gradual formation of significant compensatory lordotic cervical spine [2]. Apart from the problems with sitting, a study also reported the presence of pain, upper celiac artery syndrome, pelvic organ dysfunction, and malnutrition signs. [11]

Regarding the treatment of kyphosis, the utilization of corsets and special adaptations for fixing patients in a wheelchair is given very little attention in the literature. However, one study reported the effectiveness of this treatment method for kyphosis when the root cause is hypotension of muscles [8]. Only in one study was the question of the effectiveness of a corset for severe neurological patients in a wheelchair discussed in more detail [12]. The absence of any regularity in treatment outcomes was discussed; for example, one attempt to correct kyphosis led to an improvement in the sagittal profile of the spine and aggravation of curvature. Some studies have reported that data on the use of braces to prevent the progression of the rigid type of kyphosis are currently absent. Therefore, the use of braces has been recommended for daytime use to improve functioning [2]. Different treatment options were proposed for one patient in a wheelchair, including a special belt and custom-made wheelchair. A side table is recommended to support the patient's arms during self-correction of kyphosis. However, this can only alleviate a patient's position by adapting external fixators to its deformation. The literature does not specify which patients have had success with the use of these devices. Furthermore, there were cases where the use of this method did not lead to improvements, and thus, surgical correction for corporodesis was required [2].

According to the pathogenesis of its development, treatment of patients with fixed kyphosis is closely linked with the ability to effectively eliminate contractures and abnormal installation in the joints of the lower extremities. Therefore, it is con-

sidered that the correction of hamstring syndrome (flexor tendon plasty) can significantly correct kyphosis. The most frequently used is Eggers procedure, which includes the transfer medial flexor group at the tibia [5], and a simple tendon lengthening [2, 8]. A decrease in the severity of kyphosis of the lumbar and thoracic spine was noted; however, data on the extent to which there was a decrease was not provided. Furthermore, the authors discuss whether or not the patient was able to sit with their legs straight.

The ineffectiveness of conservative treatment, elimination of hamstring syndrome, or use of surgical methods for the correction of kyphosis in patients with cerebral palsy is a real issue. Despite this, the available literature does not adequately explore this issue. With respect to spine pathology in these patients, complete attention was directed to the possibility of surgical correction of scoliosis. There are only two studies regarding the experience of kyphosis correction in patients with cerebral palsy in the literature. One study, which is based on the treatment of 30 patients [2], considered the presence of fixed (and in some cases non-fixed) mobile kyphosis of the long arcs that caused significant functional problems with sitting and lying as indicators for surgery in adolescent subjects. Furthermore, the correction and stabilization of the spine was considered to be the objective of the surgery. Therefore, a set of standard tools similar to those necessary for the correction of scoliosis was used. To determine the need to perform preliminary discapophysectomy, a child is laid on his back in a position of hyperextension. If the child experienced discomfort, this was sufficient to perform a dissection on levels 5-6 at the top of the strain in the thoracic region. If the child was comfortable in the prone position on a solid table, performing posterior fixation of the spine was generally considered necessary. Given that kyphosis is accompanied by smoothing of the lumbar lordosis (in most cases) or hyperlordosis, it was considered necessary to fix the entire spine, giving it a satisfactory sagittal profile, and also to establish fixation of the pelvis to control anteroposterior tilt. It was also noted that that the top of the deformation may be high enough (sometimes at Th4) to require corresponding proximal fixation (in some cases up to level C7). Occasionally, in adolescents with thoracic kyphosis, it was considered to be impossible to fix the pelvis.

Other studies analyzed the surgical correction of patients with cerebral palsy having hyperkyphosis and hyperlordosis (24 and 14 cases, respectively). However, the age of patients and the degree of mobility of the deformations were not stated. As a result of fixation, the degree of spine kyphosis decreased from 93.8° to 34.8° and the degree of lordosis decreased from 91.8° to 48.6°. Following surgery, there was a reduction in the sitting difficulties and the severity of pain, and the occurrence of upper celiac artery compression syndrome and dysfunction of the pelvic organs observed before surgery were completely eradicated [11].

## Discussion

As observed in this literature review, literary resources on the occurrence, prevention, and treatment of kyphosis in patients with cerebral palsy are extremely scarce. The study of this typical deformation is particularly important because of the fact that affected patients lead largely sedentary lives, which in turn significantly complicates this disease. There are no biomechanical studies devoted to the influence of kyphosis on the statics and kinematics of a patient or the criteria for determining the severity of unfixed kyphosis to assist in the selection of appropriate treatment. The relationship between fixed and non-fixed kyphosis is virtually uninvestigated, and the frequency of transition from one form to the other is unknown. The effectiveness of kyphosis correction using a corset, according to the severity of the disease, severity of contractures, and deformities of the lower extremities as well as the patient's age remains unclear. Surgical stabilization of the spine is described only in relation to the fixed form of kyphosis, and the results are shown only in isolated studies.

In conclusion, kyphosis in patients with cerebral palsy is largely unexplored, particularly by Russian researchers. Further work in this area is urgently required.

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## КИФОЗ У БОЛЬНЫХ ДЦП — ПРИЧИНЫ ЕГО РАЗВИТИЯ И ВОЗМОЖНОСТИ КОРРЕКЦИИ (ОБЗОР ЛИТЕРАТУРНЫХ ИСТОЧНИКОВ)

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Статья посвящена анализу литературных источников по проблеме лечения кифоза у больных ДЦП. Среди наиболее часто встречающихся причин развития кифоза авторы указывают на связь его с патологическими рефлексомиями новорожденных и грудных детей с ДЦП, наличием у них hamstring — синдрома, а также слабости мышц — разгибателей туловища. Обращено внимание на существенное нарушение качества жизни больных при наличии у них выраженного кифоза.

Среди методов лечения применяют различные варианты корсетов, однако результативность данного метода лечения невысока. Отмечено, что в подростковом возрасте у части пациентов развивается фиксированная деформация, при которой все авторы с успехом применяют корректирующие и стабилизирующие операции на позвоночнике. С этой целью используют разнообразные методики фиксации и инструментарий.

**Ключевые слова:** ДЦП, кифоз, контрактура.

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