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**INVITED LECTURE**

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**AGE AS AN IMPORTANT FACTOR IN SETTING AN  
INDICATION FOR OPERATIVE TREATMENT FOR  
CHILDREN WITH CEREBRAL PALSY**

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**Azra DELALIĆ***Clinic for Physical Medicine and  
Rehabilitation  
University Clinical Center Tuzla**School of Medicine,  
University in Tuzla**Tuzla, Bosnia and Herzegovina***Correspondence to:***azra.delalic@ukctuzla.ba***ABSTRACT**

Cerebral palsy is the result of brain damage in the early developmental period with clinically expressed various disorders, especially motoric ones. Child begins with a normally developed musculoskeletal system, but in time, due to spasticity and lack of activity contractures and deformities that can slow down its further functional recovery occur. Timely application of orthopedic-surgical treatment can have a positive effect on further course of rehabilitation, but also, for children who were previously operated and where applied certain operational techniques, occurring recurrences of the same deformity or secondary deformity are more frequent. By applying non-operative methods in decreasing spasticity one can delay the time of operative intervention or avoid the operation in children with cerebral palsy.

**Keywords:** *Cerebral palsy, child's age, orthopedic-surgical treatment***CEREBRAL PALSY**

Cerebral palsy (CP) is described as a clinical entity which is used to tag a group of variable motoric disorders caused by nonprogressive impairment or brain damage in an early developmental age, which is often followed with impairment of senses, perception, cognition, communication, behavior, epilepsy and secondary musculoskeletal problems.<sup>1</sup> Brain damage which is caused by CP in a non-progressive one, but the symptoms of neurological deviation are variable and depend on the applied treatment, process of maturation and plasticity of brain.<sup>2,3</sup> Goal of rehabilitation of children with brain damage is to achieve an active mobility, to prevent development of deformity and to inhibit abnormal movements that occur depending on position of the child. Intensive growth, postural problems and sometimes inadequate treatment can lead to progressive impairment of musculoskeletal system with delay of motoric developmental phases. In children with clinically expressed quadriplegia and the most severe level of impairment we can prevent the hip dislocation and decrease the number of operative

interventions.<sup>4</sup>**SPASTICITY AND DISTONIA**

Spasticity and dystonia present a large problem for children with CP, because the hypertonic muscles are shortened and that leads to contractures and osteo-articular deformities. Usual methods in treatment of spasticity are kinesiotherapy, hydrotherapy, hypothermia, orthosis application or general pharmacotherapy (diazepam, baclofen, dantrolene), but procedures of correct positioning of the child during the daily activities or handling can also help.<sup>5</sup> Children that were subjected to late or inadequate treatment secondary musculoskeletal deformations may occur in time, which leads to deterioration of clinical image. Most common contractures of children with CP on lower extremities are flex-adductor with inner hip rotation, knees flexor and equinus feet position.

**ORTHOPEDICAL-SURGICAL TREATMENT**

In the last 30 years a fewer use of operative treatment

is present as a result of inducing new methods of spasticity treatments. Neuro-surgical methods of cerebral lesions have no significance in the treatment of CP, but they are important in spasticity treatment of spinal cord (dorsal rhizotomy). Orthopedic surgery has an important role in a treatment of children with CP in the sense of improvement of passive mobility, deformity correction or in the utmost case blocking the joints in functional position.<sup>6</sup> For most of the patients with operative treatment the goal is to improve or to accelerate walking phase, improvement of hygiene maintenance and stability in sitting position for the children that cannot walk. Most common operation of the children with CP are resection of nerve fibers of spastic muscles, transpositions and elongations of tendons, corrective osteotomies and arthrodesis. Multi-disciplinary approach is needed for setting indications for orthopedic-surgical treatment, which means that beside assessing motoric functions we should consider child's emotional and mental status as well an obligatory agreement with the family that has to be prepared to actively participate in the process of rehabilitation before and after the operation.

### CHILD'S AGE IN THE TIME OF THE OPERATION

There are various opinions considering the child's age when reviewing indications for operation. According to Matasović the optimal age for orthopedic-surgical interventions for children with CP is a period from age five to seven, maximum age limit is fifteen, while some of the foot area operations can be done with a completed one year of life.<sup>7</sup> Others consider that the age is very important and that the operation must be completed early, as soon as the deformity is manifested and starts to present a function disturbance and the physical measures of treatment were omitted. Optimal time for lower limbs operation is after year two or three and for upper limbs is between five and seven.<sup>8</sup> Research conducted in the Tuzla canton area points to a presence of deformities of musculoskeletal system on examined children with CP, and the most common deformity on lower limbs is foot equinovarus.<sup>9</sup> Foot equinovarus is the most commonly operatively corrected deformity in the area of the same region and at 57% of children operations were performed before the age of five, and the largest number of operated were age four. Child's age in the time of operation hasn't statistically influenced on the success of rehabilitation treatment evaluated one year postoperatively.<sup>10</sup> These results match to the research of other authors conducted in a shorter period of time after the operation, underlining the improvement of motoric functions and walk in all patients regardless on the age in the time of operation.<sup>11,12</sup> However, according to the research that was

conducted couple of years after the operation, the child's age in the time of operation and the types of operative techniques had an impact on occurrence of relapses of the same or secondary deformities. Most authors in their researches quote relapses of foot equinovarus and repeated surgery on children that were operated before the age of five, while at the children that were operated at the age of six and more there were no relapses meaning that the earlier operations before the age of five were reckless meaning they were slowing the maturation process of the nervous system making the results of operative treatment different and unpredictable.<sup>13,14,15,16</sup> Goal of the Koman and associates<sup>17</sup> analysis in 2003 included 31 studies used to analyze factors related to occurrence of the appearance of foot equinovarus relapses in children with CP that were operated. In 9 studies relapses in children operated before the age of seven which appeared earliest 4 to 5 years after the operation were quoted. Lesser number of relapses were associated with diplegia rather than hemiplegia.

### SPASTICITY TREATMENT

Occurrence of relapses on earlier operated children is one of the reasons why researches directed to application of therapy methods which are used to lessen spasm of muscles and to postpone the time of operation. According to the research conducted by Swedish authors the spasticity that leads to contractures and deformities is increased by the age of four at children with CP, and after that it gradually decreases until the age of twelve which is significant for clinical practice and treatment planning.<sup>18</sup> Different methods for spasticity treatment and shortened tendons are being used when it comes to younger children until improvement of bone and nervous system maturity is achieved. Bone maturity of children with CP that can walk matches the chronological age, while for the children with quadriplegia, higher degree of impairment and lower body mass index the bone development is slowed down which is important to know when planning optimal time for orthopedic-surgical intervention.<sup>19</sup> Tilton<sup>20</sup> emphasizes the significance of an early prevention of the contractures which can be used to reduce the number of operated children in latter age. There are number of methods to be used for prevention, but before all we should emphasize the significance of intensive physical and occupation therapy between the age of 5 and 7 which is the best time for operation if it is indicated.<sup>21</sup> Other authors suggest equinovarus treatment of younger children by method of corrective plaster immobilisation that leaves no scars on tendons which is important in the case of needed surgery in latter.<sup>22,23</sup> Botulinum toxin is being used for decreasing

the spasticity level on children from age two as a way of contracture prevention. Application of botulinum toxin in combination with kynesitherapy decreases the spasticity and improves the functional status in case of spastic diplegia.<sup>24</sup> Botulinum and operative treatment on children with CP should be treated as a complementary methods, which defer depending on child's age when indicated and depending on different causes that lead to pathological walk.<sup>25</sup> Applying the newer methods in spasticity treatment, as if selective dorsal rhizotomy, intrathecal baclofen application and local application of botulinum toxin at children with CP until the age of eight was able to decrease the need for orthopedic-surgical contracture treatment from 40% down to 15%.<sup>26</sup>

### **TYPES OF OPERATIVE TREATMENTS AND APPEARANCE OF RELAPSE**

Appearance of relapses or secondary deformities in time of operation can be influenced by the type of applied operative technique in the time of operation. Earlier classical approach to the operative treatment of children with CP is known under the name "birthday operations" implied that the operations were done individually for every level in certain period of time, while it is proven by a computer analysis that it is better to perform the operation on more levels at the same time if necessary.<sup>27</sup> Simultaneous operative deformity corrections on lower limbs at children with CP lower the costs and eases the postoperative rehabilitation without the increased risk for patients.<sup>28</sup> Insignificant number of postoperative complications was noted in the sense of kalkanous deformity on children with corrected spastic equinus by lengthening of aponeurosis m. triceps surae but there is a high level of equinus relapses particularly on children that were operated before the age of five.<sup>14</sup> Risk factors for occurrence of kalkanous deformity represent a higher degree of impairment, female, children operated before age of eight and percutaneous lengthening of tendon, while the risk factor for hemiplegia equinus, males and lengthening the aponeurosis.<sup>12</sup> Lee et Bleck<sup>29</sup> found a larger number of equinus relapses at elongation of Achilles tendon using the Strayer-Baker method rather than Hoke.<sup>29</sup> Today we use less invasive methods like selective percutaneous lengthening of tendons of lower extremities, which leaves smaller scars and contributes to the improvement of functional state in all the operated patients.<sup>30</sup> Some of the operative techniques cause weakness of operated muscles, which causes knuckle instability and appearance of bone deformations as it is quoted in postoperative researches of the hip and foot knuckle area. Dietz and associates<sup>31</sup> quote m. triceps surae weakness and instability of foot

knuckle after operative lengthening of Achilles tendon in diplegies and quadriplegies, while the quoted complication wasn't evidenced at operated hemiplegias or diplegias, where the operation was performed on one leg. Way to avoid these complications is the operation on m. gastrocnemius or the application of conservative methods of treatment, as confirmed by Saraph and associates<sup>32</sup> research on children with spastic diplegia that had corrected foot equinus in average age of 12,6 by an intramuscular lengthening of m. gastrocnemius with significant improvement of dorsal flexion of the foot while the knee is either bend or stretched without the following weakness of m. triceps surae. Turker and Lee<sup>33</sup> study quotes emphasized hip instability which occurs years after the adductor tenotomy. Mentioned postoperative complications can be reduced by preoperative estimate and effective kynesitherapy programme as quoted by Tirelli and associates<sup>34</sup> and many other studies. Computer walk analysis that is used in most of the countries contributes to better preoperative estimation of children. Walk analysis helps select the children with spastic bilateral CP that had no improvement by conservative method of treatment and could make an improvement in continued rehabilitation and certainly to make this analysis common in management of children with CP.<sup>35</sup> Correct walk assessment with the use of computer analysis of walk and botulinum toxin in spastic muscles can decrease the number of orthopedic-surgical interventions and help postpone the time of operative treatment of children with CP.<sup>36</sup>

### **CONCLUSION**

Age of child with cerebral palsy in time of orthopedic-surgical intervention on tendons or muscles affects the results of treatment. Children that were operated before the age of five have a more frequent appearance of relapses of the same deformity, while techniques of operative intervention have more influence on appearance of secondary deformities. Application of botulinum toxin is one of the methods for treatment of spasticity which can be used to postpone or avoid suggested operative intervention, and computer walk analysis contributes the determination accuracy of muscle or a group of muscles that should be operatively lengthened meaning less number of postoperative relapses and secondary deformities.

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