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Pavlik's method in developmental dysplasia of the hip

Gelişimsel kalça displazisi tedavisinde Pavlik yöntemi

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Gelişimsel kalça displazisi (GKD) tedavisinin en önemli komplikasyonu avasküler nekrozdur. Yirminci yüzyılın ilk yarısında bu sorun GKD tedavisi gören çocukların %30'unda görülüyordu. Bu komplikasyonu önlemek için Arnold Pavlik, 1940'lı yılların sonlarında, kalçanın çok hareketli bir organ olduğu ve iyileşmesi için harekete ihtiyacı olduğu düşüncesinden yola çıkarak dinamik bir tedavi yöntemi geliştirdi. Bu yöntemde, iyileşme için kalça ve dizlere fleksiyon kazandıran bantlar kullanılmaktadır. Bu şekilde, bebek normal bir kalçaya doğal hareketlerle ve kendi kendine sahip olmaktadır. Pavlik'in yöntemi tüm dünyada kullanılmaktadır. Bu derlemede, yapılan çalışmalar ışığında Pavlik tedavi yönteminin komplikasyonlarına dikkkat çekilmesi ve bildirilen başarı ve avasküler nekroz oranlarının özetlenmesi amaçlandı.

One of the worst complications following treatment of developmental dysplasia of the hip is avascular necrosis. In the first half of the 20th century, the incidence of this problem reached up to 30% of treated children. To avoid this complication, Arnold Pavlik developed a new method in the late 1940s and called it a dynamic approach to treatment, which was based on the ingenious idea that the hip is an organ of movements and needs movement to be healed. Healing is accomplished by using stirrups as an aid to attaining flexion of the hips and knees, whereby the child achieves a normal hip nonviolently by himself. Pavlik's method spread slowly throughout the world and this literature review points out problems with this method, and summarizes the rates of success achieved and avascular necrosis reported by various authors.

Disappointed by a high rate of avascular necrosis (AVN) of the femoral head as a result of the conservative treatment of congenital dislocation of the hip, Arnold Pavlik developed a new method which he called 'functional treatment'. He reported his experience with this new mode of treatment for the first time at a meeting of the Czechoslovak Orthopaedic Society in Prague in 1946. He defined the 'stirrups' he used as the tool, not the therapeutic principle, which helped to reach active movements in dislocated or dysplastic hip joints. Pavlik felt that movement is the principal necessity for the correct treatment of congenital dysplasias of the hip joint. This is the source of his well-known saying that 'the hip is an organ of movement'. Thus, movement became a basic condition for the first phase – reduction – in the treatment of what we call today 'developmental dysplasia of the hip (DDH). This is in contrast to what Pavlik called 'passive mechanical' treatment. Even if Pavlik did not mention it, in his principles he applied the well-known Wolf's Law.[1]

In 1950, Pavlik published a paper entitled 'Stirrups as an aid in the treatment of congenital dysplasias of the hip'.[2,3] The construction of the stirrups is detailed in this publication and the seven points explaining the principles of this functional method of treatment are described. Pavlik clearly stated that the lower limbs of the child should be brought into flexion at the hip and knee joints. It is well-known that children, like adults, are unable to hold their lower limbs together in the supine position with flexed knees. In this unnatural position in which the muscles tire quickly, folded limbs move into abduc-

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tion. As Pavlik explained, this led to gradual, spontaneous, and non-violent reduction of the dysplastic (dislocated) hip. He continued to explain that the child by himself, without force, determines the range of abduction as permitted by the adductor muscles. The adductors are often tense, but their tension relaxes gradually and abduction increases on each side. Extreme abduction causes pain, because of tension and pressure on the circumflex arteries. If this is not relieved, it leads to AVN of the femoral head. Thus, some degree of adduction is permitted until the child achieves stable reduction, and the stirrups then act as a retention device and later for remodeling, until a fully normal stable hip is reached (Fig 1). This is entirely different from methods employing passive or manual reduction first, as was done before Pavlik described his method.

It is interesting to see how simple and inexpensive the stirrups are, so inexpensive, in fact, that some parents look for more sophistical modes of treatment. Also noteworthy is Pavlik's comment that the duration of treatment depends on the state of the joints and the age of the baby at the start of treatment, but always takes several months.[2,3] We must not forget that, at that time, Pavlik started treating babies at a few months of age but later suggested starting even earlier.

In 1953, in his second paper on the subject, Pavlik reported the first statistical data on the treatment of 761 hips (261 hypoplasias, 255 subluxations, 245 dislocations). The rate of success for dysplasias and subluxations was 100%, for dislocations 84.1%. None of the successfully treated hips demonstrated signs of AVN at the end of treatment. Of 39 (15.9%) dislocated hips treated by passive mechanical methods, i.e., closed reduction and fixation, after failure of Pavlik's method, only 7 (8.2%) developed AVN, which represents a total of 0.9% of AVN for all children who were initially treated with Pavlik's method. Comparing these results to those of Lorenz, Hilgenreiner and Hanausek, his rate of AVN is essentially lower. In this article, Pavlik also explained how the incorrect use of Frejka's pillow led him to develop the dynamic method treatment. He again emphasized that the hip is an organ of movement. His observations that the dislocated femoral head never shows signs of AVN are also worthy of mention.[4]

In 1955, Pavlik reported the results of treatment of another 663 hips, almost doubling his original 761 hips, for a total of 1424 hips. The results were virtually the same.[5]

The first paper on this subject published abroad by Pavlik himself was the one in Zeitschrift für Orthopaedie in 1957. This is the most cited work but also, most probably, the reason for much misunderstanding related to the use of Pavlik's method because the title – "The functional method of treatment using a harness and stirrups as the primary method of conservative therapy for infants with congenital dislocation of the hip" – was not clear enough for the reader to understand that the principle of the treatment was different. Many authors tried to 'improve' Pavlik's method, changing 'dynamic' back to the 'passive mechanical'. In some ways, this paper can be considered as the summary of two previous works.[6,7] In 1959, Pavlik published a similar paper in Russian.[8]

From a historical point of view, the paper published in 1959, titled 'To the question of the originality of treatment of congenital dysplasias of the hip

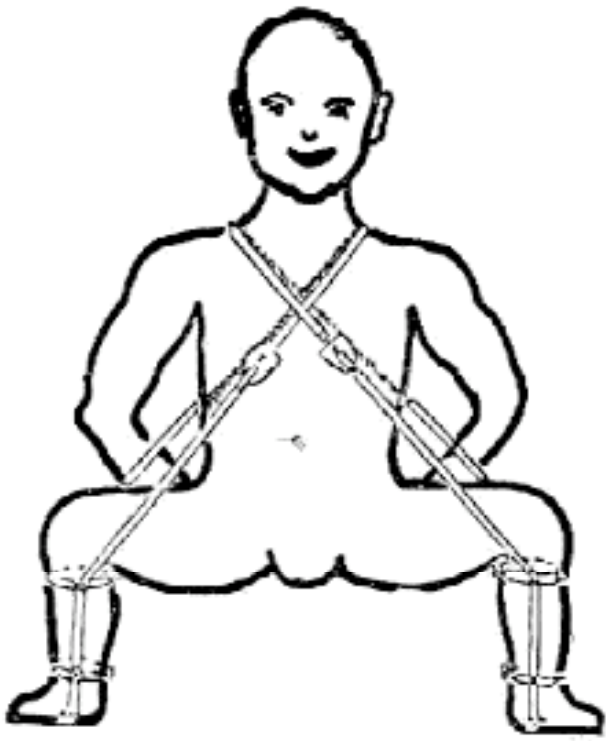

Figure 1. The stirrups, redrawn from Pavlik's original. Note that there is no back buckle to 'adjust' the extension of the hips.

joint by active movements in the stirrups', may be most interesting. In the English translation of this paper published in JPO, Part B,[9,10] the difference between the functional and passive mechnical methods of treatment of DDH is stressed. In this article, Pavlik 'answered' the question asked by Scapinelli some 45 years later in an EFFORT bulletin[11] about the originality of his method. Scapinelli wrote that Bauer and Ortolani used stirrups before Pavlik. However, in 1959 Pavlik disputed the fact that some authors tried to claim that his method was a modification of other methods. He stated that "it is not a modification of Bauer's method of even an inappropriate copy of his "spreizband". Pavlik showed that Bauer did not use the functional-dynamic method but the static, passive mechanical method, using his spreizband as a passive-mechanical retentive device, after manual, often forced, closed reduction of the dislocated or dysplastic hip. He wrote that there were no antecessors to his method, as he was the first to use a dynamic method of treatment.[9]

Even after the publication of these six papers by Pavlik on the subject,[2-10] there exists a great deal of literature dealing with this problem, as described herein. It seems that many authors did not understand the point of functional treatment and that the stirrups (or harness) are the tool and not the principle.

Pavlik's method of treatment spread slowly at first. It was first accepted in Czechoslovakia, Austria,[12-14] Hungary[15,16] and Yugoslavia.[17] Erlacher introduced the method to Blount in 1959 and published a short report in JAMA [18] but the method did not reach the expected popularity in the USA at that time.[13] Among the first who used the method systematically were Fried from Israel[19] and Suzuki from Japan who visited Pavlik in 1957 but who added rubber straps to the device, enabling extension in the hip joint, contrary to all of Pavlik's rules.[20]

The first wave of publications in the 1960s and 1970s, mainly from Central Europe, described the low percentage of complications and 0 or close to 0 percent of AVN.[13-16,19] Reports on the use of Pavlik's method increased in the 1980s. The problem with comparing results in these publications lies in the different diagnostic approaches, age at start of treatment, different clinical and radiological evaluations,

Table 1. Avascular necrosis and Pavlik harness

	No. of hips	AVN	
		No	%
Pavlik[5]	1.424	18	0.9
Reiter[14]	266	7	2.6
Glauber ve Vizkelety[16]	888	26	3
Ueno et al.[23]	168	7	4.1
Ramsey et al.[22]	27	–	–
Kalamchi and McFarland[24]	139	–	–
Filipe and Carlioz[25]	134	4	2.98
Iwasaki[26]	240	14	7.2
Tonnis[27]	–	7	–
Takahasi[28]	219	11	6.2
Total	3.505	87	2.48

AVN: Avascular necrosis.

and different periods of follow-up. Of some interest is the book by Klisic[18] resulting from an international meeting on babies' hips in Belgrade, Yugoslavia, in 1987. At this meeting of 90 presentations, 16 dealt with the treatment of DDH using Pavlik's method. All those who used Pavlik's method of treatment reported high success rates and 0-6% of AVN, except for Iwasaki who reported higher rates because of his modification of Pavlik's dynamic method to a passive-mechanical method.

Most important, and possibly the turning point in the treatment of DDH using Pavlik's method, was the publication of the results of a multicenter study by Grill in 1988[21], involving 2,636 babies with 3,611 pathological hips. Treatment was started at a mean of 11 months, so late by today's understanding. The treated children were followed for an average of 4.5 years (range, 1-8.9 years) and the success rate was 93%, with 2.38% for dysplasia, subluxation and dislocation (range, 1.28-16.4%). The worse results were for more severe pathologies. Most significant are the results of hips treated exclusively with Pavlik's method, seen in Table 1. Other publications reporting the results of treatment with Pavlik's method between 1980 and 1999 are summarized in Table 2. Their results are compared to those achieved by Pavlik – first three in the table.

If it was difficult to compare the results of treatment using Pavlik's method in the period of radiological diagnosis of DDH, it is even more difficult in the "sonographic period". The introduction of

Table 2. Success rate and AVN reported from 1980 to 1998

	Success rate (%)	AVN (%)
Pavlik[4]	84.1	–
Pavlik[5]	82.7	–
Pavlik[6]	84.1	–
Harris et al.[31]	80	0.7
Johnson et al.[32]	92	–
Kalamchi ve MacFarlane[24]	86	–
Ramsey et al.[22]	96.4	–
Touzet et al.[33]	87	–
Suzuki and Yamamuro[29]	94	16
Viere et al.[34]	97.5	–
Suzuki et al.[30]	86	8 (7% type 1) = 1%

sonography to the diagnosis of DDH enabled starting treatment much earlier and essentially changed the approach to treatment. Different sonographic methods [Graf, Harcke, Terjesen, Suzuki], the combination of clinical and sonographic examinations makes comparison even more complicated.

What may be the most quoted 'improvement' of Pavlik's method is the report by Ramsey.[22] Despite the small cohort of treated hips, with 0% of AVN, interest in this publication was focused on the description of a 'safe zone' which should be controlled, according to the authors, by the adjustment of the rear stirrups. This is in total contrast to Pavlik's original idea, where the only purpose for the device is flexion at the hip joint, enabling the child to adjust the abduction and adduction himself.

Another misunderstanding of Pavlik's method is expressed in the publication by Hangen et al who evaluated the success of treatment by following sonographic improvement of the hip to normal. If the hip was not improved after five weeks, they considered this as a treatment failure. Despite this, their success rate was 84.9%, similar to Pavlik's and our experience.[23] This approach is in contrast to what Pavlik himself wrote: "It is necessary to individualize the treatment of each joint, without a time limit."[5]

Malkawi's report, assessing experience with the treatment of 699 sonographically pathological hips, using Pavlik's method precisely, may be the best account. He claimed 100% reduction with no AVN, followed and proved sonographically, with stabilization of the hip within 6 weeks.[24]

The work of Harding et al presents very interesting results. On the one hand they claim 89-99% success using Pavlik's method; on the other hand, they limited treatment to three weeks to achieve reduction of a fully dislocated hip, contrary to Pavlik who never claimed a time limit for the treatment.[25]

Using their own method of sonographic evaluation, Suzuki and coworkers assessed 101 hips treated by Pavlik's method. They claim 84% success and 8% AVN. However, as it was Type I AVN in 7% which settled spontaneously, the real rate of AVN was 1%. The misunderstanding of Pavlik's method is seen in the adding of a pillow between the hips. We remember that Pavlik developed his method because of the failure of the Frejka pillow.[26,27]

Using Harcke's method of sonographic follow-up, Taylor and Clarke reported their experience of treatment of 370 hip joints. They described their own algorithm in the treatment of DDH using Pavlik's stirrups. Their reported success rate was 95.7%, with 0.3% AVN.[28]

As described by Eidelman et al in 2003, we developed the concept of 'true developmental dysplasia of the hip'. Despite the still-growing popularity of Pavlik's method at that time, we were unable to find a study dealing with the relationship between gender, sonographic and clinical pathology, age at start of treatment, and duration and outcome of treatment. To answer these questions, we assessed

patients treated with Pavlik's method over a 5-year period. Practically 0% AVN for all the treated population and 98% success can be attributed to the fact that treatment was started before the age of 14 weeks.[29]

Mubarak and Bialik recently published their experience after visiting the places where Pavlik was born and worked. Pavlik developed his harness and method of treating DDH in infants because of the high rate of avascular necrosis at that time. This historical review highlights Pavlik's career from the time he worked with Frejka and then later in his own clinic in Olomouc, Czech Republic (from 1938 until his untimely death in 1962). Subsequently, Pavlik's method became the treatment of choice worldwide for infants with hip dysplasia because of the principles he espoused.[30]

Conclusion

Today we can say that an increasing number of reports on the successful use of Pavlik's method for treatment DDH is testimony not only to the rise in popularity of this method but more to the fact that it is the treatment of choice in the early management of this problem. Assessing the literature, we can conclude that using Pavlik's method exactly as he described and not modified, the success rate is about 90% and, most importantly, 0% AVN for dysplastic hips and for all hips treated exclusively by Pavlik's method. In cases where Pavlik's method failed, mostly because treatment was started late, and the hips were then post-treated by various, what Pavlik called 'passive mechanical methods, the rate of AVN increased to 18%.

We can summarize this short review by using Pavlik's own words: 'The principle of the method is to bring the child's lower limbs to flexion in the hips and knees, using stirrups. It is well-known that neither child nor adult is able keep the lower limbs adducted in flexion. This is non-physiological; the muscles become tired quickly and the limbs go into abduction. And this is what the hip joint needs for the treatment of dysplasia." Later, with more experience, Pavlik added subluxation and dislocation. Pavlik continued: "Flexion, abduction and adduction are free! The badly developed hip joint needs movement for healing, because the hip joint is an organ of movement." This is the core of Pavlik's ingenious idea for treating DDH and made his method so physiological, so popular, and so successful.

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