

Epiphysiodesis of the first ray as a method of treatment of adolescent hallux valgus

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Abstract— Objective: Presentation of short-term results from the application of epiphysiodesis of the first ray as a method of treatment of adolescent hallux valgus.

Material and method: The operative technique was introduced in USHATO in January 2018 like a operative procedure for treatment of mild and moderate deformity of adolescent hallux valgus (AHV). The technique includes percutaneous access to the growth zones in the area of the first metatarsal bone and proximal phalanx and partial epiphysiodesis of the growth complex. The study presents 12 cases in 9 children with a mean age of 10.1 years (min. 5 years, max. 13 years). Most of the patients were female - 77.78%. According to the three-dimensional Stanrock classification and the HV severity classification, the twelve cases fell into group II-A and moderate severity. Three angular parameters hallux valgus angle (HVA), intra-metatarsal angle (IMA), distal-metatarsal articulation angle (DMAA), were used to monitor the results, and the measurements were performed preoperatively, intraoperatively and postoperatively.

The American Orthopaedic Foot and Ankle Society (AOFAS), was used to report clinical outcomes.

Results: Patients were followed up for a mean period of 17.58 months. For this period we do not established postoperative recurrences, and all cases remain in the same group according Stanrock classification and the HV severity classification.

In the three monitored radiographic parameters we report clinical, but not statistical improvement: HVA by an average of 1.19°, IMA by an average of 0.55° and loss of correction in DMAA by 0.9°. For the follow-up period, we report a statistical improvement in the clinical parameters reported on the AOFAS scale ($p < 0.4$).

Conclusions: Surgical technique is the method of choice for mild and moderate AHV with narrow indications for its use in relation to the appropriate age group. The short follow-up period in our series is insufficient for final conclusions, but the technique offers a number of advantages and appears to be an effective mini - invasive method of treatment of AHV.

Keywords— AHV, Hemiepiphysiodesis, Growth potentials of the 1st ray.

1. Introduction

Hallux valgus is a complex pathology of the foot, with changes in the morphology and biomechanics of the front and midfoot. The disease accompanies human development, but was described as a separate nosology only in 1871.^{1,2,15}

The pathology is very common, including in children and adolescents. Juvenile hallux valgus is defined as a lateral deviation of the proximal phalange relative to the first metatarsal bone greater than 14°, occurring before and during puberty. Determinant for the diagnosis of "juvenile" is the condition of the physique of the I MTK and the proximal phalanx. At this age they are still open.^{2,3}

Most of the children and adolescents with HV often have no complaints. In patient with symptomatic deformity, the leading pain is localized in the superficial medial soft tissues due to pressure from the shoe on the bony protrusion of the head of the I MT. This pain and the available aesthetic deformity are the main reasons for patients and their parents to searching for a treatment, including a surgical solution to the problem at an early age. This is the reason why in the last two decades, some of the more than 300 known surgical methods for the treatment of HV have entered in the pediatric orthopedics.^{1,3}

The presence of a growth zone in this area is one of the reasons for reporting a high percentage of postoperative recurrences of deformity.^{4,5}

2. Operative technique

The operation is performed in the presence of a growth complex in the area. Under radioscopic control, the proximal part of the I MTK and the physique are located. A small 2 cm skin incision is made 2 cm distal to the first metatarsal - cuneiform joint. Under radioscopic control in phase and profile projection from the medial and distal, K- wire guide to the lateral part of the epiphyseal complex of the first metatarsal. A 2.8 mm cannulated drill bit in the area of the medial cortex is passed through it. A cannulated screw with a partial thread and a diameter of 3.0 mm is placed on the guide needle. At least three of the screw threads must pass into the epiphysial plate. It is important to choose the right length of the cannulated screw and to cover it completely in the medial cortex.

Epiphysiodesis of the proximal phalanx is performed with a lateral skin incision 1.5 cm distal to the I-st metatarsophalangeal joint. Under X-ray control, a K-wire guide is passed to the medial pole of the proximal phalanx growth complex. A 2.8 mm cannulated drill bit is passed along the guide with the formation of a step cut in the area of the lateral cortex. A cannulated screw with a diameter of 3.0 mm, with a partial thread is placed on the guide needle. At least three of the screw threads must pass into the medial part of the phalanx epiphysis. FIG. № 1.



Fig. № 1 A. Position of the foot on the X ray machine. B.C. Translation of the K-wire guide to lateral epiphysal plate of the first metatarsal using radioscopic control. D.E. Translation the K-wire guide to the medial epiphysal plate of the proximal phalange. F. Postoperative X-ray in AP-view

Postoperative care. Post-operative X-ray of the operated limb in two projection is made on the operating table. Full load is allowed on the first postoperative day without use of additional help and any othosis. Control radiographs are performed every 3 months.

3. Materials and methods.

The presented operative technique was introduced in USBALO "Prof. B. Boychev" at the beginning of 2018. The study included 12 cases in 9 children with an average age of 10.1 years (min. 5 years, max. 13 years). Tabl. №1.

Most of the patient were female - 77.78%, in 68.7% the right foot is affected, and in three cases the deformity was bilateral. In 7 of the children were unsatisfactory with the result after conservative treatment, the rest were with delayed diagnosis. In all of the patients the preoperative clinic is typical with complaints of inflammation and pain in the area of the first ray, caused by the deviation in the first MTP joint. According to the three-dimensional Stantrock classification and HV severity classification, the twelve cases fell into group II-A and medium degree of severity.¹¹

In all cases, epiphysiodesis of I MT was combined with epiphysiodesis of the proximal phalanx using 3.0 mm cannulated screws.

Tabl. № 1. Distribution of the number of cases treated with epiphysiodesis of the first ray.

N	SEX	AGE	SDE	ХВЪ			ИМЪ			ДМАЪ			Проследяване месеците	AOFAS	
				Диагност.	Интраопер.	Краен	Диагност.	Интраопер.	Краен	Диагност.	Интраопер.	Краен		Диагност.	Краен
1	F	8	1	19	19.1	26	11	11	6	5	5	5	17	88	72
2	F	11	2	18.3	18.3	12	8.4	8.5	7	6	6	6	22	88	100
3	F	9	2	20.3	20.5	23.5	10	10.4	10.7	12	10	11	19	80	75
4	F	10	1	28	28.3	19.5	5.5	5.5	5.6	13	13	13	15	88	97
5	F	11	1	17.5	17.5	14	7.8	8	8	10	10	13	10	93	100
6	F	13	1	25	25.1	25	9	9	9	20	20	20	23	93	93
7	F	10	1	31.2	31.2	27.1	9	8	9	10	10	10	16	88	93
8	F	10	2	29.2	29.2	28	9	8	8	10	14	14	19	85	85
9	M	5	2	28.2	28.2	28	10.8	10	10.5	12	12	12	14	85	85
10	M	11	2	19.3	19.3	19	8.4	8.5	8.5	8	8	10	24	85	85
11	F	10	2	27.4	27.4	27	5.2	5.2	5.2	4	4	4	4	20	85
12	F	13	1	25	25.1	25	9	9	9	20	20	20	12	93	93

Three angular parameters hallux valgus angle (HVA), intrametatarsal angle (IMA), distalmetatarsal articular angle (DMAA) were used for monitor the results, and the measurements were performed preoperatively, intraoperatively and postoperatively.

The AOFAS scale was used to report clinical outcomes.

Descriptive methods and Student's t-test for related samples were used for statistical data processing.

4. Results

The average follow-up period was 17.58 months (min - 10 months max - 24 months). The last full control review was accepted as the end result of the study, and in all cases it was before the end of growth. To report the results we used preoperative, intraoperative and postoperative radiographs Fig.№2.

The mean preoperative angle of hallux valgus was 24.03° (max 31.2° - min 17.5°). For the follow-up period due to the lack of improvement of the static deformity intraoperative, values of the angular parameters before and after the operation were compared.

For the follow-up period, we report an improvement in the correction to an average of 22.84° (min 12° max 28°) ($p > 1.01$). As reported, the improvement is clinical, but not statistically significant.



	Pre-operative	3m. postoperative	6m. postoperative	9m. postoperative	12m. postoperative
HVA	18°	16°	16°	15°	10°
IMA	7°	7°	7°	7°	6°
DMAA	6°	12°	10°	5°	5°

Fig. № 2. 10 y. ♀ C.Д. bilateral hallux valgus. Epiphysiodesis of the first metatarsal and proximal phalanx

The mean preoperative intrametatarsal angle (IM) was 8.59° (max 11°- min 5.2°). For the follow-up period we also report only clinical improvement of IM, without a statistically significant difference as the values of postoperative IM is 8.04° (max 10.7° - min 5.2°) ($p > 1.26$)

In the final results of the distal metatarsal articulation angle (DMAA) we report a loss of correction of an average of 0.9° compared to preoperative and postoperative parameters.

For the follow-up period we report statistical improvement of the clinical parameters reported on the AOFAS scale as $p < 0.4$

We do not report postoperative recurrences of the deformity, in the follow-up period and all cases remains the same group according to the Stanrock classification and the HV severity classification.

5. Discussion

Like the conservative the surgical treatment of AHV before skeletal maturity, it is debatable, with the main criticism the postoperative recurrence. Complications are reported in all reconstructive techniques in the field of I-ray^{9,10}. At this time, no surgical technique shows an advantage and all have a high recurrence rate in this age range.

The high recurrence rate described in the literature and observed in our studies gives us the reason to find another way for treatment of the deformity, which is less invasive, does not require a long recovery period, but at the same time retains and improves the degree of deformity.^{11,13,17}

The percutaneous technique for regulated growth described by Bowen and Johnsen in 1980 is a mini invasive alternative for correcting angular deformations, based on the growth potential of long tubular bones⁴. In the pediatric orthopedics clinic of US-BALO, Prof. B. Boychev ” the team has sufficient experience, with reporting good results in the treatment of this type of pathology in the knee joint.

David N. and co-authors first described the technique of lateral epiphysiodesis of I MTK in 1996, with excellent results. Over the years, small series have been published in the literature with reporting an excellent result^{18,19}.

Epiphysiodesis is based on the growth potential of bones, and the time for their implementation is crucial for their effectiveness. In our series, this technique was performed in 12 patients as a method of treatment after ineffective conservative therapy and the presence of pain impairing quality of life. The mean age at the time of the operation was 10 years. This age is little bit lower than that described by Green et al., in their algorithm¹². Given that foot growth ends at the age of 14 for girls and 16 years for boys, we estimated that a longer period before the completion of bone maturity would give higher opportunities for controlled correction of the deformity.^{14,16}

We report clinical improvement of the AOFAS scale postoperatively from 87 to 91 points. An interesting fact observed by us is the improvement of discomfort and pain in the area of the first ray without statistically significant improvement of the angular parameters in the area.

In AHV, the asymmetric growth of the I MTK creates an incorrect distribution of the angular load on the I MTP joint, especially in its lateral part. This is considered to be the root cause of pain in the area. After performing hemi-epiphysiodesis in the proximal region of the I MTK, we believe that bone growth in the lateral part is impaired. This leads to a proportional distribution of pressure on the articular surface of the I MTP joint, causing a pain reduction. This explains the resulting clinical improvement without significant radiological correction.

In our series, no patient reported an increase in foot pain postoperatively, with only one finding moderate pain in the I MTK after a full day of professional practice of gymnastics. Despite clinical improvement and lack of progression of the deformity, no statistically significant correction of the angular parameters was reported.

It is important to note the need for strict postoperative follow-up in this procedure. The postoperative protocol is based on control radiographs over a 3-month period, aimed at reducing the possibility of complications such as damage to the epiphyseal plate, failure of fixation and excessive correction.

6. Conclusion:

In conclusion, we can say that hemi-epiphysiodesis of I MT is the method of choice for mild and moderate AHV, with narrow indications for its use in relation to the appropriate age group. The short follow-up period in our series is insufficient for conclusions, but the technique offers a number of advantages and appears to be an effective mini - invasive method of treatment of AHV.

7. References

1. Герчев А. Хирургия 1958 2 139-150
2. Герчев А. Хирургия 1959 5-6
3. Герчев А , Кехайов Р, Георгиева С, Алексиев В, Георгиев Хр. Скарф остеотомия
4. Bowen J, Johnson W. Percutaneous epiphysiodesis. Clin Orthop Relat Res 1984; 190: 170-173.
5. Chiang M, Wang T, Kuo K, Huang S, Wu K. Management of Juvenile Hallux Valgus Deformity: the role of combined Hemiepiphysiodesis. BMC Musculoskelet Disord. 2019; 20. 1:472.
6. Clark H, Veith R, Hansen S. Adolescent bunions treated by the modified Lapidus procedure. Bull Hosp Jt Dis Orthop Inst. 1987; 47: 109-122.
7. Coughlin M, Mann R. The pathophysiology of the juvenile bunion. Instr Course Lect. 1987. 36: 123-136.
8. Dick W, Henche H. The McBride operation of hallux valgus in adolescents. Z Orthop Ihre Grenzgeb. 1976; 114, 3: 388-393.
9. Dindo D, Demartines N, Clavien PA. Classification of surgical complications: a new proposal with evaluation in a cohort of 6336 patients and results of a survey. Ann Surg. 2004;240,2:205–213.
10. Gerbert J. The indications and techniques for utilizing preoperative templates in podiatric surgery. J. Am. Podiatr. Med. Assoc. 1979; 69: 139-148.
11. Goldner J, Gaines R. Adult and juvenile hallux valgus: analysis and treatment. Orthop Clin North Am. 1976; 7: 863-887.
12. Green J, Nicholson A. Analysis of serial radiographs of the foot to determine normative values for the growth of the first metatarsal to guide hemi-epiphysiodesis for immature hallux valgus . J Pediatr Orthop. 2015; 37:3 37-343.
13. Harb Z, Kokkinakis M, Ismail H. Adolescent hallux valgus: a systematic review of outcomes following surgery. J Child Orthop. 2015; 9: 105–112.
14. Helal B: Surgery for adolescent hallux valgus, Clin Orthop Relat Res. 1981; 157: 50.
15. Hueter C, Kelikian H. Hallux valgus allied deformities of the forefoot and metatarsalgia. Philadelphia & London.1965:10.
16. Moscadini S, Moscadini G. Hallux Valgus Correction in Young Patients with Minimally Invasive Technique . Chapter from the book The Role of Osteotomy in the Correction of Congenital and Acquired Disorders of the Skeleton 236/258
17. Robinson A, Limbers J .Modern concepts in the treat-ment of hallux valgus. J Bone Joint Surg Br. 2005; 87: 1038–1045.

18. Salmeron F, Sales De Gauzy J. Scarf osteotomy of hallux valgus in children and adolescents. *Rev Chir Orthop Reparatrice Appar Mot* 2001; 87, 7: 706–711
19. Schlickewei C, Ridderbusch K, Breyer S, Spiro A, Stücker R, Rupperecht M. Temporary screw epiphyseodesis of the first metatarsal for correction of juvenile hallux valgus. *J Child Orthop*. 2018;12, 4: 375–382.

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