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Efficacy of the treatment of the leg length discrepancy with epiphysiodesis

Ocena skuteczności leczenia nierówności kończyn dolnych metodami blokowania chrząstek wzrostowych

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Summary

Introduction. Material presents the outcome of the treatment of the lower limb discrepancy (LLD) with epiphysiodesis using Phemister, Blount's and Metaizeau techniques.

Materials and methods. The study included 51 patients, with mean age 12 years and 6 months (from 9 years, 4 months to 15 years, 4 months), who underwent epiphysiodesis with different techniques due to LLD with the mean value 3.9 cm (2.0-11.5), with different etiology. Mean follow-up was 6 years and 6 months.

Kemnitz and Campens classification based on clinical measurement of LLD was used to assess the outcome of the treatment.

Results. Good result was obtained in 74.5% of the patients, fair result in 5.9% and bad result in other 19.6%. The mean final LLD was 1.8 cm. The group in which the epiphysiodesis was performed only on the femur got greater correction and better outcome than the group in which the epiphysiodesis was performed only on the tibia. The most common complication was valgus deformity, occurred in 5 patients (9.8%).

Conclusions. The greatest efficiency of the epiphysiodesis is obtained in patients with their femur blocked. Axial deformity is the most common complication of this treatment.

Key words: leg length discrepancy, epiphysiodesis, surgical treatment, Phemister technique, Blount's stapling, Metaizeau technique, efficacy

Streszczenie

Wstęp. W pracy przedstawione zostały wyniki leczenia nierówności kończyn dolnych (kcd) metodą Phemistera, skoblami Blounta oraz techniką Metaizeau.

Materiał i metody. Materiał obejmuje 51 pacjentów w wieku od 9 lat, 4 miesięcy do 15 lat, 4 miesięcy (średnia 12 lat i 6 miesięcy), których leczono różnymi metodami blokowania chrząstek wzrostowych z powodu nierówności kcd o średniej wielkości 3,9 cm (2,0-11,5), o różnej etiologii. Średnia okresu obserwacji wynosiła 6 lat i 6 miesięcy.

Wynik leczenia oceniano na podstawie pomiaru klinicznego nierówności kcd, stosując klasyfikację Kemnitza i Campensa.

Wyniki. Wynik dobry uzyskano u 74,5% pacjentów, wynik zadowalający u 5,9% pacjentów, a zły u 19,6% pacjentów. Średnia nierówności kcd po zakończeniu wzrostu kcd wynosiła 1,8 cm. Grupa, w której blokowano tylko segment udowy charakteryzowała się większą korekcją nierówności kcd i lepszym wynikiem leczenia niż grupa, w której blokowano sam segment goleniowy. Najczęstszym powikłaniem było koślawe zagięcie osi blokowanej kończyny dolnej (kd), które wystąpiło u 5 pacjentów (9,8%).

Wnioski. Najwyższą skuteczność epifizjodezy obserwuje się u pacjentów, u których blokowano segment udowy. Zaburzenie osi blokowanej kd jest najczęstszym powikłaniem leczenia.

Słowa kluczowe: nierówność kończyn dolnych, epifizjodeza, leczenie operacyjne, metoda Phemistera, skoble Blounta, technika Metaizeau, skuteczność

INTRODUCTION

Epiphysiodesis is an accepted method for treating leg length discrepancy (LLD) in growing children. Open epiphysiodesis, firstly described by Phemister (1)

in 1933, was followed by other methods: in 1949 epiphyseal stapling described by Blount and Clarke (2), in 1986 – Canale's percutaneous epiphysiodesis (3), in 1998 – percutaneous epiphysiodesis using transphy-

seal screws by Metaizeau (4). This study presents outcome of the treatment of leg length discrepancy with Phemister, Blount's and Metaizeau techniques.

MATERIALS AND METHODS

Material consists of 51 patients – 27 girls and 24 boys – selected from the 212 patients who, in years 1960-2008, underwent epiphysiodesis due to LLD in our Department. Criteria for inclusion in the study were: (1) complete documentation of clinical examination before the surgery and after growth-plates closure and (2) no other surgical interventions that could influence the outcome. Preoperational data for every patient as well as the outcome of the treatment for 34 patients were gained from the archive. Other 17 patients were recently assessed by clinical and radiological examination during final follow up.

Etiologic factors are presented in table 1.

Table 1. LLD etiologic factors.

Hypoplasia of the lower limb	11
Idiopathic LLD	8
Congenital dislocation of the hip	8
Osteomyelitis	7
Pediatric hip diseases	4
Club foot	3
Neurogenic	2
Traumatic	2
Other: – Solitarybone cyst – Sclerodermia – Arteriovenous fistula – Femoral bone chondroblastoma – Congenital coxa vara – Recklinghausen disease	6

The average metrical age at the time of surgery was 12 years, 6 months (range: 9 years, 4 months – 15 years, 4 months), for girls – 11 years, 11 months (range: 9 years, 10 months – 13 years, 9 months) and for boys – 13 years, 2 months (range: 9 years, 4 months – 15 years, 4 months).

Skeletal age using the J. Kocyńska-Sikorska's atlas (5) was determined for 39 patients who had in their documentation hand's and wrist's radiograms. The average skeletal age at the time of surgery was 12 years, 2 months (range: 9 years – 14 years, 6 months), for girls – 11 years, 5 months (range: 9 years – 13 years) and for boys – 12 years, 11 months (range: 10 years – 14 years, 6 months).

The timing of the epiphysiodesis was determined with Anderson-Green method (6).

Mean follow-up was 6 years, 6 months (range: 1 year, 9 months – 19 years, 6 months). All cases were followed up to skeletal maturity.

The mean preoperative clinical LLD was 3.9 cm (range: 2.0-11.5). Radiological LLD (available only in 24 patients) was 3.5 cm (range: 1.4-6.6). Outcome assessment was based on clinical examination.

Phemister technique was performed in 44 patients, Blount's stapling – in 6 patients (in one patient both techniques were combined on different levels) and Metaizeau technique – in 2 patients. The site of the epiphysiodesis was distal femur in 24 patients, proximal tibia in 8 patients, both levels in 19 patients.

For 43 patients the goal of the treatment was equalization, for 3 patients – planned 1-2 cm inequality (due to dysfunction on different level: hip or foot stiffness) and for other 5 patients with high LLD the goal was to decrease inequality only. According to Kemnitz (7) and Campens (8) criteria final result within 1.5 cm from the assumption was assessed as good, between 1,5 and 2.0 cm – as fair, and more than 2.0 cm – bad result.

RESULTS

Data of all patients and results of the treatment for the whole group are presented in table 2. Actual LLD correction has been calculated as difference between preoperative LLD and at final follow-up. Negative result at final follow-up means overcorrection. Mean, minimal and maximal difference between metrical and bone age and LLD at final follow-up has been computed with absolute value.

Good result was achieved in 38 patients (74.5%): equalization \pm 1.5 cm in 34 patients, planned inequality left in 3 patients and one patient with planned decrease of LLD only. Overcorrection appeared in 8 patients (15.7%), in each case classified as good result (the final LLD was less than 1.5 cm). Fair result was achieved in 3 patients (5.9%) and bad result in other 10 patients (19.6%), including 5 patients (9.8%) with failure of the epiphysiodesis, consequently their preoperative LLD did not decrease.

Good result was achieved in 81.5% of girls, including 7.4% overcorrection and 66.7% of boys, including 25% overcorrection (fig. 1.) There was no statistically significant difference between genders (Fisher test; $p = 0,336$).

Comparing group with bad result ($n = 10$) with others ($n = 41$) they have smaller preoperative LLD (mean 3.4cm and 5.9cm respectively) and this difference is statistically significant (Mann-Whitney test; $p = 0,001$).

Average of relative LLD correction is similar for girls and boys and accounts for 60% and 58.1% respectively of average of preoperative LLD (tab. 3).

Effectiveness of the LLD treatment according to the site of the epiphysiodesis is depicted on figure 2. Three cases of overcorrection occurred in the group with both sites blocked and other 5 in the group with only femur blocked. There was no case of overcorrection in the group with only tibia blocked.

Average of relative LLD correction is the highest in the group with only femur blocked and accounts for 73.3% of average of preoperative LLD. In the group with both sites blocked it accounts for 56.8% and in the group with only tibia blocked – 33.3% (tab. 4). This difference is statistically significant (Fisher test; $p = 0,011$).

Table 2. Characteristics of patients and results.

No.	Gender	Side	Blocked site*	Method	Age at the time of surgery (years ^{months})		Difference m.a. - b.a.	LLD (cm)				LLD correction (cm)	
					Bone age	Metr. age		Preoperative		Final follow-up		LLD correction (cm)	
								clin	rtg	clin	rtg	clin	rtg
1.	F	R	F	Phem	11 ⁶	12 ¹	0 ⁷	2.5	3.0	1.5	1.3	1.0	1.7
2.	F	L	FT	Phem	10 ⁶	12 ²	1 ⁸	3.5	4.7	-1.0	-1.2	4.5	5.9
3.	M	L	F	Phem	12 ⁶	13 ⁴	0 ¹⁰	3.5	3.0	1.8	1.8	1.7	1.2
4.	M	R	T	Phem	10	9 ⁴	-0 ⁸	4.5	4.0	0.5	0.6	4.0	3.4
5.	M	R	F	Phem	11	13 ³	2 ³	3.5	2.7	-1.0	-1.3	4.5	4.0
6.	M	L	F	Phem	14 ⁶	14	-0 ⁶	2.0	1.4	0.0	1.1	2.0	0.3
7.	F	L	F	Phem	12	12 ⁴	0 ⁴	2.0	2.0	1.0	0.6	1.0	1.4
8.	F	R	FT	Phem	11 ⁶	12 ⁶	1	5.0	6.0	3.5	4.4	1.5	1.6
9.	F	L	FT	Phem	11 ⁶	11 ⁶	0	3.0	3.8	1.0	2.4	2.0	1.4
10.	M	R	FT	Phem	14	13 ¹¹	-0 ¹	4.0	3.2	1.4	2.2	2.6	1.0
11.	F	R	F	Phem	12 ⁶	13 ⁹	1 ³	2.0	1.6	0.0	-0.4	2.0	2.0
12.	M	R	FT	Phem	12	12 ⁹	0 ⁹	6.0	5.3	5.5	7.3	0.5	-2.0
13.	M	L	F	Phem	14 ⁶	14 ³	-0 ³	2.0	2.4	1.0	1.2	1.0	1.2
14.	M	L	T	Phem	11	11 ⁵	0 ⁵	3.5	3.4	0.5	0.5	3.0	2.9
15.	F	L	F	Phem	12 ⁶	12 ⁸	0 ²	3.0	3.1	1.5	1.5	1.5	1.6
16.	F	R	F	Phem	12	12 ¹¹	0 ¹¹	3.0	3.4	0.7	1.5	2.3	1.9
17.	M	R	T	Phem	12 ⁶	14 ¹¹	2 ⁵	2.8	1.5	2.6	2.1	0.2	-0.6
18.	M	L	T	Phem	n/d*	10 ⁶	n/d	5.0	4.4	3.5	3.3	1.5	1.1
19.	F	R	FT	Phem	n/d	12 ⁵	n/d	4.5	5.2	2.5	4.5	2.0	0.7
20.	F	R	T	Phem	12	11 ⁸	-0 ⁴	6.0	6.6	6.5	7.5	-0.5	-0.9
21.	M	L	FT	Blount	14	15 ⁴	1 ⁴	3.5	3.9	0.0	-0.3	3.5	4.2
22.	M	L	FT	Phem + Blount	12 ⁶	13 ¹	0 ⁷	4.5	4.1	2.0	2.1	2.5	2.0
23.	F	R	F	Metaiz	11 ⁶	12 ⁷	0 ¹¹	2.0	1.7	0.5	0.0	1.5	1.7
24.	M	R	F	Metaiz	13	13 ⁶	0 ⁶	3.0	2.4	1.5	0.7	1.5	1.7
25.	M	R	FT	Phem	14	12 ⁸	-1 ⁴	3.5	n/d	0.0	n/d	3.5	n/d
26.	M	L	F	Phem	12	12 ⁶	0 ⁶	3.0	n/d	5.0	n/d	-2.0	n/d
27.	M	L	P	Phem	13	13 ⁴	0 ⁴	4.5	n/d	5.0	n/d	-0.5	n/d
28.	M	R	FT	Phem	14	13 ⁹	-0 ³	3.6	n/d	2.0	n/d	1.6	n/d
29.	F	L	FT	Phem	10 ⁶	10 ²	-0 ⁴	4.5	n/d	1.5	n/d	3.0	n/d
30.	F	R	F	Phem	13	13 ³	0 ³	2.5	n/d	1.0	n/d	1.5	n/d
31.	F	L	F	Phem	9	9 ¹⁰	0 ¹⁰	5.5	n/d	1.5	n/d	4.0	n/d
32.	M	L	T	Phem	13	13 ⁷	0 ⁷	2.5	n/d	0.7	n/d	1.8	n/d
33.	F	L	FT	Phem	10 ⁶	10 ⁷	0 ¹	7.0	n/d	0.0	n/d	7.0	n/d
34.	M	L	F	Phem	13 ⁶	13 ¹⁰	0 ⁴	2.5	n/d	-0.5	n/d	3.0	n/d
35.	F	L	F	Phem	12 ⁶	13 ⁷	1 ¹	2.5	n/d	1.0	n/d	1.5	n/d
36.	F	L	FT	Phem	12	13 ⁷	1 ⁷	3.0	n/d	1.0	n/d	2.0	n/d
37.	F	L	FT	Phem	11	11 ⁴	0 ⁴	5.0	n/d	2.5	n/d	2.5	n/d
38.	F	R	F	Phem	10	11 ⁷	1 ⁷	5.0	n/d	0.0	n/d	5.0	n/d
39.	F	R	F	Phem	11 ⁶	10 ⁷	-0 ¹¹	5.0	n/d	1.5	n/d	3.5	n/d
40.	M	R	F	Phem	13	12 ⁹	-0 ³	3.2	n/d	-0.5	n/d	3.7	n/d
41.	M	R	F	Blount	13 ⁶	14 ⁹	1 ³	2.5	n/d	-0.5	n/d	3.0	n/d
42.	F	R	F	Phem	n/d	11	n/d	2.5	n/d	0.5	n/d	2.0	n/d
43.	F	L	T	Phem	n/d	12 ¹	n/d	2.0	n/d	1.0	n/d	1.0	n/d
44.	M	L	F	Phem	n/d	13 ¹	n/d	2.5	n/d	2.0	n/d	0.5	n/d
45.	F	R	F	Phem	n/d	11 ¹	n/d	5.0	n/d	0.5	n/d	4.5	n/d
46.	F	L	FT	Phem	n/d	11 ¹⁰	n/d	6.5	n/d	1.5	n/d	5.0	n/d
47.	F	R	F	Phem	n/d	11 ⁷	n/d	2.5	n/d	-1.0	n/d	3.5	n/d
48.	F	R	FT	Phem	n/d	11 ¹	n/d	11.5	n/d	11.0	n/d	0.5	n/d
49.	F	L	FT	Blount	n/d	12 ¹	n/d	10.0	n/d	8.0	n/d	2.0	n/d
50.	M	R	FT	Blount	n/d	12 ¹	n/d	4.0	n/d	1.5	n/d	2.5	n/d
51.	M	R	FT	Blount	n/d	13 ¹	n/d	4.0	n/d	-1.5	n/d	5.5	n/d
MEAN					12²	12⁶	0⁹	3.9		1.8		2.2	
MIN					9	9⁴	0	2.0		0.0		-2.0	
MAX					14⁶	15⁴	2⁵	11.5		11.0		7.0	

*F – distal femoral; T – proximal tibial; M.a. – metrical age; B.a. – bone age; n/d – no data.

Table 3. Mean, min and max values of LLD and correction for both genders.

	Girls	Boys
Preoperative LLD (cm)	4.3 (2.0-11.5)	3.5 (2.0-6.0)
LLD at final follow-up (cm) (absolute value)	2.0 (0.0-11.0)	1.7 (0.0-5.5)
LLD correction (cm)	2.5 (-0.5-7.0)	2.1 (-2.0-5.5)

Table 4. Mean, min and max value of LLD and correction according to the site of epiphysiodesis.

	Femur + tibia	Femur	Tibia
Preoperative LLD (cm)	5.1 (3.0-11.5)	3.0 (2.0-5.5)	3.9 (2.0-6.0)
LLD at final follow-up (cm) (absolute value)	2.5 (0.0-11.0)	1.1 (0.0-5.0)	2.5 (0.5-6.5)
LLD correction (cm)	2.9 (0.5-7.0)	2.2 (-2.0-5.0)	1.3 (-0.5-4.0)

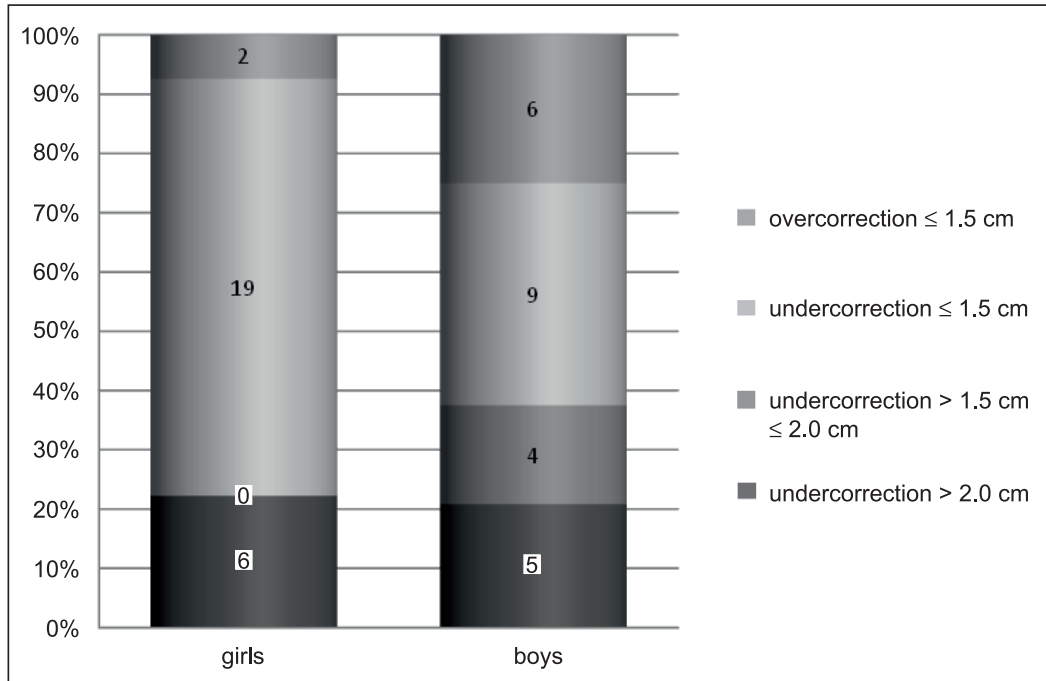


Fig.1. Comparison of results of the treatment for both genders.

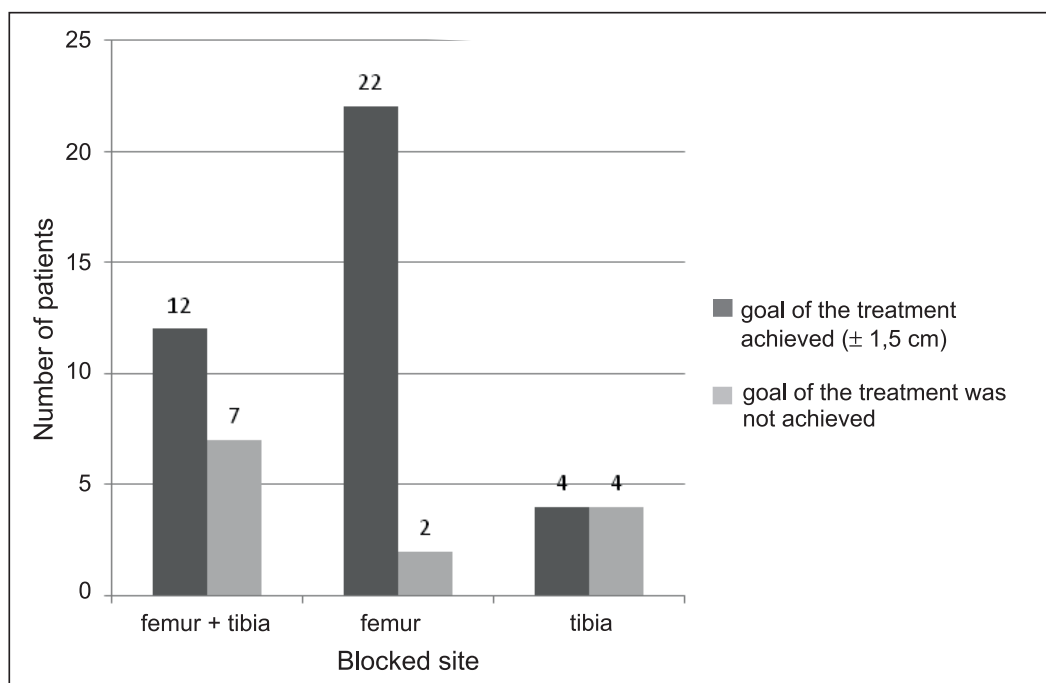


Fig. 2. Effectiveness of the LLD treatment according to the site of the epiphysiodesis.

Average of the time from surgery to growth plates closure according to the blocked site is presented in table 5. Assuming the growth plates closure in girls in 14 years of age and in boys in 16, the group with only femur blocked had greater average of LLD correction despite lesser average value of the time from surgery to growth plates closure comparing to the group with only tibia blocked. There was no relation between time from surgery to growth plates closure and final result (Mann-Whitney test; $p=0,162$).

Table 5. Mean, min and max value of time from surgery to growth-plates closure according to the site of epiphysiodesis.

	Femur + tibia	Femur	Tibia
Bone age (years ^{months})	2 ⁹ (2-4 ¹)	2 ⁹ (1-5)	3 ⁸ (2-5 ¹⁰)
Metrical age (years ^{months})	2 ⁵ (0 ⁵ -3 ¹¹)	2 ² (0 ³ -4 ²)	3 ⁵ (1 ¹ -6 ⁸)

Comparison of LLD and LLD correction for different etiology is presented in table 6. No relation between etiology and the outcome has been found.

Tabela 6. Average of LLD and correction according to etiology factors.

Etiologic factors	LLD (cm)		LLD correction (cm)
	Preoperative	Final follow-up	
Traumatic (2)*	3.4	-0.3	3.7
Congenital dislocation of the hip (8)	3.9	0.9	3.0
Osteomyelitis (7)	4.6	2.0	2.6
Pediatric hip diseases (4)	3.7	1.2	2.5
Idiopathic LLD (8)	2.9	0.4	2.5
Hypoplasia of the lower limb (11)	4.7	2.4	2.3
Neurogenic (2)	3.5	1.5	2.0
Club foot (3)	3.3	2.8	0.5
Other (6)	3.9	2.5	1.4

*Number of patients.

For this analysis only 39 patients with bone age determined were taken into account. Average of preoperative LLD according to patients' bone age in which the epiphysiodesis was made is presented in table 7. The average of treatment outcome is similar in all groups.

Table 7. Average of LLD according to patients' bone age in which the epiphysiodesis was proceeded.

Time from surgery to growth-plates closure (years)	LLD (cm)	
	Preoperative	Final follow-up
> 3	4.3	1.5
≤ 3 i > 2	3.3	1.2
≤ 2	3.1	1.3

Distribution of difference between bone and metrical age among these 39 patients is presented in table 8.

Table 8. Distribution of difference between bone and metrical age.

Bone and metrical age difference (months)		Number of patients
M.a. > b.a.	< 6	7
	6-11	11
	12-17	6
	≥ 18	5
TOTAL		29
M.a. < b.a.	< 6	6
	6-11	3
	≥ 12	1
TOTAL		10

The average of bone and metrical age difference accounts for 9 months.

For this analysis only 36 patients with bone age determined and permanent physeal fusion were taken into account. The average of actual and predicted with Green-Anderson method correction difference accounts for 1.4 cm (range: -0.9 – 7.3). Actual and predicted correction variance is depicted on figure 3. Trend line for LLD correction based on clinical examination has been added. It shows that the higher preoperative LLD the higher actual and predicted correction difference.

Distribution of actual and predicted correction difference among these 36 patients is presented in table 9.

Table 9. Distribution of actual and predicted correction difference.

Correction (cm)		Number of patients
Actual < predicted	< 1,0	7
	1,0-1,9	6
	2,0-2,9	8
	≥ 3,0	4
TOTAL		25
Actual > predicted	< 1,0	11

Eight patients underwent temporary growth-plates arrest: 6 with Blount's staples and 2 with Metaizeau technique. Among patients with Blount's stapling in 4 cases growth did not resume after staples removal resulting in 2 cases of overcorrection. In one patient growth has resumed and in another – staples were removed after growth-plates closure. In Metaizeau group in both patients growth has resumed after screws removal. There was no case of "rebound effect" – accelerated growth after blockade removal.

Complications occurred in 8 patients (15.7%) (tab. 10). The most frequent complication was knee valgus deformity, which occurred in 5 patients (9.8%).

DISCUSSION

There are different grading systems of epiphysiodesis results in literature. Usually good result is assessed was final LLD ≤ 1.5 cm (7, 8). According to this criteria

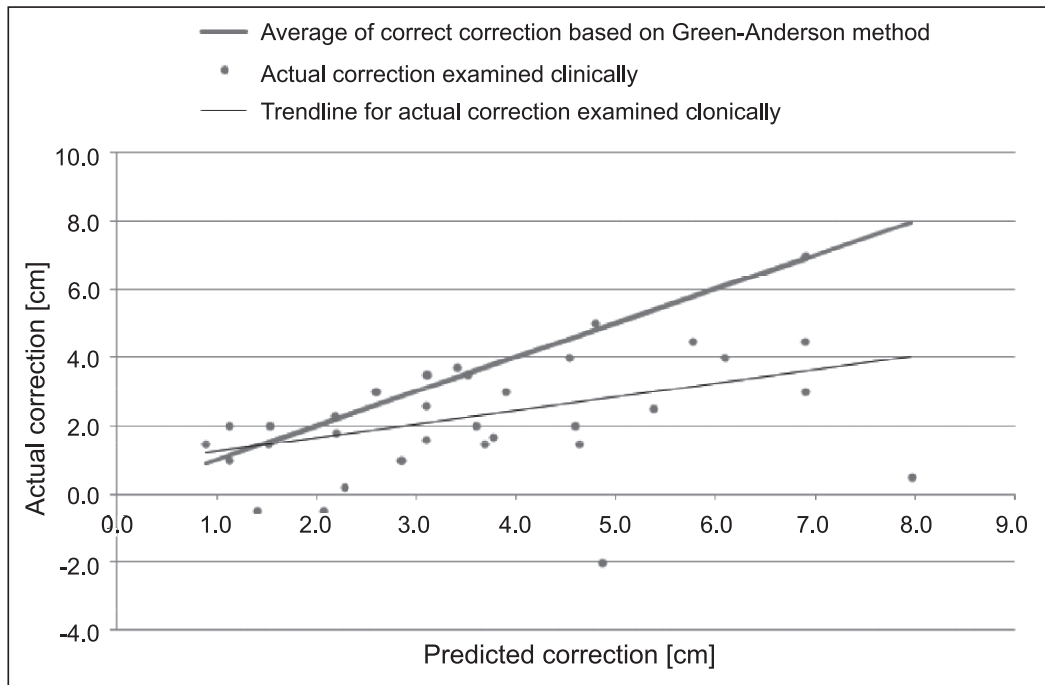


Fig. 3. Actual and predicted correction variance.

Table 10. Complication occurred.

	Gender	Blockedsite*	Method	Complication description
Valgus knee deformity	F	F	Phemister	10° examined clinically, distal femoral physis;
	F	F T	Phemister	13° radiologically, proximal tibial physis;
	M	F	Phemister	7° radiologically, distal femoral physis;
	M	F T	Blount's staples	15° clinically;
Valgus knee deformity, knee hyperextension, curved screws	F	F	Metaizeau	7° valgus knee – radiologically, distal femoral physis; 10° knee hyperextension, clinically;
Knee hyperextension	F	F T	Phemister	10° clinically;
	F	F T	Phemister	10° clinically;
Postoperative infection	F	F T	Blount's staples	Knee edema after staples removal, conservative treatment

*F – distal femoral; T – proximal tibial.

amount of good results obtained in our series (74.5%) is comparable to others. Campens et al (8) published the results of open Phemister technique, percutaneous epiphysiodesis and Metaizeau technique where good results account for 74%, 89% and 70% respectively. Kemnitz et al (7) evaluated group of patients treated with percutaneous epiphysiodesis with 68.5% good result. Craviari et al (9) accepted as good result final LLD ranged from -1.0 cm to 1.5 cm (80% of patients), including very good result: final LLD ranged from -0.5 cm to 1.0 cm (31.7% of patients). Gorman et al (10) presented results of LLD treatment with Blount's staples with 74% of final LLD ≤ 2.0 cm, including 37% of final LLD ≤ 1.0 cm.

Kemnitz et al (7) submit for poor and fair results (final LLD > 1.5 cm) wrong timing on Moseley chart in 15.8% patients, faulty evaluation of bone-age in 12% and asymmetrical closure of the physis in 3.5% patients. In Campens et al (8) series there were two cases

of bad result – one treated with Metaizeau technique (6.7%) and one with percutaneous epiphysiodesis (3%). Authors suggest too advanced bone age estimation at the time of surgery as a reason. In other 3 patients (9%) treated with Phemister technique the actual correction did not correspond with the predicted, however they considered the insufficient epiphysiodesis as a reason. Ramseier et al (11) report that exact residual height should be calculated before the epiphysiodesis and monitoring the growth after the procedure should be proceeded in order to obtain the satisfactory result. Craviari et al (9) also find regular observation after the surgery as necessary to avoid under- or overcorrection. In their series in 4 cases (6.6%) complementary epiphysiodesis on second level of the same leg had to be proceeded resulting in 2 very good results, one good and one poor.

Overcorrection occurred in 15.7% patients in presented material and in each case the goal of the treat-

ment has been obtained due to final LLD ≤ 1.5 cm, whereas Craviari et al. (9) consider overcorrection ≤ 1 cm as a good result (obtained in 26.7% patients), but overcorrection > 1 cm (obtained in 3.4% patients) as a poor result. Campens et al. (8) consider overcorrection ≤ 0.5 cm obtained in two cases (6%) as good result. Some authors (7, 9, 11) recommend the contralateral physis closure in order to avoid overcorrection. In presented series no contralateral epiphysiodesis after equalization has been made. However in Craviari et al. (9) material in 2 cases (3.3%) contralateral segment has been blocked in order to avoid overcorrection with very good final result. Kemnitz et al. (7) consider overcorrection ≥ 1.5 cm as complication because it is less acceptable than an undercorrection. In their series in 5 cases (8.8%) overcorrection ≥ 1.5 cm occurred including 2 cases of overcorrection ≥ 2.0 cm that needed contralateral epiphysiodesis. Whereas Ramseier et al. (11) recommend contralateral epiphysiodesis just at the time of equalization. In their series it has been made in 3 cases (15.8%)

The average of actual and predicted with Green-Anderson method correction difference in presented material is 1.4 cm, whereas in Little's et al. (12) publication it is only 0.7 cm. The reason for such difference could be insufficient epiphysiodesis or incorrect bone-age estimation that, according to many cases of undercorrection in this material, was estimated as too advanced as it actually was. Perhaps better result in this series could be also obtained if Moseley charts (13) were used.

No literature describing physis activity in patients treated with temporary epiphysiodesis and with blockade removal before growth-plates closure has been found, therefore different results of treating axial deformity with this method has been discussed. In this material of 5 patients treated with Blount's staples with their removal before growth-plates closure only in one patient (20%) activity of the physis resumed. In Mielke and Stevens (14) material growth resumed in all 25 patients likewise in Stevens et al. (15) series in all 75 patients. In Mielke and Stevens (14) material in 7 patients (28%) deformity recurred, so as in Stevens et al (15) series in 5 patients (6.7%) rebound effect needing repeated stapling, whereas in presented material there was no deformity recurrence or rebound effect. Stevens et al. (15) recommend slight overcorrection before staple removal in order to prevent deformity recurrence.

In series presented by Khoury et al. (16) in 13 patients screws have been removed before growth-plates closure. After removal in 6 of these patients (46%) rebound effect occurred, in other 6 cases (46%) correction remained unchanged and in another one (8%) correction progressed. Khoury et al. (16) suggest that screws should be removed at the time of full correction, not overcorrection. It responses with Metaizeau et al. (4) results where in 2 patients (22%)

screws were removed before growth-plates closure to avoid overcorrection. In both cases correction remained unchanged. Also in this material in both patients after screws removal physes resumed growing with no rebound effect.

Common complication in presented material was valgus knee deformity that occurred in 5 patients (9.8%), which is quite high rate, compared to other researches. In series presented by Kemnitz et al. (7), Campens et al (8), Surdam et al. (17), Inan et al. (18), Craviari et al. (9) the axial deformity rate was 3.5% (2 patients), 3% (one patient), 1.8% (one patient), 1% (one patient) and 8.3% (5 patients) respectively.

Gorman et al. (10) indicate that proximal tibial stapling is connected with higher risk of axial deformity than distal femoral and varus deformity is more frequent. In turn in presented material one patient with distal femoral stapling developed valgus deformity. Khoury et al. (16) also reported problems with tibial epiphysiodesis. In their series in one patient (3.4%) treated with Metaizeau technique screws curved on tibial site however in presented series in one patient two screws curved on femoral site.

In presented material axial deformity in each case was connected with valgus deformity. No confirmation in the literature about such results has been found.

Five patients (9.8%) in the presented material had failure of their epiphysiodesis thereby LLD did not decrease. This is quite high rate according to different researches. In study presented by Campens et al. (8) the rate of failure of epiphysiodesis was 3% in patients treated with Phemister technique and 6% in patients treated with percutaneous epiphysiodesis. These results are comparable to these presented by Inan et al. (18) and Surdam et al. (17) where this rate was 2% and 5.4% accordingly. In each case reoperation was needed. Thereby Surdam et al. (17) suggest having regular checkups after surgery. On the other hand in Alzhrani et al. (19) series none of the patients had failure of their epiphysiodesis, neither in Phemister's nor in percutaneous epiphysiodesis' group.

CONCLUSIONS

1. LLD treatment with epiphysiodesis gives opportunity to obtain correction however it is connected with risk of under- or overcorrection or asymmetrical physis blockade.
2. Distal femoral epiphysiodesis enables for gaining greater correction than proximal tibial epiphysiodesis however risk of overcorrection is higher.
3. The most common complication of epiphysiodesis for LLD is knee axial deformity that might be connected with insufficient blockade of the medial part of the physis. This may suggest that physeal fusion is more difficult on the medial side of the physis.

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