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Original Article

Therapeutic effect of posterior release in the treatment of clubfoot deformity

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Abstract: Background: It is difficult to obtain adequate recoveries of the ankle dorsiflexion function only by Ponseti method in serious clubfoot deformity. The surgery of posterior release (PR) could be a useful option in this condition. This study evaluates the effective range of this operation, and describes the components and details of the procedure. Methods: A retrospective clinical review of 22 patients with 24 feet was performed to evaluate the surgery. The surgery was performed from January 1, 2017 to December 31, 2017. The patients' information was initially collected before surgery, including the severity of the deformity which was evaluated using a Pirani scoring system with a full score of 6 points. The number of series plaster and the degree of ankle planter flexion were recorded. After series plaster by Ponseti method, the patients underwent PR if there was severe plantar flexion deformity. Each case of PR was recorded independently in three stages, namely tendon-Achilles lengthening (TAL), tendon-flexor lengthening (TFL), posterior capsula release (PCR), PR = TAL+TFL+PCR. The median age in operation was 10 months. Results: In the operation of PR, the average correction angle was 66.96±21.92 degree. PCR was the core part in this procedure and average correction angle was 44.38±16.55 degree. The average correction angle of TAL was 19.98±14.47 degrees, and the average correction angle of TFL was 7.32±4.58 degrees. Conclusion: PR surgery is a useful supplement to the Ponseti method. The PCR and TAL are the main steps.

Keywords: Clubfoot, Ponseti, posterior release, significance, level IV evidence

Introduction

Congenital clubfoot is one of the most common (1 to 2 in 1000 live births) congenital orthopedic conditions requiring intensive treatment [1]. The goal of the correction of the clubfoot is to obtain a dorsiflexion function of 10 degrees or more. When the plantar flexion deformity is too serious, however, it is very difficult to achieve the desired correction result by minimally invasive tenotomy.

The treatment method has gone through hundreds of years of exploration and continuous improvement in modern medicine. The Ponseti method is the mainstream method for treating this disease at this stage [2, 3]. The Ponseti method, proposed and developed by Professor Ignacio Ponseti, refers to a series of operations during treatment, including four components: series of plaster orthopedics, percutaneous Achilles tenotomy, wearing orthodontic shoes, and tibialisanterior muscle tendon transfer.

Talipes equinus, a congenital ankle joint plantar flexion deformity, is mainly corrected by tendon tenotomy. Achilles tendon severing has different surgical methods. However, some authors have found that it is difficult to ensure adequate recovery of the dorsiflexion function regardless of the technique of cutting off the tendon. Adequate correction of the dorsiflexion function is the key to prevent recurrence. If there is residual ankle joint equinus deformity after tenotomy, it will lead to high recurrence rate, and need surgical dissection in the future [4].

Other studies have also suggested that in some cases with severe equinus deformity, it is very difficult to completely correct the deformity by minimally invasive methods [5, 6], and the large deformity of the plantar flexion cannot be fully corrected. Some authors have proposed a complete correction of the plantar flexion deformity through posterior capsule release [7-11]. This requires us to understand the effective range of posterior release surgery to better guide clinical surgical options.

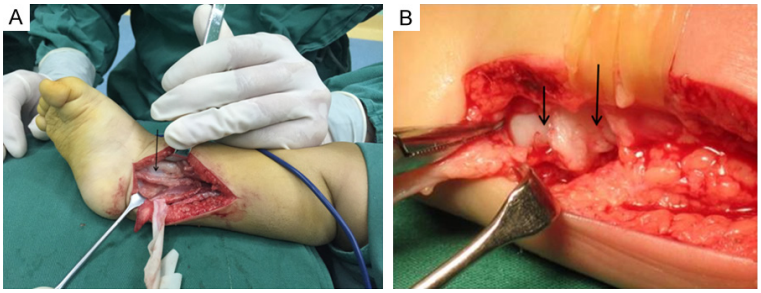

Figure 1. The posterior capsule needed to be release (black arrow in A). The posterior joint after release, including subtalar joint (short arrow in B), ankle joint (long arrow in B).

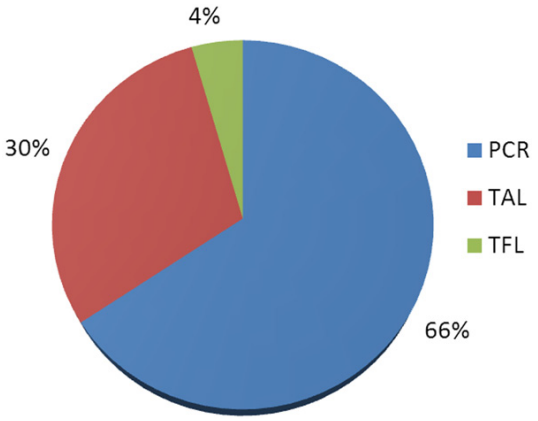

Figure 2. Contribution ratio of the different surgery approach to the total surgery effect of Effect Range (ER). Different surgery approach including Posterior Capsula Release (PR), Tendon-Achilles Lengthing (TAL), Tendon-Flexor Lengthing (TFL). PR%+TAL%+TFL% = 100%.

Materials and methods

Clinical data

From January 1, 2017 to December 31, 2017, a total of 22 patients with 24 feet were enrolled in the study. All were congenital clubfoot patients. All patients were operated to put series plaster by Ponseti method first; the casting continued until there was no better correctional effect. If the plantar flexion deformity was more than 20 degrees, they would undergo posterior release surgery. The patients information were initially collected before surgery, including that the severity of the deformity was evaluated using a Pirani score by 6 points. The number of plaster series and the degree of ankle planter flexion were recorded.

Surgical methods

The posterior release surgery included extension of the Achilles tendon, prolongation of the flexor digitorum and long flexor of the hallux, and release of the posterior joint capsule. The sum of the effects of the three surgical stages constitutes the total correction angle of the posterior release. The extension of flexor toe and flexor hallux tendon is not an inevitable option, and it depends on the intraoperative condition. The posterior joint capsule release includes two parts: the ankle joint and the posterior joint capsule of the subtalar joint (**Figure 1**).

Recording method

We evaluated this surgery by ER (effective range) which means the angular change of the ankle dorsiflexion. The ER of posterior release (PR) was recorded independently in three stages, namely tendon-Achilles lengthing (TAL), tendon-flexor lengthing (TFL), posterior capsula release (PCR). The plantar flexion deformity could be solved almost completely by these three stages. We measured the dorsiflexion angle of ankle joint in every stage of the surgery to describe the ER of PR. The baseline is anterior tibia line and foot line (**Figure 2**), and the intersection angle between them is considered the dorsiflexion angle. The angular change from preoperation to the end has been recorded. Through numerical calculation, the contribution rate of each part in the operation was obtained, and the average correction level of posterior release was obtained. Through the analysis of 24 cases of operation and literature review, the details of this operation method were summarized in order to guide the treatment.

Statistical analysis

SPSS21.0 software was used for data calculation and analysis. The age distribution, original deformity score, number of plaster and the data characteristics of operation effect were calculated respectively. The three independent operations of Achilles tendon lengthening (TAL),

Table 1. Summary of patient data for posterior release

Serialnumber	gender	Months	Plaster times	Pirani	PR = TAL+TFL+PCR
1	male	6	5	6	109 = 25+11+73
2	male	8	5	6	82 = 23+N+53
3	male	11	6	6	96 = 35+N+61
4	female	7	6	6	105 = 35+N+70
5	male	8	5	6	48 = 10+N+35
6	female	33	7	6	41 = 21+N+20
7	male	72	4	5.5	51 = 25+N+26
8	female	11	5	6	78 = 0+9+69
9	male	7	5	5.5	55 = 20+N+35
10	male	6	6	6	63 = 27+N+36
11	female	34	7	5	56 = 22+4+30
12	male	48	5	5.5	40 = 3+1+36
13	female	4	7	6	99 = 17+17+65
14	female	L6 R6	L6 R6	L5 R5	L50 = 23+N+27 R54 = 29+N+25
15	female	29	5	6	64 = 23+N+41
16	female	37	5	5.5	43 = 22+N+21
17	male	50	7	5.5	58 = 11+10+37
18	female	L36 R32	L6 R6	L6 R6	L73 = 23+5+45 R60 = 20+5+35
19	male	2	5	6	103 = 16+N+87
20	female	26	4	5	45 = 8+1+36
21	female	5	5	6	80 = 21+N+59
22	male	9	3	4.5	54 = 20+N+34

Note: N, no this step.

flexor tendon lengthening (TFL) and posterior capsule lysis (PCR) were also calculated. The relationship between the operation effect and the contribution rate was explored.

Results

Cases characteristics

A total of 22 patients were included in the study, which was a continuous case data within 1 year. The following was a summary of all patient data (**Table 1**).

The age distribution of the patients in this study group was as follows. The minimum age was 2 months, the maximum age was 72 months, and the median age was 10 months. It was a skewed distribution. The patients within 1 year were significantly more than other age groups and the patients over 1 year old were evenly distributed, which was consistent with the encouragement of early treatment of the clubfoot.

The patient's original malformation was evaluated using the Pirani scoring system with a full score of 6 points. In 24 feet, 19 feet had a malformation scored ≥ 5.5 points, 4 feet scored 5 points, and only 1 foot scored less than 5 points. Each patient was first chosen using the Ponseti plaster technique, and the number of plaster corrections was recorded. The data was in a normal distribution. The minimum correction was 3 times before surgery and maximum correction up to 7 times, with an average of 5.46 times.

In this group of patients, patients 14 and 18 had bilateral posterior release. Patients 8, 10, 12, 16 and 22 also had bilateral onset, but the other side was less deformed. There were only 7 cases of bilateral patients and 15 cases of unilateral patients. There were 6 patients with 7 feet that have been operated before. Among them, patient 6, 9, 10, 16 and 20 have experienced a series of plaster and percutaneous Achilles tendon tenotomy, while patient 18 had undergone bilateral open release surgery (Turco operation) in local hospitals.

There were 6 patients with combined malformation, just as arthrogryposis and contralateral vertical talus deformities. Patient 6 was complicated with fibular hemimelia, had only 4 toes, and the length of limbs was significantly shorter than that of the opposite side. Patient 15 combined with congenital lumbar intraductal lipoma. Considering the occurrence of deformity, it may be both congenital and neuropathic. Patient 17 had arthrogryposis, bilateral hip dislocation, and the contralateral vertical talus deformity. Patient 18 had arthrogryposis, hand flexion contracture deformity. Patient 20 had arthrogryposis.

Surgery characteristics

The ER of posterior release was recorded as PR, which is the sum of the effects of the three

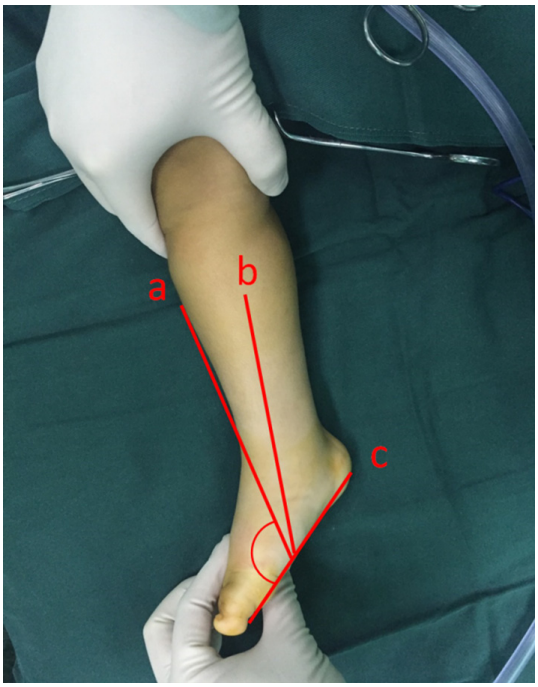

Figure 3. Measurement of the ankle joint flexion angle, the angle between line a and line c (a = anterior tibia line, b = calf axis, c = plantar parallel line).

surgical procedures. The Achilles tendon lenghthing was recorded as TAL, the flexor tendon lenghthing was recorded as TFL, and posterior capsule release was recorded as PCR, PR = TAL+TFL+PCR. TFL was applied in some patients, but not in all.

The overall correction angle of posterior release was the core item of this study. The minimum correction was 40 degrees, the maximum correction was 109 degrees, and the average correction was 66.96±21.92 degrees. In the three surgical procedures, TAL occurred in 24 cases, the minimum correction effect was 0 degrees, the maximum was 35 degrees, and the average was 19.98±14.47 degrees. TFL was a selective operation. In the 24 cases, 9 cases completed this step, and the other 15 cases only partially distracted the tendon to facilitate the posterior joint capsule to be exposed without extension. The average was 7.32±4.58 degrees. All cases conducted PCR with a minimum correction of 20 degrees and a maximum of 87 degrees, and average was 44.38±16.55 degrees. The ER of the posterior release surgery consisted of three parts (**Figure 3**).

The TAT (Tenotomy of Achillis Tendon) procedure is the classical surgery to correct the plantar flexion deformity in Ponseti method. The TAT group was chosen as the control group, and the cases came from the same year, matched by Pirani score and gender distribution. The quantity of TAT cases was much better than PR, but the age was much younger, so the oldest cases were selected among all the TAT done in our hospital the same year (**Table 2**). There was statistical difference in ER between the two groups results, in other words, the more serious cases could be treated by PR.

Discussion

The controversy and necessity of choosing open surgery

The Ponseti method has proven to be a very successful and effective mainstream method. Its series of plaster, combined with minimally invasive surgery (tenotomy), can obtain a good prognosis for most patients. Ponseti emphasized that surgery of opening joints should be avoided because he believed that it will increase the risk of permanent foot stiffness [12]. This view has also been supported by other literature [13-15]. Smith et al. believe that patients treated with surgery will have higher pain scores, lower activity and lower quality of life [16]. In addition, surgically treated clubfoot has a tendency to develop skeletal deformities, including distal tibia and talus. Burghardt et al. used imaging methods to analyze 65 patients with surgical clubfoot, with an average follow-up of 10 years. They noted significant flat talus, valgus and flexion deformity of distal tibia in most patients [15].

Although there are various drawbacks to extensive open surgery as described above, series casting combined with limited open release surgery can still be of great help. Completely abandoning open surgery will result in insufficient ankle dorsiflexion. Hosseinzadeh et al. believe that the probability of recurrence is related to the degree of ankle dorsiflexion [4]. Some studies have also found that residual forefoot adduction after series casting [17] and a higher Pirani score at the beginning of treatment [18] increase the likelihood of recurrence of deformity, which also requires follow-up surgery. Although surgery is no longer the preferred treatment for idiopathic clubfoot, targeted surgery with “a limited surgery” is still very helpful in cases when the deformity cannot be

Table 2. Demographics

Demographics	Control Group	Study Group	P
Age (mo)	8.67±8.19	20.54±18.71	0.008
Gender (m/f)	12/10	11/11	0.833
Pirani score	5.52±0.56	5.67±0.46	0.329
Cast times	6.13±2.86	5.46±1.02	0.292
ER (effective range)	29.88±9.13	66.96±21.92	0.000 (1.3221E-8)

completely corrected by the Ponseti method only. Mahan et al. found that if the patient was operated by an experienced doctor, there was no significant difference between the surgical group and the control group, and the operation could achieve satisfactory results [19]. Bocahut et al. shared 199 cases of medial and posterior open surgery, and most of them achieved excellent results [20].

In terms of experience, the Ponseti method is used to treat infants. In the early stage, the Ponseti casting technique can solve the adduction and varus deformity as effectively as possible. There is a growing evidence to support the use of it in older children [21-23]. With the expansion of treating age, the effectiveness of casting combined with minimally invasive surgery will inevitably decline to some extent. For those cases of delayed diagnosis and treatment, many scholars have put forward different suggestions, and there are many surgical approaches for treatment [24-26]. The combination of small-scale open surgery and the dealing with over-age cases is one of the mainstream methods at the second stage.

Jauregui has found that atypical clubfoot may have a higher probability of posterior release [27]. The indication for posterior articular capsule incision is that the dorsiflexion cannot reach 10 degrees after extension of the Achilles tendon.

In this group of patients, the Pirani score (6 points system) was used. Among 24 feet, 19 feet had a malformation scored ≥ 5.5, 4 feet scored 5 points, and only 1 foot scored less than 5 points. The average score was 5.67 points, close to full marks. The original deformity of patients who needed open surgery was very serious, and it was difficult to obtain full correction through series of casts and minimally invasive surgery. In the posterior release surgery group, the average number of casting before surgery was 5.46, which was also in line with the traditional cognition that the deformed heavier foot needed more casts to correct.

In this group, there were 6 people with 7 feet for the second operation. Most of the recurrence cases in these revisions had poor muscle soft tissue conditions, weak strength of valgus, and adhesion factors caused by the first operation. The elasticity was reduced, the range of motion of the joint cannot be significantly increased by the tenotomy operation, and the posterior side release was required.

Evaluation of treatment effect

The evaluation of the treatment effect includes body surface measurement and imaging measurement. In this paper, it was recorded and evaluated by body surface measurement. The clinical description of the ankle joint flexion angle is usually based on the calf axis (b). In this study, the angle between the anterior tibia line (a) and the plantar parallel line (c) was recorded for the convenience of measurement (**Figure 2**), this angle was not the true ankle flexion angle. The range of surgical correction was only the relative change of this angle, and it was independent of the initial data, which was good for measurement and calculation.

Jauregui and his team performed a detailed and effective study on posterior release [27]. A total of 16 people and 20 feet required posterior joint capsule incision, and all had complete joint function correction. The angle was significantly improved compared to preoperative. In this study, the posterior release can achieve a larger correction angle, and the incision of the posterior capsule can be corrected by an average of 44 degrees during surgery.

Regarding imaging measurements, several studies have reported that the use of plain film can predict the probability of recurrence or the resistance and difficulty of treatment [28]. Shabtai et al. believe that the lateral film is taken at the maximum dorsiflexion if the tibial-calcaneus angle is greater than 77° and a talus-calcaneus angle less than 29° may require additional surgery [29]. In an indepen-

dent study of the Ponseti method for the treatment of clubfoot, the dorsiflexion lateral radiograph is taken before the tenotomy. If the dorsiflexion is less than 16°, it is considered to be a relevant risk factor for increased recurrence rate [30]. Zimmerman pointed out that patients with posterior joint capsule release should measure ankle joint mobility before, during and after surgery, and the indicators on the lateral radiographs should be evaluated at the time of follow-up [28].

The imaging part of the evaluation of clubfoot was not covered in this study. Although intraoperative fluoroscopy was used in a small number of patients to measure the tibial-calcaneus angle, the sample size was too small and did not have statistical significance. In this study, only the data of body surface measurement collected during the operation were compared with the immediate data before and after the operation, and the effective correction range of the operation was obtained. No follow-up analysis of the angle changes in the process of rehabilitation after the operation was made.

Surgical techniques and intraoperative correction range of posterior release

The posterior release surgery is a general term of series operation performed on the plantar flexion deformity, which is used to meet the functional requirements of ankle dorsiflexion. The contents involved in the surgery mainly include TAL, TFL and PCR.

The contracture of Achilles tendon is the main pathogenic factor of the ankle joint deformity. In all patients with posterior release, TAL is essential. Jauregui concluded that all children underwent Achilles tendon prolongation at the same time as the posterior capsule was released [27], which is similar to the result of our study. The Achilles tendon extension can be corrected to an average of 19.96 degrees, and the correction effect is limited. The possible causes include: secondary surgery (6/22, 27%), combined with other congenital malformations, especially multiple joint contractures (6/22 people, 27%). The Achilles tendon is usually extended in a Z shape, and the tendon is maintained at a 10 degree dorsiflexion while the knee joint is in a straight position. In this group of patients, the contribution rate of the flexor tendon lengthening in the total corrected range was very low. 9 out of 24 cases did it, which accounted for 37.5% of the cases.

The incision of the posterior capsule is an important part of the posterior release surgery, especially the posterior capsule of the tibiatalus joint is the most important. It needs to protect the posterior nerve-vascular bundle during the surgery, and the flexor digitorum and flexor hallux tendon should be pulled apart for protection. In these cases, the posterior joint capsule can be corrected by an average of 44 degrees. The correction effect during the operation is very obvious. For severely stiff cases, the calcaneofibular ligament should be cut at the same time. This operation is extremely easy to injure the musculus peroneus longus/brevis and requires protection of them.

Postoperative rehabilitation and prognosis

Regardless of the treatment method used in the previous period, the rational use of the brace is an important part in the rehabilitation. Regarding the time of plaster fixation, some literatures have mentioned that the extension of the capsulotomy should be extended to 8-12 weeks, while the method of Jauregui is only fixed for 3 to 5 weeks after surgery [27]. At the same time, he believed that after the removal of plaster post-operation, parents should be informed and trained immediately to carry out professional physical rehabilitation at home to improve ankle mobility.

There were some limitations in this study. First, the present study only described the intraoperative data. Long-term prognosis was not reported at the present study, which will be reported in the future. Second, follow-up information after operation was not recorded in the study.

Posterior release surgery is a useful supplement to the Ponseti method. It corrects the excessive plantar flexion deformity after a series of casts.

In this paper, all cases were fixated by cast for 4 to 6 weeks post-operation. After removing the plaster, Dennis-Brown orthodontic shoes or one-sided ankle braces were used. At the same time, family members were instructed to massage three times a day for 10 to 20 minutes each time. Long-term prognosis will be reported in future research.

Disclosure of conflict of interest

None.

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References

[1] O'Shea RM and Sabatini CS. What is new in idiopathic clubfoot? Curr Rev Musculoskelet Med 2016; 9: 470-477.
[2] Spiegel DA. CORR Insights(R): results of clubfoot management using the Ponseti method: do the details matter? a systematic review. Clin Orthop Relat Res 2014; 472: 1617-1618.
[3] Radler C. The Ponseti method for the treatment of congenital club foot: review of the current literature and treatment recommendations. Int Orthop 2013; 37: 1747-1753.
[4] Hosseinzadeh P, Steiner RB, Hayes CB, Muchow RD, Iwinski HJ, Walker JL, Talwalkar VR and Milbrandt TA. Initial correction predicts the need for secondary achilles tendon procedures in patients with idiopathic clubfoot treated with ponseti casting. J Pediatr Orthop 2016; 36: 80-83.
[5] Park SS, Lee HS, Han SH, Park JW and de Peralta MJ. Gastrocsoleus fascial release for correction of equinus deformity in residual or relapsed clubfoot. Foot Ankle Int 2012; 33: 1075-1078.
[6] Mary P, Damsin JP and Carlioz H. Correction of equinus in clubfoot: the contribution of arthrography. J Pediatr Orthop 2004; 24: 312-316.
[7] De Langh R, Mulier JC, Fabry G and Martens M. Treatment of clubfoot by posterior capsulectomy. Clin Orthop Relat Res 1975; 248-253.
[8] Nomura S, Kondo M, Maekawa M, Himeno S and Matsuo T. Limited plantar flexion of the ankle in the surgically treated congenital club foot. Fukuoka Igaku Zasshi 1982; 73: 476-487.
[9] Simons GW. Complete subtalar release in club feet. Part I--A preliminary report. J Bone Joint Surg Am 1985; 67: 1044-1055.
[10] Miura Y, Kamegaya M, Saisu T and Moriya H. Effect of postoperative early ankle motion exercise using hinged ankle-foot orthoses in clubfoot. J Pediatr Orthop 2005; 25: 529-532.
[11] Fujak A, Forst R and Forst J. Outcome after Achilles tendon lengthening with a posterior capsulolysis according to Imhauser in idiopathic congenital clubfoot. Ortop Traumatol Rehabil 2008; 10: 367-376.
[12] Ponseti IV. Common errors in the treatment of congenital clubfoot. Int Orthop 1997; 21: 137-141.
[13] Machida J, Kameshita K, Okuzumi S and Nakamura N. Flexibility of idiopathic congenital clubfeet treated by posteromedial release without talocalcaneal joint release. J Pediatr Orthop B 2014; 23: 254-259.
[14] Limpaphayom N, Kerr SJ and Prasongchin P. Idiopathic clubfoot: ten year follow-up after a soft tissue release procedure. Int Orthop 2015; 39: 81-86.
[15] Burghardt RD, Tettenborn LP and Stucker R. Growth disturbance of the distal tibia in patients with idiopathic clubfeet: ankle valgus and anteflexion of the distal tibia. J Pediatr Orthop 2016; 36: 343-348.
[16] Smith PA, Kuo KN, Graf AN, Krzak J, Flanagan A, Hassani S, Caudill AK, Dietz FR, Morcuende J and Harris GF. Long-term results of comprehensive clubfoot release versus the Ponseti method: which is better? Clin Orthop Relat Res 2014; 472: 1281-1290.
[17] Hosseinzadeh P, Peterson ED, Walker J, Muchow RD, Iwinski HJ, Talwalkar VR and Milbrandt TA. Residual forefoot deformity predicts the need for future surgery in clubfeet treated by Ponseti casting. J Pediatr Orthop B 2016; 25: 96-98.
[18] Aydin BK, Senaran H, Yilmaz G, Acar MA and Kirac Y. The need for Achilles tenotomy in the Ponseti method: is it predictable at the initiation or during the treatment? J Pediatr Orthop B 2015; 24: 341-344.
[19] Mahan ST, Spencer SA and Kasser JR. Satisfactory patient-based outcomes after surgical treatment for idiopathic clubfoot: includes surgeon's individualized technique. J Pediatr Orthop 2014; 34: 631-638.
[20] Bocahut N, Simon AL, Mazda K, Ilharreborde B and Souchet P. Medial to posterior release procedure after failure of functional treatment in clubfoot: a prospective study. J Child Orthop 2016; 10: 109-117.
[21] Bashi RH, Baghdadi T, Shirazi MR, Abdi R and Aslani H. Modified Ponseti method of treatment for correction of neglected clubfoot in older children and adolescents--a preliminary report. J Pediatr Orthop B 2016; 25: 99-103.
[22] Banskota B, Banskota AK, Regmi R, Rajbhandary T, Shrestha OP and Spiegel DA. The Ponseti method in the treatment of children with idiopathic clubfoot presenting between five and ten years of age. Bone Joint J 2013; 95-B: 1721-1725.
[23] Faizan M, Jilani LZ, Abbas M, Zahid M and Asif N. Management of idiopathic clubfoot by ponseti technique in children presenting after one year of age. J Foot Ankle Surg 2015; 54: 967-972.
[24] Faldini C, Traina F, Di Martino A, Nanni M and Acri F. Can selective soft tissue release and

cuboid osteotomy correct neglected clubfoot? Clin Orthop Relat Res 2013; 471: 2658-2665.
[25] Gupta P and Bither N. Ilizarov in relapsed clubfoot: a necessary evil? J Pediatr Orthop B 2013; 22: 589-594.
[26] Khanfour AA. Ilizarov techniques with limited adjunctive surgical procedures for the treatment of preadolescent recurrent or neglected clubfeet. J Pediatr Orthop B 2013; 22: 240-248.
[27] Jauregui JJ, Zamani S, Abawi HH and Herzenberg JE. Ankle range of motion after posterior subtalar and ankle capsulotomy for relapsed equinus in idiopathic clubfoot. J Pediatr Orthop 2017; 37: 199-203.
[28] Zimmerman CC, Nemeth BA, Noonan KJ, Vanderbilt TP, Winston MJ, O'Halloran CP, Sund SA, Hetzel SJ and Halanski MA. Reliability of radiographic measures in infants with clubfoot treated with the Ponseti method. J Child Orthop 2015; 9: 99-104.
[29] Shabtai L, Hemo Y, Yavor A, Gigi R, Wientroub S and Segev E. Radiographic indicators of surgery and functional outcome in Ponseti-treated clubfeet. Foot Ankle Int 2016; 37: 542-547.
[30] O'Halloran CP, Halanski MA, Nemeth BA, Zimmermann CC and Noonan KJ. Can Radiographs predict outcome in patients with idiopathic clubfeet treated with the Ponseti method? J Pediatr Orthop 2015; 35: 734-738.