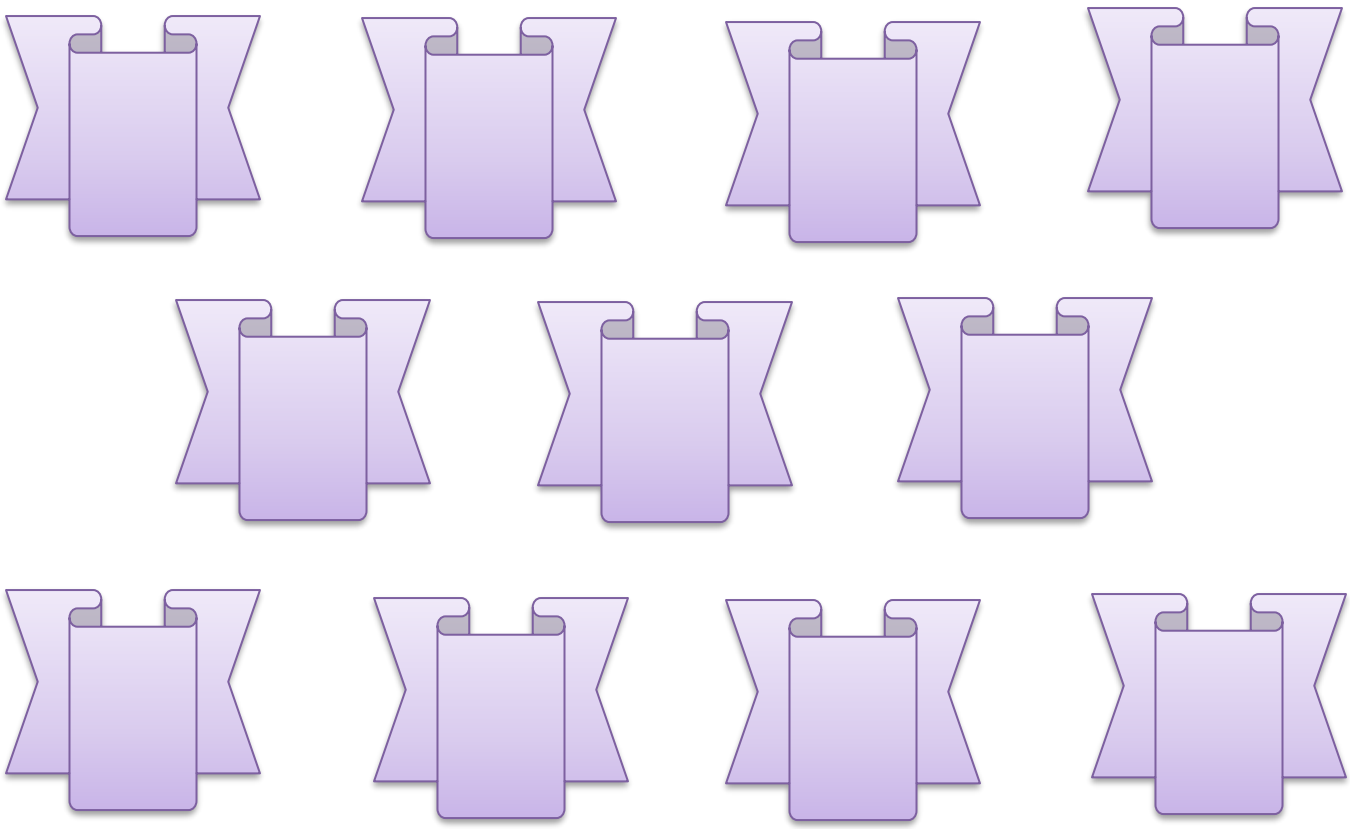
International Journal of Medical Arts

Volume 5, Issue 11, November 2023

https://ijma.journals.ekb.eg/



Print ISSN: 2636-4174

Online ISSN: 2682-3780

Available online at Journal Website
https://ijma.journals.ekb.eg/
Main Subject [Orthopedics]

Original Article

Outcome of Different Surgical Techniques for Management of Adolescent Tibia Vara; Systematic review

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Article information

Received: 02-11-2023

Accepted: 11-12-2023

DOI: 10.21608/IJMA.2023.246192.1852.

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Citation: Rizk AA, Abulsoud MI, Shamma AA. Outcome of Different Surgical Techniques for Management of Adolescent Tibia Vara; Systematic review. IJMA 2023 November; 5 [11]: 3796-3807. doi: 10.21608/IJMA.2023.246192.1852.

ABSTRACT

Background: Adolescent tibia vara [ATV] is a multiplanar malformation that can cause diminished function and permanent damage. ATV is believed to be a multifaceted developmental disease of the proximal tibia, which results in a malformation of the varus and procurvatum. In genetically vulnerable individuals, this disorder may also be partially attributed to mechanical strain.

The Aim of the work: This pooled analysis goal is to evaluate and compile the data about the efficacy and complications of the most popular surgical lines of treatment of tibia vara in adolescents: osteotomy, Ilizarov, and hemiepiphysiodesis.

Methods: Considering the search strategy, a literature study was conducted from 2010 to 2020 in the Web of Science, PubMed, Scopus, and Cochrane datasets. Studies were selected if it included. This systematic review had 15 published papers with a total sample size of 357 limbs.

Results: Temporal hemiepiphysiodesis is used effectively to treat mild/moderate ATV in patients with sufficient growth. Temporal hemiepiphysiodesis has been linked to an elevated failure and recurrence rate of approximately 28.4%. In managing ATV, a modified Rab osteotomy with minimal fixation using two or three screws yields encouraging outcomes. However, the post-operative time of healing is affected by BMI. Thus, it's not the best choice for obese patients with ATV. For correcting mild to moderate ATV, medial opening wedge high tibial osteotomy—with or without a bone graft—is an appropriate approach.

Conclusion: The best surgical technique for adolescent tibia vara depends on the patient's circumstances. Osteotomy is generally preferred over hemiepiphysiodesis due to its lower recurrence rate. The use of simple circular frame fixation with proximal tibial osteotomy is the ideal option for treating neglected ATV, mainly when the patient is obese and has severe deformities.

Keywords: Adolescent Tibia Vara; Osteotomy; Ilizarov; Hemiepiphysiodesis.

INTRODUCTION

Tibia vara [TV], also known as Blount's disease, is a pathologic complicated angular malformation of the lower extremities centred at the upper tibial physis that results in a bow leg malformation [1, 2]. The hallmark of TV is a localized lack of growth in the posteromedial region of the upper tibial metaphysis and epiphysis. TV is a growth disease characterized by a progressive angular deformity of the tibia brought via a disturbance in the growth of the epiphyseal cartilage and metaphysis. This results in a varus [bowleg] deformity, with medial twisting of the tibia and flexion of the diaphysis [shaft] on the proximal tibial epiphysis [3].

TV pathogenesis is believed to result from imbalanced biomechanical load distribution and hereditary predisposition. Pathologic varus malformation is caused by asymmetrical growth resulting from biomechanical loading of the proximal tibial physis [1, 2]. People with greater thigh circumference and BMI may have varus moments, which are caused by their gait pattern and can worsen the deformity. Frequently, there may be concomitant abnormalities of the distal tibia and femur [varus or valgus] [4].

Nine decades after the initial description, TV treatment is still complex. It is necessary to consider the femur's role in the varus malalignment [5]. Restoring limb alignment, joint congruency, equalizing limb length, and meticulous follow-up are all part of the management, as recurrences can happen in as many as 50% of cases [6, 7].

The correct position of the leg can be restored with the use of several surgical methods, including Circular Ilizarov external fixation [8, 9], non-circular external fixation [10, 11], internal fixation [12, 13], hemi hemi-plateau elevation with / without epiphyseal distraction [14, 15], double elevating osteotomies [16], serrated W/M osteotomies [17], epiphyseal stapling [18], Taylor Spatial Frame correction [19], and hemiepiphysiodesis by guided growth [20].

The simplicity of applying the technique, the period it takes to complete curvature repair in clinical and radiographic pictures, the avoidance of recurrence, and the comorbidities [i.e., nerve injury, infection, non-union, malunion] vary among all these procedures [7, 21].

As far as we know, no prior systematic review has evaluated the effectiveness of different techniques in treating adolescent tibia vara [ATV] with a focus on the success rate and the optimal technique for each case. This pooled analysis goal is to evaluate and compile the data about the efficacy and complications of the most popular surgical lines of treatment of tibia vara in adolescents; osteotomy, Ilizarov and hemi-epiphysiodesis and the rate of recurrence of each of them.

METHODS

The PRISMA [Preferred Reporting Items for Systematic Reviews and Meta-analyses] guidelines were followed in conducting this systematic study [22]. Search framework using PICOS [participants, intervention, outcome, and study design] model: Participants: studies including patients with adolescent tibia vara, intervention [exposure]: studies including any surgical intervention [osteotomy, hemiepi-physiodesis, Ilizarov], outcome: radiological outcomes, recurrence and complications, study design: Any study design except case report or animal studies.

Eligibility criteria: We included studies that included patients who suffered from adolescent tibia vara [above ten years] and published after 2000. We excluded studies including children below ten years old, studies published before 2000, non-English studies, case reports, animal studies, non-full text studies [abstract only], or letters to the editor.

Literature search: The literature search was operated by MesH terms in the Web of Science, PubMed, Scopus, and Cochrane datasets in 1/1/2023 applying the advanced search approach: [Adolescent OR “late-onset” [MesH]] AND [“tibia vara”[MesH] OR “Blount disease” OR “Osteochondrosis Deformans Tibiae”[MesH]] AND [Osteotomy[MesH] OR Hemiepiphysiodesis[MesH] OR Ilizarov[MesH]].

Studies selection: Summaries and paper titles were used to filter the search findings. Applying Endnote software, the redundant studies were eliminated. After identifying relevant research, the papers were obtained and examined to ascertain their appropriateness for eventual inclusion. A manual search was conducted for more articles in the citation lists of all the relevant papers.

Data extraction: Applying a standard Microsoft Excel software data extraction form,

the researcher obtained the following information from the included articles: study characteristics as the author, year, study design, patient number, follow-up period, patient characteristics as [age, sex, and BMI], intervention characteristics, functional outcome, and radiological outcomes, complications, and recurrence.

Quality assessment: The level of quality was evaluated using the Joanna Briggs Institute [JBI] Critical Appraisal Tool. The 10-item JBI checklist for the series of cases assesses the following: if subjects were included consecutively; the reliability of the detection approaches; the recording of demographic details, clinical data, and outcomes; the presentation of clinic demographic data; the relevance of the method of statistical analysis; and finally, if the eligibility criteria were met [23].

Synthesis methods: Using the employed methodology, the retrieved data were narratively synthesized in groups. We performed a narrative synthesis in accordance with the Synthesis without Meta-Analysis [SWiM] guidelines [24] and presented the impact variables found in the selected publications.

Success rate: The acceptable degree of improved function in ATV can vary based on how severe the deformity is and the treatment goals. In general, the intervention aims to return normal alignment and function of the affected leg to the greatest extent possible [25].

Clinical outcome scores before and after surgery were retrieved. The most recent documented follow-up clinical values were applied. When a favourable or excellent outcome was observed during follow-up and paired with a recognized grading system, the therapeutic plan was considered successful. To be clear, if an ankle showed a post-operative functioning score of 80 or higher at the last follow-up, the treatment was deemed effective. The success rate was defined as the proportion of favourable and excellent functioning results [26].

RESULTS

Searching on scientific databases [PubMed, Scopus, Web of Science, and Cochrane Library] using an advanced search strategy resulted in 390 papers, and 20 were collected from other sources. One hundred eighty-nine duplicated papers were excluded using endnote software. Then, the researcher performed title and abstract screening on the remaining 221 papers. During this process, 168 studies were excluded due to different causes, 10 non-English studies, 145 papers included not-adolescent tibia vara, and 13 studies abstract only available. After title and abstract screening, full-text screening was performed on 53 articles. Throughout full-text screening, 38 studies were excluded [6 case reports, 4 review articles, 13 other techniques, 10 infantile tibia vara, and 5 studies published before 2000]. The remaining 15 articles were involved in our pooled analysis [Figure 1].

The summary of the included studies is illustrated in Table 2. The study design was a case series in all included studies. The total sample size was 357 limbs. From them 7 patients [10 limbs] underwent external fixation using Ilizarov in one study [27], 95 patients [102 limbs] in 5 studies [28-32] underwent hemiepiphysiodesis, 50 patients [58 limbs] in 3 studies underwent tibial osteotomy, and 112 patients [129 limbs] in 6 studies underwent tibial osteotomy combined with external fixation. The age of patients included was more than 11 years ranging from [11 to 21 years old]. The majority of included patients were obese. The time of external fixation in 4 studies ranged from 11 to 16 weeks, and the follow-up period ranged from 5 to 48 months.

Quality assessment: The quality assessment was performed using the JBI checklist. Among the included studies, three scored ten out of ten [8, 33, 34], and one study scored six out of ten [35] with an overall mean score of 8.3.

In all included studies, there were clear inclusion criteria, relevant techniques for each participant in the case series, and condition identification for each participant using valid methods. The last reported criteria were appropriate statistical analysis [9/15]. The outcome was reported in 11 included studies. Reporting of clinical information of the participants was evident in all included studies. In a recent retrospective study performed by **Zein *et al.*** [36] to assess the using of proximal tibial osteotomy with Ilizarov external fixator for adolescent tibia vara. The knee score improved from 51±11.2 preoperative to 94± 6.8 post-operative. The functional outcome was further illustrated in Table [4]. The complication rate was 90% after external fixation using Ilizarov followed by 52% after external fixation combined with osteotomy. superficial wound infection after external fixation was 80% and

decreased to 64% when combined with tibial osteotomy. The highest recurrence rate was after hemiepiphysiodesis. 28.4% of included patients underwent further correction attempt using tibial osteotomy technique [Table 5]. The recurrence rate was higher after hemiepiphysiodesis [41.4%] than after osteotomy technique [3.4%] or osteotomy combined with external fixation [2.4%] [p=0.00].

Patients' satisfaction: Patients' satisfaction was reported in only three studies. In the **Hegazy *et al.*** [37]'s study, at the end follow-up, every patient expressed satisfaction with their operation. In **Aly *et al.*** [38], six months after the cast was taken off and full weight bearing was achieved postoperatively, there was a notable improvement in the Lysholm score, with 15 patients scoring excellent [78.9%], Two good [10.5%], one fair [5.2%], and one poor [5.2%]. In the **EL-Gafary *et al.*** [27] study, no patients needed subsequent operation to achieve satisfactory results.

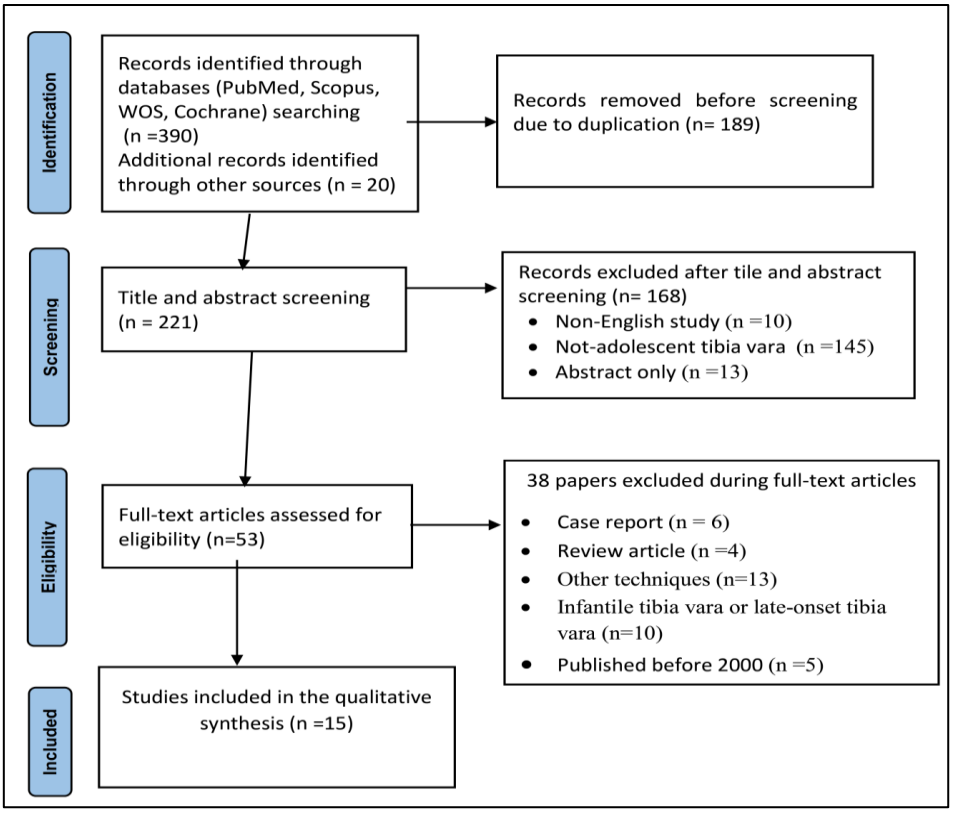

Figure [1]: PRISMA flow chart for studies identification and screening process

Table [1]: Quality assessment

	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Total score
EL-Gafary *et al.* [27]	Yes	Yes	Yes	N/R	Yes	Yes	Yes	No	Yes	No	7
Radwan [39]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No	No	7
Danino *et al.* [30]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	N/R	Yes	8
Heflin *et al.* [29]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No	8
Mcintosh *et al.* [28]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	9
Murphy *et al.* [32]	Yes	Yes	Yes	N/R	No	Yes	Yes	Yes	Yes	Yes	8
Oto *et al.* [31]	Yes	Yes	Yes	No	No	Yes	Yes	Yes	Yes	NO	7
Aly *et al.* [38]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	9
Eidelman *et al.* [35]	Yes	Yes	Yes	N/R	N/R	Yes	Yes	No	NO	Yes	6
Gordon *et al.* [8]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	10
Griswold *et al.* [34]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	10
khaled *et al.* [40]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	NO	9
Hegazy *et al.* [37]	Yes	Yes	Yes	No	No	Yes	Yes	Yes	Yes	Yes	8
Sachs *et al.* [33]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	10
Zein *et al.* [36]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	N/R	Yes	9

The summery of included studies was further illustrated in Table 3.

Table [2]: Summary of included studies

Author	Study design	Sample size	Intervention	Age [year]	Male	BMI	Outcome	Time of external fixation weeks	Follow-up
EL-Gafary *et al.* [27]	case series	7 [10 limbs]	Ilizarov	14	3	NR	The Ilizarov stabilization and malformation repair took an average of 14 weeks [range: 12–30 weeks]. In every patient, the 4.5 cm mean shortness [3.5-5.5cm range] was rectified, leaving a residual limb length variation of ±5mm.	NR	NR
Radwan [39]	case series	23 [26 limbs]	Hinged Ilizarov Frame and proximal tibial osteotomy	14 [11-17]	23	NR	Acute treatment of ATV with a two-ring hinge. The gradual correction Ilizarov frame is a safe technology that combines the advantages of acute and gradual correction. It reduces the requirement for operational fluoroscopy by enabling the surgeon to repair any inaccuracy at the clinic.	12 [10-14]	9 months [5-13]
Danino *et al.* [30]	Retro-spective case series	28 [32 limbs]	Temporal hemiepiphysiodesis with tension band plating	NR	NR	NR	During the follow-up period, 87.5% of the deformity corrections have been achieved.	NR	24.5 months
Heflin *et al.* [29]	Retro-spective case series	9	Temporal hemiepiphysiodesis with tension band plating	13.5	8	27.53	For treating ATV, temporary hemiepiphysiodesis with tension-band plating wasn't the optimum option.	NR	30.45months
Mcintosh *et al.* [28]	Retro-spective	49	Lateral tibial hemiepiphysiodesis	13.4	46	40.7	In 66% of the individuals, the lateral hemiepiphysiodesis was not effective.	NR	39.6
Murphy *et al.* [32]	case series	4 [6 limbs]	lateral proximal tibial hemiepiphyseodesis single transphyseal screw	12.3	NR	36	When a patient has enough growth, hemiepiphysiodesis with transphyseal screws is a valuable method for correcting deformity in adolescents with TV.	NR	23 months
Oto *et al.* [31]	Retro-spective Case series	5 [6 limbs]	eight-plate [Orthofix] hemiepiphysiodesis	13 [12-14]	3	33.5	It is not advised to employ a tension band plate hemiepiphysiodesis [eight-plate, Orthofix] to treat obese children with severe ATV..	NR	22 [13 to 31].
Aly *et al.* [38]	Case series	19 [25 legs]	Modified oblique high tibial osteotomy with minimal fixation	17.23 ±5.27	16	32.05	A modified Rab osteotomy requiring little fixation effectively repaired the procurvatum, internal torsion, and varus deformity. 10.2 weeks are required for a successful union.	NR	3.4 years
Eidelman *et al.* [35]	Retro-spective	8	Tibial osteotomy and Taylor spatial frame	14.6 [14–17]	100%	NR	Every patient had their abnormalities precisely corrected anatomically.	NR	3.7 years [2.1–4.1]
Gordon *et al.* [8]	Case series	15 [19 limb]	Osteotomy and Ilizarov ring external fixator	14.9	NR	113kg	This strategy will lower the chance of developing early-stage degenerative arthritis in the knee.	NR	5
Griswold *et al.* [34]	Case series	9 [11 tibia]	OPENING WEDGE OSTEOTOMY	15.01	NR	137.1kg	To repair ATV, proximal opening wedge osteotomy [POWO] is a repeatable, safe, and efficient procedure.	NR	1.45 years
Khaled *et al.* [40]	Retro-spective	22	Biplanar medial opening wedge osteotomy without a graft	16 [14-18]	12	NR	Healing took eight weeks on average.	NR	2 to 4 yr
Hegazy *et al.* [37]	Case series	13 [19 limbs]	Single-stage V-shaped osteotomy using Ilizarov fixator	14±0.8	9	88.2 kg	This method offers a good foundation for a consistent approach to treating severe ATV. The mean duration within the sample was 11.2±1.2 weeks.	11.2±1.2 weeks	16.8±4.4
Sachs *et al.* [33]	Retro-spective case series	23 [25 limbs]	Taylor spatial frame and tibial osteotomy with or without fibular osteotomy	14.7 [13-21]	21	NR	ATV repair did not require fibular osteotomy or fixation.	15.9 weeks	NR
Zein *et al.* [36]	Retro-spective case series	30 [32 tibiae]	Proximal tibial osteotomy and Ilizarov external fixator	16.6± 2.7	26	NR	When treating cases of late-onset TV, particularly in patients with severe deformities, acute correction combined with simple circular frame fixation is a great option.	12.6 [± 2.3] weeks	33.22± 6.77

Table [3]: Summary of outcome

Author	MAD	TFA	MPTA	LDTA	PPTA	Rotation	LDFA	Functional score	Other angles
EL-Gafary *et al.* [27]	NR	27.1±8.1//2.8±1.9	73.6±13.38//87.6±0.92	NR	80.4±5.62//79.1 ±3.39, correction of Tibial Slope 9.65±0.32//10.82±4.7	NR	NR	7 excellent, 2 good	NR
Radwan [39]	35 [20-50]//5 [0-10 mm].	-25 [range -30-20] of ITT improved to 5º [range 0-10] of ETT.	70º [60-80]//90º [85-95],	NR	72 [64-80]//80º [78-82]	NR	NR	NR	NR
Danino *et al.* [30]	NR	NR	NR	NR	NR	NR	77.2 ± 6.1//86.6±6.3	NR	NR
Heflin *et al.* [29]	Incomplete neutral MA correction 6 limbs, complete 9 limbs	NR	NR	NR	NR	Torsional correction success in 2 and failed in one	NR	NR	NR
Mcintosh *et al.* [28]	97 [22-150]//73 [34 - 154]	NR	76 [61-87]//78 [53-94]	NR	NR	NR	94 [87-103]//92 [80-105]	NR	NR
Murphy *et al.* [32]	49.5±20 [28-83]//20.8±10.3 [varus 27- valgus -28]	NR	82.2±4//92.2±2.1	NR	NR	NR	91±3.3//88±3.2	LLD, leg length discrepancy 5mm,2.8 [in 2 patients]	
Oto *et al.* [31]	68.45±17.5//72.32±34.6	–34.3± 6.7//5.7°± 2.8	81 [76 to 84]//80 [75 to 84]	NR	NR	NR	NR	NR	NR
Aly *et al.* [38]	76.13±23.29/5.74±7.3	-20.04±5.24//2.04±4.07	75.57±3.29//87.96 ±3.05	87.5±3.23//87.04±1.77	77.48±8.5//82.65 ±2.66	-20.22 ±7.71//5.65 ±3.42	87.09 ±1.62//86.83±1.34	Lysholm score: 15 excellent, 2 good, 1 fair and 1 poor	
Eidelman *et al.* [35]	55.8 [44–77]// 4.9 [2–11] mm	NR	71.4 [67–77] //87.1 [85–89]	NR	75.1[68–81]	improvement 10 [5–15]	NR	NR	NR
Gordon *et al.* [8]	108 [41-208]//1 [20 to –30]	NR	71 [61 to 77]//88 [83 to 98]	85 [79-93] //89 [82-93]	71 [58-88]//77 [57-89]	NR	95 [82-102] //87 [83-98]	NR	NR
Griswold *et al.* [34]	88.7 [43 - 132]/24.8 [5 - 49]	NR	79 [70 - 84]/89.54 [84-94]	NR	NR	NR	95.82 [90 - 101]//93.64 [85 - 98]	NR	NR
Khaled *et al.* [40]	NR	13.6 [9 to 23]//2.6	76.7 [68-81]// 88 [86-91]	NR	NR	NR	NR	NR	NR
Hegazy *et al.* [37]	NR	34 [25-41]//−2.0 [−5.0–5]	NR	NR	NR	NR	NR	The angle of medial tibial plateau depression 38 [27–56]//7[0–11]; FCTSA 54[42-78]/ /86[82–92]	
Sachs *et al.* [33]	NR	NR	group A: 74// 89; group B: 75//91	group A: 83// 92; group B: 85// 93	group A: 76//80, group B:74//82	NR	post-operative group A 93; group B 95	NR	NR
Zein *et al.* [36]	56.2 ± 8.3//2.8 [± 1.6] mm	NR	65.7° [± 7.8]//89.8° [± 1.7]	NR	65.7°± 7.8 //89.8°± 1.7	NR	NR	HHS Knee Score: 51±11.2; 94± 6.8; 91% good, excellent result	NR

Preoperative //postoperative value; MAD: medial deviation of mechanical axis; TFA: tibial femoral angle; MPTA: medial proximal tibial angle; LDTA: lateral distal tibial angle; PPTA: posterior proximal tibial angle; LDFA: lateral distal femoral angle; LDFA: lateral distal femoral angle; FCTSA: femoral condyle tibial shaft angle; NR: not-reported; ITT: Internal tibial torsion; ETT: External tibial tortion.

Table [4]: Complications, recurrence rate, success rate

Author	Sample size	Over-correction	Under-correction	Superficial wound infection/ pin tract infection	Implant failure	Other complications	overall	Success rate	Recurrence
EL-Gafary *et al.* [27]	10 limbs	1	-----	8	-----	-----	9	---	-----
Overall external fixation	10	1 [2.7%]	----	8 [80%]	----	------	9 [90%]	---	no
Danino *et al.* [30]	32 limbs	-----	-----	-----	broken screw 1, screw failure 2	growth plate closure [3], early restricted ROM 1	7	28 [87.5%]	
Heflin *et al.* [29]	9 limbs	1	4	-----	Broken screw 2, screw migration 1	-----	7	3[34%]	2 osteotomies
Mcintosh *et al.* [28]	49 limbs	-----	-----	-----	-----	-----	no	---	21 osteotomies
Murphy *et al.* [32]	6 limbs	-----	-----	-----	-----	-----	no	---	0
Oto *et al.* [31]	6 limbs	-----	-----	-----	-----	-----	no	---	6 osteotomies
Overall hemiepi-physiodesis	102	1 [0.98%]	4 [3.92%]	No	6 [5.88%]	4 [3.92%]	14 [13.7%]	31/41 [75%]	29 [28.4%]
Aly *et al.* [38]	25 limbs	-----	2	2	-----	tingling in the lateral aspect of the leg 1	5 [20%]	22 [89.4%] *	-----
Griswold *et al.* [34]	11 limbs	-----	-----	1	-----	seroma 1, wound abscess 1	3	---	-----
Khaled *et al.* [40]	22 limbs	-----	-----	------	-----	-----	---	-----	1
Overall osteotomy	58 limbs	----	2 [3.44%]	3[5.17%]	no	3[5.17%]	8 [13.8%]	22/25 [89.4%]	1 [1.72%]
Eidelman *et al.* [35]	8 limbs	-----	-----	7	-----	Bleeding after injury of genicular artery by half-pin 1	8		-----
Gordon *et al.* [8]	19 limbs	-----	-----	15	-----	-----	15		-----
Hegazy *et al.* [37]	19 limbs	-----	-----	19	-----	-----			-----
Sachs *et al.* [33]	25 limbs	-----	-----	7 in group A and 4 in group B	-----	-----	11		-----
Zein *et al.* [36]	32 limbs	3	---	8	-----	-----	11	29 [91%] *	no
Radwan [39]	26 limbs	-----	-----	23	-----	-----	23		no
Overall osteotomy combined with external fixation	129	3 [2.9%]	no	83 [64.34%]	----	1 [0.77%]	68 [52.7%]	29/32 [91%]	---

*calculated from functional score

Table [5]: Evaluation for recurrence rate after surgical treatment

Techniques	No of studies	sample size	Recurrence	Percentage	X^2	P value
External fixation	**1**	10	0	0.0%	48.628	**< 0.001**
Hemiepiphysiodesis	**4**	70	29	41.4%		
Osteotomy	**3**	58	2	3.4%		
Osteotomy combined with external fixation	**4**	85	2	2.4%		

DISCUSSION

ATV is a multiplanar malformation that can cause diminished function and permanent damage. ATV is believed to be a multifaceted developmental disease of the proximal tibia, which results in a malformation of the varus and procurvatum. In genetically vulnerable individuals, this disorder may also be partially attributed to mechanical strain [25]. The Heuter-Volkmann principle is considered to cause physeal damage when severe biomechanical stresses are applied to the medial proximal tibia. This leads to asymmetric medial physeal growth restriction and pathological varus deformities [41, 42].

Restoring the joint's mechanical axis and alignment, enhancing function, and lowering the likelihood of early joint deterioration should be the objectives of treatment [43].

Because of the patient's posture and closeness to skeletal maturation, conservative treatment—bracing, for example—is unsuccessful for the late-onset variety and shouldn't be taken into consideration. To identify and treat every contributing factor to the malformation, comprehensive surgical preparation is necessary before attempting a surgical solution. Creating the perfect reconstructive design requires careful pre-operative preparation and deformity assessment, considering all concomitant abnormalities and skeletal development [25].

The two mainstays of surgical options are either osteotomy or growth regulation, both of which can be performed using procedures for either progressive or acute repair [40].

As far as we know, this is the first pooled analysis focusing on the efficacy of various surgical techniques in treating adolescent tibia vara. This systematic review included 15 published papers with a total sample size of 357 limbs. From the 7 patients [10 limbs] underwent external fixation using Ilizarov in one study, 95 patients [102 limbs] underwent hemiepiphysiodesis in 5 studies, 50 patients [58 limbs] in 3 studies underwent tibial osteotomy, and 112 patients [129 limbs] in 6 studies underwent tibial osteotomy combined with external fixation. The majority of included patients were obese. Although not always, patients with ATV are usually obese; in the adolescent cohort, 90% of cases were observed to be obese. The degree of the deformities and the patient's residual growth are taken into account when treating ATV [41, 44].

Our study investigated that temporal hemiepiphysiodesis has a success rate of 87.5% in treating mild to moderate adolescent tibia vara with sufficient growth. However, the use of temporal hemiepiphysiodesis isn't the best choice for the treatment of obese patients with severe ATV.

ATV can be effectively treated by lateral proximal tibial hemiepiphysiodesis, also known as directed growth, especially in individuals with a physis that functions, enough growth potential, and mild to moderate deformities [32, 34, 45].

This procedure is appealing since it focuses straight on the point of deformity, has a quick recovery period, and requires minimal invasiveness; nonetheless, outcomes for this patient group can vary; thus, caution is advised. Up to 50% of instances have been documented to have inadequate correction, having older patients [age 14] and those with higher BMIs [45] and more deformities having a higher failure rate [46].

Obesity patients also have concerns about implant breakage. Recent results, however, indicate that hemiepiphysiodesis alone may be able to fully treat 88% or more of individuals with ATV [47, 48].

Many methods have been employed with good results, such as hemiepiphysiodesis with a tension band plate and screw construct, as first proposed by **Stevens** [19], or percutaneous transphyseal screws, which were recently shown to produce an efficient and secure correction with little chance of failure of the implant even in obese individuals [32].

Our result confirmed the highest failure and recurrence rate after hemiepiphysiodesis; 28.4% underwent further correction attempts using the tibial osteotomy technique. **Scott** [49] reported untoward events after hemiepiphysiodesis, including backing out of implants, repeated deformity after hardware elimination, and even inhibition of growth after physeal staples introduction.

Schroerlucke *et al.* [50] discovered that 44% of their ATV patients' deformities could not be corrected by the extraperiosteal plates. **Oto *et al.*** [31] stated that none of their ATV patients were able to make the necessary corrections using the plate.

In a previous systematic review, after temporary hemipiphysiodesis, patients with ATV had a 49% reoperation rate. They expected an overestimated number and justified it with selection and historical bias [46].

Children who have had aberrant physis abnormalities, including ATV or Rickets, have frequently needed unscheduled procedures in the future, and their outcomes have been less predictable [51]. This may be explained by the fact that, according to hand imaging, Blount patients typically have more developed skeletal ages than chronological ages, making it more challenging to determine how much growth will remain. Being older at hemiepiphysiodesis increases the chance that skeletal maturity won't produce a sufficient correction. This could have to do with the restricted growth that teenagers still have and the advanced bone age that these fat children have been documented to have [52].

For many years, tibial osteotomy has been a popular surgical procedure for treating ATV, particularly in cases when kids are getting close to adulthood. Osteotomy, in contrast to directed growth, is independent of age or residual growth and permits complete repair of all deformity elements [varus, procurvatum, internal torsion, leg length disparity]. According to the surgeon's preference, several fixation techniques can be used with either an acute or gradual repair [34, 45].

Our systematic review demonstrated that in the treatment of ATV, a modified Rab osteotomy with minimum fixation by two or three screws exhibits encouraging outcomes with the satisfactory repair of varus deformity [coronal plane], internal torsion [axial plane], and procurvatum [sagittal plane]. However, the post-operative time of healing is affected by BMI. Thus, it's not the best choice for obese patients with ATV. One effective method for treating mild to moderate ATV is medial opening wedge high tibial osteotomy, either with or without a bone graft.

An osteotomy of the proximal tibia using an opening or closing wedge can be used to treat acute ATV. For patients who wish to avoid external fixation and have mild to moderate deformities, this is a desirable choice. Both plates and intramedullary nails can be used for internal fixing procedures. Immediate weight bearing, avoiding intricate corrective programs, and a decreased chance of infection and pin site issues are some potential advantages. However, this has to be evaluated against the higher risk of delayed union, compartment syndrome, and neurovascular problems [25].

Furthermore, while some authors have claimed that acute correction is generally less reliable than other methods, others have found little evidence to support a preference for one method over another. For these reasons, gradually, treatment methods for complex tibial defects have become widely accepted [53].

Our study revealed that gradual correction using a hinged two-ring Ilizarov frame requires a longer time for repair of deformity when used alone and has been linked to an elevated rate of superficial pin tract infections and a difference in residual limb length. However, the use of simple circular frame fixation with proximal tibial osteotomy decreased the correction time and the early knee degenerative arthritis risk. Moreover, when treating cases of neglected ATV, it is a great option, particularly when treating patients who are obese and have severe deformities.

For TV, gradual repair via external fixation and proximal tibial osteotomy is commonly used. Gradual repair makes use of Ilizarov's initial description of distraction osteogenesis. In actuality, a hexapod external fixator is usually utilized for this. However, other methods, such as monolateral approaches, are rarely employed [25].

This technique's main advantage is its capacity to treat every aspect of deformity at the same time, gradually, and with the least amount of invasiveness. Among other things, the patient may benefit from increased corrective precision, a quicker healing period, increased safety for the local neurovascular structures, and the capacity to permit early weight-bearing and range of motion [54, 55].

Gordon *et al.* [8] reported that if the femur varus is greater than five degrees, it is advised to repair the tibial and femoral abnormalities at the same time. The authors present a series of surgical procedures that include proximal tibial valgus osteotomy using an Ilizarov external fixator in combination with either plate-assisted distal femur valgus osteotomy or, in cases where growth is still present, hemi-epiphysiodesis of the lateral distal femur. This all-encompassing strategy, which addressed each contributing deformity independently,

prevented shearing forces that could have been seen with severe joint line obliquity and restored both joint mechanical and horizontal lines. The present framework for treating ATV is based on the integrated approach's guiding principles [56].

Conclusion: For treating ATV, temporal hemiepiphysiodesis is not the best option and is linked to an elevated recurrence rate because it is challenging to anticipate remaining growth effectively. A modified Rab osteotomy with minimal fixation using two or three screws yields encouraging outcomes for the treatment of non-obese patients with ATV. For correcting mild to moderate ATV, medial opening wedge high tibial osteotomy—with or without a bone graft—is an appropriate approach. For correcting mild to moderate ATV, medial opening wedge high tibial osteotomy—with or without a bone graft—is an appropriate approach. Using the Ilizarov frame alone requires a longer time for correction and is associated with a higher rate of superficial pin tract infections and a difference in residual limb length. The use of simple circular frame fixation with proximal tibial osteotomy is the ideal option for treating neglected ATV, mainly when the patient is obese and has severe deformities. The recurrence rate was higher after hemiepiphysiodesis [41.4%] than after osteotomy technique [3.4%] or osteotomy combined with external fixation [2.4%] [p=0.00].

Financial and non-financial relations and activities of interest: None

REFERENCES

1. Jamil K, Abdul Rashid AH, Ibrahim S. Tibia vara and slipped upper femoral epiphysis: is there an association? J Pediatr Orthop B. 2015;24[1]:46-9. doi: 10.1097/BPB.0000000000000101.

2. Steinbeck KS, Lister NB, Gow ML, Baur LA. Treatment of adolescent obesity. Nat Rev Endocrinol. 2018 Jun;14[6]:331-344. doi: 10.1038/s41574-018-0002-8.

3. Hegazy M, Bassiouni H, El Hammady A, El-Morsi M. Osteotomy Methods for Treatment of Blount's Disease A Systematic Review. Benha Med J. 2020 Jun 1;37[2]:449-61. doi: 10.21608/BMFJ.2020.79643.

4. Sabharwal S. Blount disease: an update. Orthop Clin North Am. 2015 Jan;46[1]:37-47. doi: 10.1016/j.ocl.2014.09.002.

5. Lin YH, Chang FS, Chen KH, Huang KC, Su KC. Mismatch between femur and tibia coronal alignment in the knee joint: classification of five lower limb types according to femoral and tibial mechanical alignment. BMC Musculoskelet Disord. 2018;19[1]:411. doi: 10.1186/s12891-018-2335-9.

6. Accadbled F, Laville JM, Harper L. One-step treatment for evolved Blount's disease: four cases and review of the literature. J Pediatr Orthop. 2003 Nov-Dec;23[6]:747-52. PMID: 14581778.

7. Jones S, Hosalkar HS, Hill RA, Hartley J. Relapsed infantile Blount's disease treated by hemiplateau elevation using the Ilizarov frame. J Bone Joint Surg Br. 2003 May;85[4]:565-71. doi: 10.1302/0301-620x.85b4.13602.

8. Gordon JE, Heidenreich FP, Carpenter CJ, Kelly-Hahn J, Schoenecker PL. Comprehensive treatment of late-onset tibia vara. J Bone Joint Surg Am. 2005 Jul;87[7]:1561-70. doi: 10.2106/JBJS.02276.

9. Coogan PG, Fox JA, Fitch RD. Treatment of adolescent Blount disease with the circular external fixation device and distraction osteogenesis. J Pediatr Orthop. 1996;16[4]:450-4. doi: 10.1097/00004694-199607000-00006.

10. Wilson NA, Scherl SA, Cramer KE. Complications of high tibial osteotomy with external fixation in adolescent Blount's disease. Orthopedics. 2007 Oct;30[10]:848-52. doi: 10.3928/01477447-20071001-04..

11. Price CT, Scott DS, Greenberg DA. Dynamic axial external fixation in the surgical treatment of tibia vara. J Pediatr Orthop. 1995 Mar-Apr;15[2]:236-43. PMID: 7745101.

12. Laurencin CT, Ferriter PJ, Millis MB. Oblique proximal tibial osteotomy for the correction of tibia vara in the young. Clin Orthop Relat Res. 1996 Jun;[327]:218-24. doi: 10.1097/00003086-199606000-00027.

13. Storen H. Operative elevation of the medial tibial joint surface in Blount's disease. One case observed for 18 years after operation. Acta Orthop Scand. 1969;40[6]:788-96. doi: 10.3109/17453676908989543.

14. Janoyer M, Jabbari H, Rouvillain JL, Sommier J, Py G, Catonné Y, Colombani JF. Infantile Blount's disease treated by hemiplateau elevation and epiphyseal distraction using a specific external fixator: preliminary report. J Pediatr Orthop B. 2007 Jul;16[4]:273-80. doi: 10.1097/01.bpb.0000210591.35652.84.

15. van Huyssteen AL, Hastings CJ, Olesak M, Hoffman EB. Double-elevating osteotomy for late-presenting infantile Blount's disease: the importance of concomitant lateral epiphysiodesis. J Bone Joint Surg Br. 2005 May;87[5]:710-5. doi: 10.1302/0301-620X.87B5.15473.

16. Hayek S, Segev E, Ezra E, Lokiec F, Wientroub S. Serrated W/M osteotomy. Results using a new

technique for the correction of infantile tibia vara. J Bone Joint Surg Br. 2000 Sep;82[7]:1026-9. doi: 10.1302/0301-620x.82b7.10507.

17. Bardier M, Senie JN, Fabre J, Gaubert J. [Temporary epiphyseal stapling of the lower limbs in children suffering from Blount's disease. An experimental study based on a hundred and sixty cases]. Ann Chir. 1982 Jun;36[6]:396-401. French. PMID: 7125551.

18. Feldman DS, Madan SS, Koval KJ, van Bosse HJ, Bazzi J, Lehman WB. Correction of tibia vara with six-axis deformity analysis and the Taylor Spatial Frame. J Pediatr Orthop. 2003 May-Jun;23[3]:387-91. PMID: 12724607.

19. Stevens PM. Guided growth for angular correction: a preliminary series using a tension band plate. J Pediatr Orthop. 2007;27[3]:253-9. doi: 10.1097/BPO.0b013e31803433a1.

20. Stanitski DF, Srivastava P, Stanitski CL. Correction of proximal tibial deformities in adolescents with the T-Garches external fixator. J Pediatr Orthop. 1998 Jul-Aug;18[4]:512-7. PMID: 9661864.

21. Zayer M. Hemicondylar tibial osteotomy in Blount's disease. A report of 2 cases. Acta Orthop Scand. 1992 Jun;63[3]:350-2. doi: 10.3109/17453679209154801.

22. Beller EM, Glasziou PP, Altman DG, Hopewell S, Bastian H, Chalmers I, *et al.*; PRISMA for Abstracts Group. PRISMA for Abstracts: reporting systematic reviews in journal and conference abstracts. PLoS Med. 2013;10[4]:e1001419. doi: 10.1371/journal.pmed.1001419.

23. Moola S, Munn Z, Tufanaru C, Aromataris E, Sears K, Sfetcu R, *et al.* Chapter 7: Systematic reviews of etiology and risk. In: Aromataris E, Munn Z [Editors]. Joanna Briggs Institute Reviewer's Manual. The Joanna Briggs Institute, 2017. Available from https://reviewersmanual.joannabriggs.org/

24. Campbell M, McKenzie JE, Sowden A, Katikireddi SV, Brennan SE, Ellis S, Hartmann-Boyce J, Ryan R, Shepperd S, Thomas J, Welch V, Thomson H. Synthesis without meta-analysis [SWiM] in systematic reviews: reporting guideline. BMJ. 2020 Jan 16;368:l6890. doi: 10.1136/bmj.l6890.

25. Bernstein JM, Schoenleber SJ. Adolescent Blount's Disease: Reconstructive Considerations and Approach. Oper Tech Orthop. 2021 Jun 1;31[2]:100875. doi: 10.1016/j.oto.2021.100875.

26. Niemeyer P, Salzmann G, Schmal H, Mayr H, Südkamp NP. Autologous chondrocyte implantation for the treatment of chondral and osteochondral defects of the talus: a meta-analysis of available evidence. Knee Surg Sports Traumatol Arthrosc. 2012 Sep;20[9]:1696-703. doi: 10.1007/s00167-011-1729-0.

27. Mohamed M, Kamal AE, Shady FM, El-adly WY. Correction of Adolescent Tibia Vara by Ilizarov External Fixator. Med J Cairo Univ. 2019; 87[June]:2005-11. doi: 10.21608/mjcu.2019.54318.

28. McIntosh AL, Hanson CM, Rathjen KE. Treatment of adolescent tibia vara with hemiepiphysiodesis: risk factors for failure. J Bone Joint Surg Am. 2009 Dec;91[12]:2873-9. doi: 10.2106/JBJS.H.01245.

29. Heflin JA, Ford S, Stevens P. Guided growth for tibia vara [Blount's disease]. Medicine [Baltimore]. 2016 Oct;95[41]:e4951. doi: 10.1097/MD.0000000000004951.

30. Danino B, Rödl R, Herzenberg JE, Shabtai L, Grill F, Narayanan U, *et al.* The efficacy of guided growth as an initial strategy for Blount disease treatment. J Child Orthop. 2020 Aug 1;14[4]:312-317. doi: 10.1302/1863-2548.14.200070.

31. Oto M, Yılmaz G, Bowen JR, Thacker M, Kruse R. Adolescent Blount disease in obese children treated by eight-plate hemiepiphysiodesis. Eklem Hastalik Cerrahisi. 2012 Apr;23[1]:20-4. PMID: 22448825.

32. Murphy RF, Pacult MA, Barfield WR, Mooney JF 3rd. Hemiepiphyseodesis for Juvenile and Adolescent Tibia Vara Utilizing Percutaneous Transphyseal Screws. J Pediatr Orthop. 2020 Jan;40[1]:17-22. doi: 10.1097/BPO.0000000000001067.

33. Sachs O, Katzman A, Abu-Johar E, Eidelman M. Treatment of Adolescent Blount Disease Using Taylor Spatial Frame With and Without Fibular Osteotomy: Is There any Difference? J Pediatr Orthop. 2015 Jul-Aug;35[5]:501-6. doi: 10.1097/BPO.0000000000000317.

34. Griswold B, Gilbert S, Khoury J. Opening Wedge Osteotomy for the Correction of Adolescent Tibia Vara. Iowa Orthop J. 2018; 38:141-146. PMID: 30104937.

35. Eidelman M, Bialik V, Katzman A. The use of the Taylor spatial frame in adolescent Blount's disease: is fibular osteotomy necessary? J Child Orthop. 2008 Jun;2[3]:199-204. doi: 10.1007/s11832-008-0099-8.

36. Zein AB, Elhalawany AS, Ali M, Cousins GR. Acute correction of severe complex adolescent late-onset tibia vara by minimally invasive osteotomy and simple circular fixation: a case series with 2-year minimum follow-up. BMC Musculoskelet Disord. 2021 Aug 12;22[1]:681. doi: 10.1186/s12891-021-04496-y.

37. Hegazy M, Abdelatif NM, Mahmoud M, Khaled SA, Abdelazeem AH, El-Sayed MM, Abdel Karim MM, Elshazly O. Correction of severe adolescent tibia vara by a single-stage V-shaped osteotomy

using Ilizarov fixator. Eur Orthop Traumatol. 2015 Jun;6:99-105. doi: 10.1007/s12570-015-0291-5.

38. Aly AS, Abdelhamid Alsabir AR, Fahmy HA, Fayyad TA. Modified oblique high tibial osteotomy with minimal fixation for correction of adolescent tibia vara: a prospective case series study. J Child Orthop. 2021 Feb 1;15[1]:6-11. doi: 10.1302/1863-2548.15.200097.

39. Radwan MA. Correction of Adolescent Blount's Disease Deformity Using Hinged Ilizarov Frame. Orthop Res Online J. 2020;6[4]:634-7. doi: 10.31031/OPROJ.2020.06.000643.

40. Khaled M, Said G, Abubeih H, El-Sherif E. Acute correction of adolescent tibia vara with biplanar medial opening wedge osteotomy without a graft. Curr Orthop Pract. 2019 Jan 1;30[1]:47-9. doi: 10.1097/BCO.0000000000000707.

41. Firth GB, Ngcakani A, Ramguthy Y, Izu A, Robertson A. The femoral deformity in Blount's disease: a comparative study of infantile, juvenile and adolescent Blount's disease. J Pediatr Orthop B. 2020 Jul;29[4]:317-322. doi: 10.1097/BPB.0000000000000722.

42. Janoyer M. Blount disease. Orthop Traumatol Surg Res. 2019 Feb;105[1S]:S111-S121. doi: 10.1016/j.otsr.2018.01.009.

43. Phedy P, Siregar PU. Osteotomy for deformities in blount disease: A systematic review. J Orthop. 2015;13[3]:207-9. doi: 10.1016/j.jor.2015.03.003.

44. Taussig MD, Powell KP, Cole HA, Nwosu SK, Hunley T, Romine SE, *et al.* Prevalence of Hypertension in Pediatric Tibia Vara and Slipped Capital Femoral Epiphysis. J Pediatr Orthop. 2016 Dec;36[8]:877-883. doi: 10.1097/BPO.0000000000000569.

45. de Pablos J, Arbeloa-Gutierrez L, Arenas-Miquelez A. Update on treatment of adolescent Blount disease. Curr Opin Pediatr. 2018 Feb;30[1]:71-77. doi: 10.1097/MOP.0000000000000569.

46. Fan B, Zhao C, Sabharwal S. Risk factors for failure of temporary hemiepiphysiodesis in Blount disease: a systematic review. J Pediatr Orthop B. 2020 Jan;29[1]:65-72. doi: 10.1097/BPB.0000000000000603.

47. Kadhim M, Hammouda AI, Herzenberg JE. Solid screw insertion for tension band plates: a surgical technique tip. J Child Orthop. 2016;10[4]:307-11. doi: 10.1007/s11832-016-0748-2.

48. Clement AE, Vanderby R Jr, Halanski MA, Noonan KJ. Guided Growth Implant Failure is a Result of Cyclic Fatigue: Explant Analysis With Scanning Electron Microscopy. J Pediatr Orthop. 2017 Jan;37[1]:e37-e42. doi: 10.1097/BPO.0000000000000661.

49. Scott AC. Treatment of infantile Blount disease with lateral tension band plating. J Pediatr Orthop. 2012 Jan-Feb;32[1]:29-34. doi: 10.1097/BPO.0b013e31823db034.

50. Schroerlucke S, Bertrand S, Clapp J, Bundy J, Gregg FO. Failure of Orthofix eight-Plate for the treatment of Blount disease. J Pediatr Orthop. 2009 Jan-Feb;29[1]:57-60. doi: 10.1097/BPO.0b013e3181919b54.

51. Castañeda P, Urquhart B, Sullivan E, Haynes RJ. Hemiepiphysiodesis for the correction of angular deformity about the knee. J Pediatr Orthop. 2008 Mar;28[2]:188-91. doi: 10.1097/BPO.0b013e3181653ade.

52. Sabharwal S, Sakamoto SM, Zhao C. Advanced bone age in children with Blount disease: a case-control study. J Pediatr Orthop. 2013 Jul;33[5]:551-7. doi: 10.1097/BPO.0b013e318285c524.

53. Gilbody J, Thomas G, Ho K. Acute versus gradual correction of idiopathic tibia vara in children: a systematic review. J Pediatr Orthop. 2009 Mar;29[2]:110-4. doi: 10.1097/BPO.0b013e31819849aa.

54. Manner HM, Huebl M, Radler C, Ganger R, Petje G, Grill F. Accuracy of complex lower-limb deformity correction with external fixation: a comparison of the Taylor Spatial Frame with the Ilizarov ring fixator. J Child Orthop. 2007 Mar;1[1]:55-61. doi: 10.1007/s11832-006-0005-1.

55. Matsubara H, Tsuchiya H, Sakurakichi K, Watanabe K, Tomita K. Deformity correction and lengthening of lower legs with an external fixator. Int Orthop. 2006 Dec;30[6]:550-4. doi: 10.1007/s00264-006-0133-8.

56. Birch JG. Blount disease. J Am Acad Orthop Surg. 2013;21[7]:408-18. doi: 10.5435/JAAOS-21-07-408.

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Print ISSN: 2636-4174
Online ISSN: 2682-3780