Early Proximal Tibial Valgus Osteotomy as a Very Important Prognostic Factor in Thai Children with Infantile Tibia Vara

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Objectives: To find the effectiveness of the early surgery (2-3 years of age)as a very important prognostic factor affecting the outcomes in Thai children with infantile tibia vara and all the prognostic factors including the usefulness of arthrographic study in correcting the deformity.

Material and Method: From 1994 to 2004,sixteen children aged average 3.61 years old (2.08-7.0) were treated in Siriraj Hospital and diagnosed as infantile tibia vara by Langenskiold radiographic staging were included in the present study and retrospectively reviewed with an average of 6.4 years follow up(range 6 month – 11.1 years). All cases were initially treated by surgery because of low compliance for brace or brace failure.They consisted of 3 boys and 13 girls. There were 24 legs including the bilateral involvement in 8 cases (2 boy and 6 girls). After arthrography, the midshaft fibular osteotomy was performed then the proximal tibial dome-shaped valgus osteotomy was done and fixed with 2 pins.The desired position was 12 degree knee valgus . The patients were divided in two groups, 1)group A,the successful group with the knee becoming normal without any deformity after single osteotomy,2)group B,the recurrent group with recurrence of the varus deformity required further corrective osteotomies to make normal axis of the knee. All variables were analyzed and compared between group A and group B. The general characteristics and radiographic findings were recorded in 1)age, 2)sex, 3)side, 4)weight in kilogram and in percentage of normal or overweight(obesity) compared with the standard Thai weight chart, 5)tibiofemoral angle (TFA) pre and postoperative treatment, 6) metaphyseal diaphyseal angle (MDA), 7)the medial physeal slope angle(MPS, 8)The preoperative arthrographic articulo-diaphyseal angle (ADA), 9.arthrographic articulo-medial physeal angle (AMPA).

Results: There were 14 legs in group A and the remaining 10 legs were in group B (average 2.4 operations).All cases healed in good alignment of the legs without major complication .All patients who were operated on early before 3 years old were 100% cured by single osteotomy in group A(11 legs).Arthrography was useful in evaluating the knee joint and drawing the angle. Considering the prognostic factors affecting the outcomes after surgery, there were 6 prognostic factors . First, the age less than 3 years old (P<0.001). Second, the normal weight (P<0.047). Third, the Langenskiold stage 1-2 (P=0.002). Fourth, the MPS angle equal or less than 59 degree (P < 0.001). Fifth, the ADA preperative angle equal or less than 18 degrees (P<0.001). Sixth and the last factor,the TFA angle postoperative treatment, equal or more than 10 degrees valgus(mean 13 degrees valgus) (P=0.009).In multivariate analysis with stepwise logistic regression of these 6 prosnostic factors, the MPS angle had the most important significance. The proximal tibial valgus osteotomy was a very important factor(P < 0.001).

Conclusion: The 6 prognostic factors and usefulness of arthrography were identified. The authors suggest that surgery should be performed early in Thai children who have met these criterias 1)age of the patients more than 2 years old , 2)Langenskiold roentgenographic characteristics of infantile tibia vara stage 2 or more at the time of diagnosis, 3)Low compliance for brace treatment.or brace failure but not more than 3 years old. The surgery should not be delayed more than 3 years of age by waiting for effectiveness of brace treatment in Thai children with infantile tibia vara. The early proximal valgus dome- shaped osteotomy was a very important controllable prognostic factor by surgeon decision.

Keywords: Early surgery, Infantile tibia vara, Prognostic factaphy

Infantile tibia vara is a developmental disorder of growth that affects the medial part of proximal tibial physis resulting in progressive varus angulation of the knee. It also known as Blount's disease. Erlacher reported the first case in 1922[1] and Blount gave a description of this condition in 1937[2]. Blount described two types of the condition, including an infantile type that develops before 3 years of age and adolescent type that develops between the ages of six and thirteen years old[2]. Lankenskiold and Riska systematically applied these changes in a classification that recognized six definitive stages of the disease by radiography[3,4].

In many expert opinions especially from Western countries[5,6,7,8,9,10], brace treatment should be considered in all patients less than two and a half years of age with infantile tibia vara Langenskiold stage 1-2. A metaphyseal diaphyseal angle (MDA) of more than 16 degrees or even 10 degrees or more with progressive varus deformity, obesity and ligamentous laxity were also recommended[5,8,]. Feldman and Schoenecker found that if the MDA is more than 16 degrees then chances are 95% that the diagnosis is infantile tibia vara[9]. By this finding the overtreatment was at least 5% depending upon the prevalence rate of the diseases. The MDA is not a gold standard in the diagnosis of infantile tibia vara[11]. The Langenskiold radiographic six stages is the gold standard but the MDA does serve as a more specific guide in differentiating Langenskiold stage 1 from physiologic bowing. It also takes approximately one year for the physician to know whether brace treatment has been successful. From their opinions the corrective proximal tibial valgus osteotomy is indicated if, following brace treatment, the varus deformity and abnormal medial tibial growth have not resolved by age 4 years. Many surgeons, even in low compliant patients, they unintentionally tried to use brace treatment and perform proximal tibial valgus osteotomy until the patients' diseases extended to Langenskiold stage 3 and older than 3 years of age.

In Thailand, the successful rate of brace treatment is still very low in nearly 0% effectiveness because of very low compliance and cooperation from the children and their parents from the hot temperature under the brace, their income, education, emotions, etc. In this situation early proximal tibial valgus osteotomy (2-3 years of age) should be considered because the long term outcomes of infantile tibia vara depended directly on the occurrence of returning to normal growth of medial physis of proximal tibia without recurrent deformity. Cook[12] found that even in physiologic load on a bowed leg child, the compressive force was sufficient to cause growth disturbance of medial tibial physis. Early surgery to release the compressive forces to medial tibial physis before permanent retard and arrest and make normal growth pattern of the tibia should be the goal of the treatment. Because of delayed surgery, the recurrence rate in proximal tibial osteotomy in all age was more than 50%[13]. Many patients suffered from many surgical procedures in correcting the recurrent deformities, bone bridge at the medial tibial physis, leg length discrepancy and also the degenerative change of the knee in long term studies[14-17].

The present study aimed to find the effectiveness of early surgery (2-3 years of age) as a very important prognostic factor affecting the outcomes in Thai children with infantile tibia vara and the usefulness of arthrographic study in correcting the deformity.

Research questions

1. Did early proximal tibial valgus osteotomy (2-3 years of age) make more than 95 % success rate (without recurrent deformity) in Thai children with infantile tibia vara?

2. What were the important prognostic factors of infantile tibia vara in Thai children?

3. What was the usefulness of arthrographics findings of the affected knee in predicting the outcomes?

Material and Method

From 1994 to 2004, sixteen children who were treated in Siriraj Hospital and diagnosed as infantile tibia vara by Langenskiold radiographic staging were included in the present study and retrospectively reviewed with an average 6.4 years follow up (range 6 month – 11.1 years). The patients who have abnormal growth and development were excluded from the studies. All cases were initially treated by surgery because of low compliance for brace or brace failure. They consisted of 3 boys and 13 girls. There were 24 legs including the bilateral involvement in 8 cases (2 boy and 6 girls). After explanation and discussion with the children and their parents all about infantile tibia vara and study plans with parents informed consent, all cases had arthrography of the affected knee performed under general anesthesia and tournique. After

Correspondence to : Kaewpornsawan K, Department of Orthopaedic Surgery, Faculty of Medicine, Sirirraj Hospital, Mahidol University, Bangkok 10700, Thailand. Phone:0-2419-7968, E-mail: sikkw@mahidol.ac.th

arthrography, the midshaft fibular osteotomy was performed then the proximal tibial dome-shaped valgus osteotomy was done by the small incision just below the tibial tubercle and fixed with 2 pins. The desired position was 12 degree knee valgus. Long leg cast was applied in knee extension position for 8 weeks and then the cast and pins were removed. The patients were divided in two groups, 1)group A, the successful group with the knee becoming normal without any deformity after single osteotomy, 2)group B, the recurrent group with recurrence of the varus deformity required further corrective osteotomies to make normal axis of the knee. The indication for additional osteotomies were recurrent varus deformity more than 10 degrees or varus deformity from the bone bridge. The bone bridge resection with fat graft was done in all bone bridge cases. All variables were analyzed and compared between group A and group B. The general characteristics and radiographic findings were recorded in 1)age, 2)sex, 3)side, 4)weight in kilograms and in percentage of normal or overweight (obesity) compared with the standard Thai weight chart, 5)tibiofemoral angle (TFA) pre and postoperative treatment, 6)metaphyseal diaphyseal angle (MDA) (Fig. 1), 7)the medial physeal slope angle (MPS) (Fig. 2), 8)The preoperati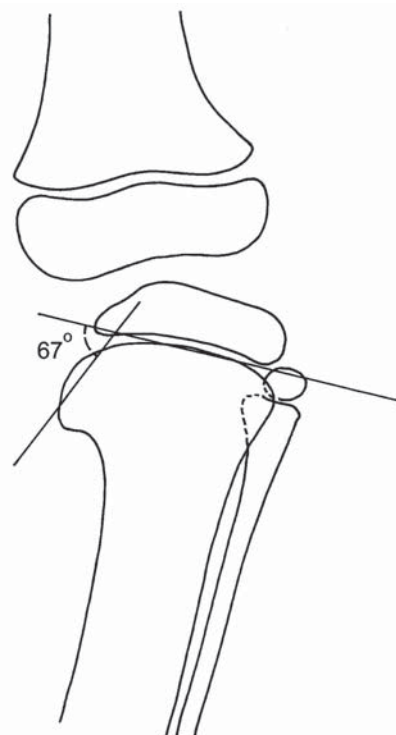ve arthrographic articulo-diaphyseal angle (ADA)-an angle formed by a line draw perpendicular to the axis of the tibia and line drawn through the medial and lateral articular surface of the tibia (Fig. 3), 9)arthrographic articulo-medial physeal angle (AMPA)- an angle formed by a line drawn through the medial and lateral articular surface of the tibia and a line through the medial aspect of the physis (Fig. 3). Statistical analysis was done with the use of the two-tailed t test for continuous variables and a chi square contingency table for dichotomous values. Univariate and multivariate analysis for prognostic factors were applied. A p value of < 0.05 was considered to be significant

Results

There were 14 legs in group A (successful group) which required only single osteotomy. The remaining 10 legs were in group B (recurrent group) which required two or more osteotomies (average 2.4 operations). All cases healed in good alignment of the legs without major complication except one case in group B who had lost dorsi flexion of the affected big toe after surgery and returned to normal within 6 months. Average age at first surgery was 3.61 years old (range, 2.08-7.0 years old). All patients who were operated on early before 3 years old were 100% cured by single osteotomy in group A (11 legs).
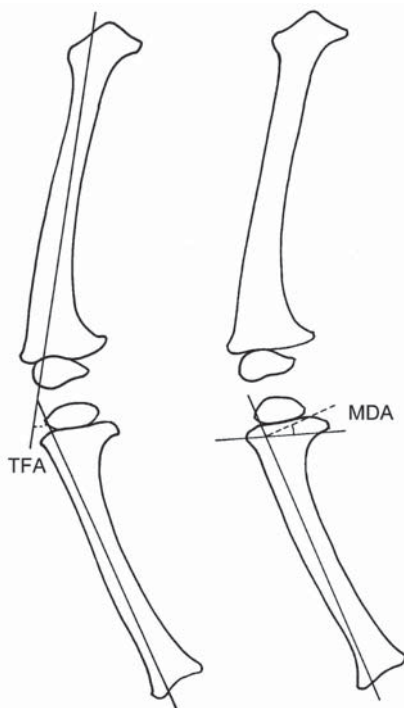
Fig. 1 The TFA (tibio femoral angle) and MDA (metaphyseal – disphyseal angle)

Fig. 2 The MPS (Medial physeal slope) angle
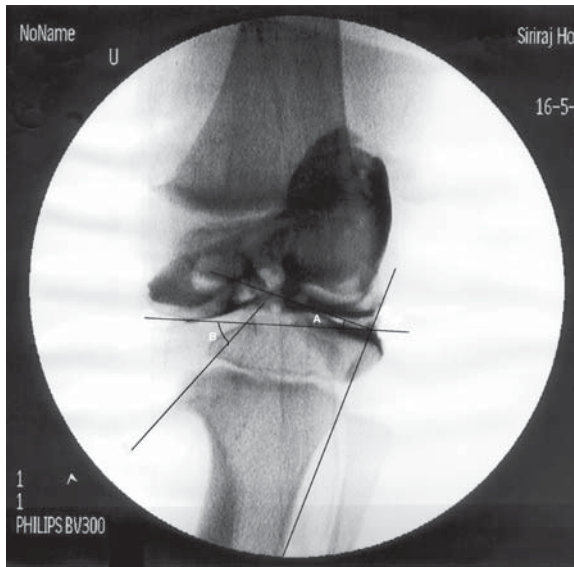
Fig. 3 The arthrographic study shows the retardation of growth of medial proximal tibial physis but the joint line was normal without depression of the knee joint
Angle A = articulo – diaphyseal angle (ADA)
Angle B = articulo medial physeal angle (AMPA)

The intraoperative arthrographic studies were useful and surprisingly showed that the medial tibial plateau height remained normal but delayed in ossification in the early Langenskiold stage until relatively late in the disease process (Fig. 3). Because the articular surface of the knee joint was clearly seen by arthrography, the preoperative ADA and AMPA angle could be easily measured (Fig. 3).

Fig. 4A-C show the radiographs of a girl with Langenskiold stage 2 in group A (successful group) who got only single osteotomy before 3 years old and ended up with a normal knee compared with a girl in Fig. 5A-E with Langenskiold stage 2. Despite bracing, the progression of the Langenskiold stage occurred and the first osteotomies were done in both knees when she was 3 years and three months old. Her right knee got two osteotomies and left knee got four osteotomies with one bone bridge resection and epiphy-seodesis of lateral proximal tibial physis. Her left knee had slight depression of the joint line and osteoarthritis is predicted.

In Table 1, there were small differences in four variables 1) TFA angle pre-operative treatment, 2) MDA angle, 3) sex, and 4) AMPA angle (P>0.050) and quite a fent differences in six varibles 1) number of operations, 2) age at surgery, 3) weight at surgery, 4) MPS angle, 5) ADA angle preoperative treatment. and 6. TFA angle
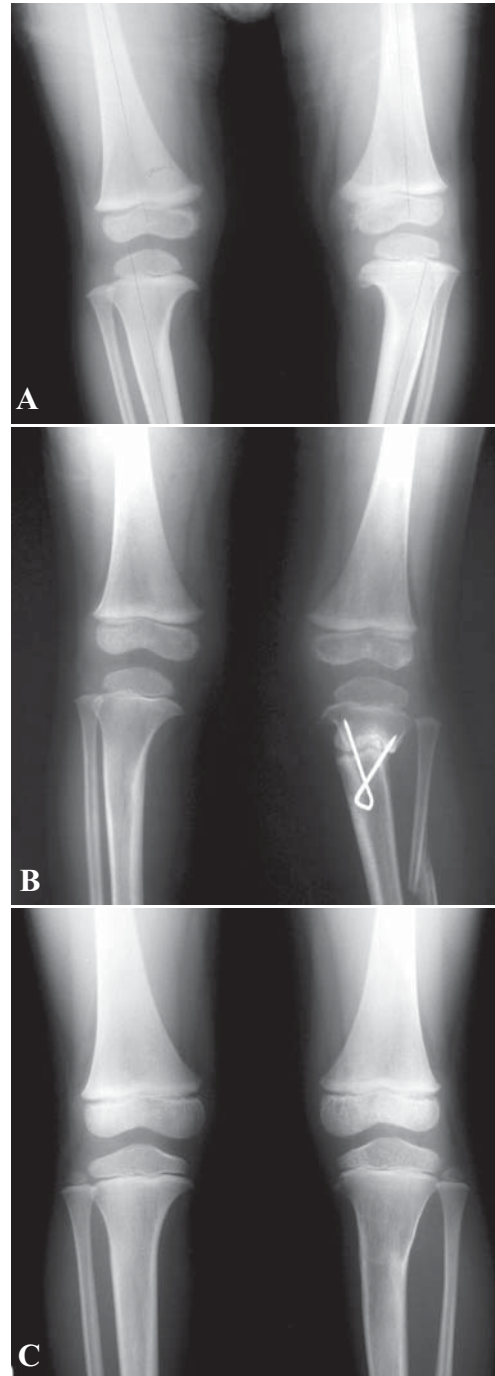
Fig. 4 Case demonstration of a girl in group A (successful group)with normal knee by single osteotomy
A. Infantile tibia vara of left knee, Langenskiold stage 2
B. Dome shaped proximal tibial valgus osteotomy of left knee at 2 and a half years old
C. Normal knee and growth of medial tibial physis in 1 year after surgery
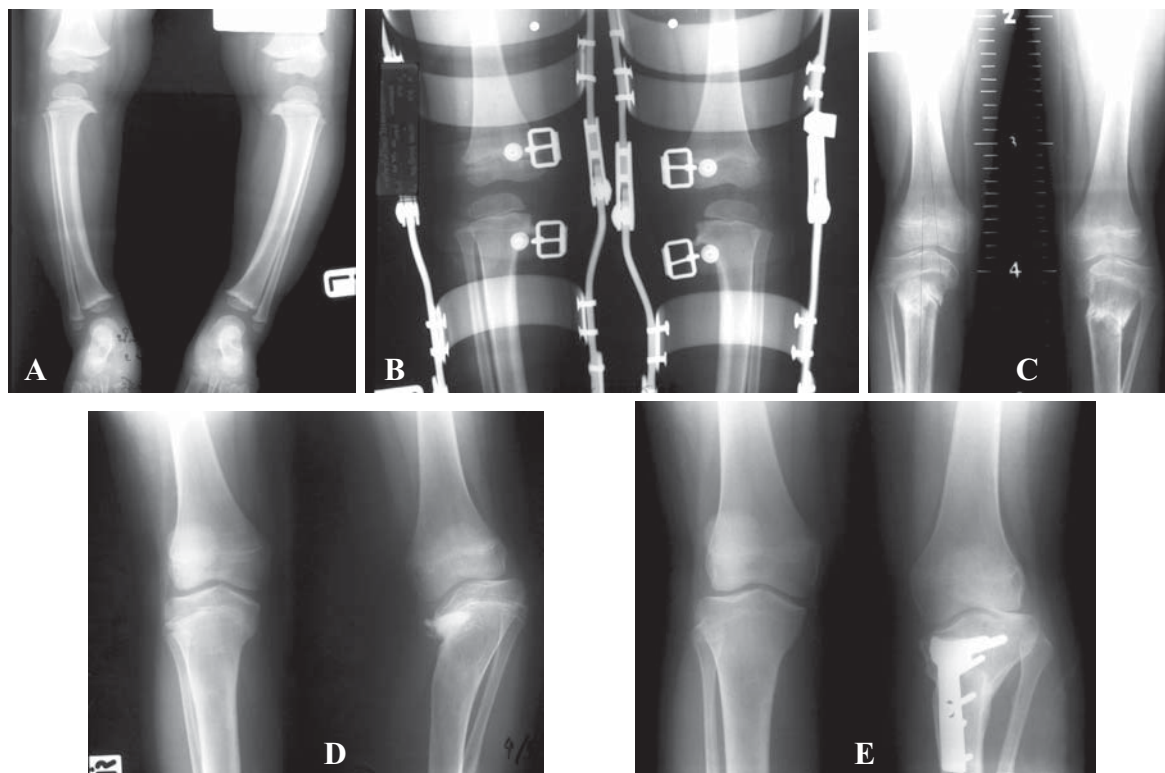
Fig. 5 Case demonstration of a girl in group B (recurrent group) with multiple osteotomies.

A: Bilateral infantile tibia vara at 2 years old, Langenskiold stage 2

B: At 2 years and 8 months, progression of the Langenskiold stage despite bracing ,first osteotomies of both tibia when she was 3 years and 3 months old

C: At 6 years old, second osteotomies of both knees, Langenskiold stage 4

D: At 8 years old, third osteotomy plus resection bone bridge of the left knee but recurrence of the deformity occurred,her right knee was good.

E: At 13 years old after fourth osteotomy and plating of the left knee with acceptable alignment, mild depression of medial articular surface of the left knee

post operative treatment. Considering the prognostic factors affecting the outcomes after surgery, there were 6 prognostic factors (Table 2). First, the age of the patients at surgery should be not more than 3 years old (P<0.005). Second, the weight of the patients at surgery should be normal weight (P<0.05). Third, the Langenskiold stage should be in stage 1-2 (P=0.002). Fourth, the MPS angle should not be more than 59 degrees (P < 0.001). Fifth, the ADA preperative angle should not be more than 18 degrees. Sixth and the last factor, the TFA angle postoperative treatment, should be more than 10 degree valgus (mean 13 degrees valgus) (P=0.009).

In multivariate analysis with stepwise logistic regression of these 6 prognostic factors, the MPS angle had the most important significance. The proximal tibial valgus osteotomy was a very important factor (P < 0.001).

Discussion

From the present study the authors found the usefulness of arthrography and the effectiveness of early surgery to make normal growth of medial tibial physis. The low rate of recurrence after single proximal tibial osteotomy were from 6 good prognostic factors at initial surgery. There was, 1)early initial surgery at the age of 2-3 years old, 2)Normal weight of the patients , 3)Langenskiold stage I-II at surgery, 4)MPS ≤ 59°, 5)ADA pre-operative £ 18 degree, and 6)The TFA postoperative angle was 10 ° valgus

Prognostic factor 1. Age of the patients at initial surgery

Ferriter and Shapiro[13] observed a 76 percent of recurrence undergoing surgery at five years old or older compared with a 31% recurrent rate in those having operative treatment before that age. Loder and

Table 1. General characteristics of variables in group A and group B

No.	Variables	Group A (successful group) total 14 leg	Group B (recurrent group) total 10 legs
1.	Number of legs with single/multiple operations	14/0	0/10
2.	Age at surgery Mean in years old	2.9	4.2
3.	Weight at surgery Mean in kilogram	19.0	25.0
4.	MPS angle Mean in degree	53.0	70.0
5.	ADA preop Mean in degree	12.2	22.8
6.	TFA angle post op.Mean in valgus degree	13.01	9.6
7.	TFA angle preop. Mean in varus degree	15.2	17.5
8.	MDA angle Mean in degree	19.3	21.0
9.	AMPA angle Mean in degree	48.4	52.6
10.	Sex, Number of girls/boys	9/5	10/0

TFA = femorotibial angle, MDA = metaphyseal-diaphyseal angle
MPS = medial physeal slope, ADA = preoperative arthrographic articulo-diaphyseal angle, AMPA = arthrographic articulo medial physeal angle

Table 2. Prognostic factors by multivariate analysis

No. Variables	Group A (successful group) Number of legs	Group B (recurrent group) Number of legs	p value
1. Age at surgery< = 3years old / > 3 years old	11/3	0/14	<0.001
2. Weight at surgery Normal/ obesity	5/9	0/10	0.047
3. Longenskiold stage at surgery Stage 1-2 / stage 3-6	13/1	3/7	0.002
4. MPS angle Mean in degree d" 59/ >18	14/0	0/10	<0.001
5. ADA pre op.Mean in degree d" 18/ >18	14/0	2/8	<0.001
6. TFA post op.Mean in valgus degree e" 10/<10	13/1	4/6	0.009

Johnston[14] found that 88 percent of children less than four years old were successfully treated with one osteotomy but only 32% of children more than four years old have adequate results after a single osteotomy. More importantly, the percentage of good results is decreased.

The present study found 100% percent of children 2-3 years old were successfully treated with single osteotomy (0% recurrent rate) and ended with a normal knee compared with a 23% success rate (77% recurrent rate) in those having operative treatment after three years old. The percentage of success rate was increased while the age during surgery was decreased. This finding supported the authors to perform early surgery immediately in brace failure or low compliant patients.

Prognostic factor 2. The weight of the patients

All recurrent groups (group B) had obesity in the present study which was statistically significantly different (0.047).

Prognostic factor 3. The Langenskiold stage at initial surgery

The increasing stage of the disease appears to be an important prognostic factor. Patients with radiographic evidence of a Langenskiold stage I or II at the time of initial osteotomy had a significantly (P = 0.02) lower incidence of recurrence of their deformity compared with patients with Langenskiold stage ≥ III[6]. The present study stressed the authors not to delay the surgery to stage three because the success rate after surgery dropped significantly (P = 0.002) from 92.8 % (13/14 legs) to 42.8 % (3/7 legs) in Table 2.

Prognostic factor 4. the MPS angle

In the study by Kling et al[18], a medial physeal slope greater than 60 degree was always associated with recurrent varus deformity after tibial osteotomy. The present study found similarity with Kling that the MPS greater than 59 degrees had 100% recurrent deformity.

Prognostic factor 5. The preoperative ADA angle .

By arthrographic study ,the ADA angle should be less than 18 degrees. This factor showed the usefulness of arthrography as a prognostic factor. It was also helpful in assessing the articular surface during surgery.

Prognostic factor 6. The TFA angle post op.

Overcorrection 5∞ (average postop. TFA angle was 13∞ valgus) gave better results. This position minimized compression across the disorganized physis and provided time for normal growth to resume.

The 6 prognostic factors were divided in to 2 groups from the surgeon perspectives, the controllable and the uncontrollable group.The controllable groups had 3 factors, 1)Age at initial surgery, 2)Stage at initial surgery and 3)TFA angle postoperative treatment. The uncontrollable group also had 3 factors, 1)The MPS angle, 2)The weight of the patients, and 3)The ADA angle preoperative treatment. Because the controllable group could be controlled by surgeon decision making during treatment. If normal alignment of the knee by single surgery is the gold standard of the treatment   in brace failure or low compliant cases, the authors recommended early proximal tibial valgus osteotomy as a very important prognostic factor to decrease the recurrent rate because prognosis depends significantly on the age of the treatment and it can be controlled by surgeon decision making. In the population of Thai patients,infantile tibia vara may have a malignant natural history and yield brace treatment results often poorer than white or black patients.

Conclusion

The prognostic factors and the usefulness of arthrography were identified. The better results occurred in children who met these prognostic factors. The authors suggest that surgery should be performed early in Thai children who have met these criterias 1)age of the patients more than 2 years old, 2)Langenskiold roentgenographic characteristics of infantile tibia vara stage 2 or more at the time of diagnosis, 3)low compliance for brace treatment but the age of the patients should be less than 3 years old. Because of the very low success rate of brace treatment the surgery should not be delayed more than 3 years of age by waiting for effectiveness of brace treatment in Thai children with infantile tibia vara. The early proximal valgus dome- shaped osteotomy was a very important controllable prognostic factor (100% success rate in single surgery) and gave the best results without major complications.

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การผ่าตัดกระดูกแข้งส่วนต้นให้เกออกในเด็กอายุน้อยเป็นปัจจัยผลการรักษาที่สำคัญมากในโรคกระดูกแข้งโค้งออกของเด็กไทย

กมลพร แก้วพรสวรรค์, สุขสันต์ ตั้งสถาพร, รัตติภรณ์ จตุนราพิทย์

วัตถุประสงค์: *เพื่อศึกษาประสิทธิผลการรักษาโรคกระดูกแข้งโค้งออกในเด็กไทยด้วยวิธีผ่าตัดในเด็กอายุน้อย (อายุ 2-3 ปี) และศึกษาปัจจัยผลการรักษาโรคทั้งหมดรวมทั้งการศึกษาประโยชน์ในการช่วยรักษาโรคของการบันทึกภาพรังสีของข้อข้างที่เป็น*

ผู้ป่วยและวิธีการ: *ตั้งแต่ปีพศ.2537-2547 เด็กไทยที่เป็นโรคกระดูกหน้าแข้งโค้งออกได้นำมาศึกษาย้อนหลังจำนวน 16 คน รวมทั้งหมดขาข้างที่เป็นโรค 24 ขา เป็น 2 ข้าง รวม 8 ขา แบ่ง เป็น ชาย 3 คน หญิง 13 คน อายุเฉลี่ยขณะผ่าตัด 3.61 ปี(2.08-7.0 ปี)ติดตามได้ทุกคนเฉลี่ย 6.4 ปี (6 เดือน ะ 11.1 ปี) ทุกคนได้รับการผ่าตัดเพราะไม่ยอมใส่อุปกรณ์พยุงขาหรือการใช้อุปกรณ์พยุงขาเพื่อรักษาแต่ล้มเหลว ระหว่างผ่าตัดจะฉีดสารทึบรังสีเพื่อบันทึกภาพรังสีของข้อ และตัดกระดูกน่องตรงกลางกับตัดกระดูกแข้งส่วนต้นให้ขาดเป็นรูปกลมโค้งดัดขาออกจากโก่งเป็นเก 12 องศาในเฝือก แบ่งคนไข้เป็น 2 กลุ่ม กลุ่ม A และกลุ่ม B กลุ่ม A กลุ่มสำเร็จขาตรงปรกติในการผ่าตัด 1 ครั้ง กลุ่ม B ได้รับการผ่าตัดมากกว่า 1 ครั้ง เพื่อให้ขาตรงปรกติ การเปรียบเทียบทำระหว่างกลุ่ม A และกลุ่ม B ในปัจจัยคือ 1.อายุ, 2. เพศ, 3. ข้างที่เป็น, 4.น้ำหนักเป็นกิโลกรัม และอ้วนหรือไม่อ้วนในมาตรฐานเด็กไทย, 5.มุม TFA, 6.มุม MDA, 7.มุม MPS, 8..มุมADA,9..มุม AMPA*

ผลการศึกษา: *กลุ่ม A มี 14 ขา กลุ่ม B มี 10 ขา (เฉลี่ย ผ่าตัด 2.4 ครั้ง) ทุกรายมีมุมของขาที่ตรงปรกติ ไม่มีผลแทรกซ้อนที่สำคัญ เด็กที่ได้รับการผ่าตัดก่อน 3 ปี หาย 100 % มีจำนวน 11 ขา ในกลุ่ม A การฉีดสารทึบรังสีเพื่อบันทึกภาพรังสีของข้อเข่ามีประโยชน์ทำให้เห็นข้อเข่าดีขึ้นและวัดมุมที่ศึกษาได้ดีขึ้น ปัจจัยผลการรักษามี 6 ปัจจัย ปัจจัยที่ให้ผลดีคือ 1.อายุน้อยกว่า 3 ปี(P<0.001), 2.น้ำหนักปรกติ(P<0.047),3.ระยะโรคที่1-2(P=0.002),4.มุม MPS $\leq$ 59 องศา(P < 0.001),5.มุม ADA $\leq$ 18 องศา(P < 0.001),6.มุม TFA หลังผ่าตัด $\geq$ 10 องศา(P = 0.009)*

สรุป: *ปัจจัยผลการรักษามี 6 ปัจจัยและประโยชน์ของการฉีดสารทึบรังสีเพื่อบันทึกภาพรังสีช่วยให้การรักษาดีขึ้น การผ่าตัดในเด็กอายุน้อยได้รับผลการรักษาที่ดีทั้งหมดและเป็นปัจจัยผลการรักษาที่สำคัญมาก เนื่องจากผลการรักษาเด็กไทยด้วยอุปกรณ์พยุงขาได้ผลน้อย การรักษาด้วยวิธีผ่าตัดจึงควรทำทันทีเมื่อมีข้อบ่งชี้คือ 1.อายุมากกว่า 2 ปี, 2.ระยะของโรคที่ 2 หรือมากกว่า, 3.ผู้ป่วยปฏิเสธการใช้อุปกรณ์พยุงขาหรือใช้แล้วล้มเหลวแต่อายุเด็กไม่เกิน 3 ปี*