

Original Article

Comparative study of the outcome of McKay surgery with and without pin in clubfoot patients

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Abstract: Background: Clubfoot is one of the most common foot deformities in children. Surgical treatment is the only choice for patients who have failed conservative treatment. To the best of our knowledge, no studies have been done to compare the McKay surgery with a pin versus without a pin. Our study aimed to compare the outcomes of McKay surgery with and without pins in clubfoot patients. Method: This study is an analytical study. The sample size included patients referred to Imam Reza Hospital from 2016 to 2018. Children who did not respond to plaster therapy were under McKay surgery. In this study, patients were divided into two groups of 50 patients. In the first group, after ligament release and tendon extension, a pin was used to maintain the direction of the talonavicular joint. In the second group, no pin was used. Every six months, radiographs were taken of the patients to monitor their progress. After collecting the study data, they were entered into SPSS software (version 25, IBM Corporation, Armonk, NY) and analyzed. Result: The mean age of patients was 5.36 ± 2.07 months. Of these, 79 were boys and 21 girls, most of the subjects were aged 4-6 months, and 24% had unilateral one-way clubs. The severity of the disease was 7 feet in grade 2 (moderate) and 93 feet in grade 3 (severe). There was a significant relationship between age, outcome and type of complications with surgical type. Conclusion: Finally, it can be concluded that McKay surgery (both with and without a pin) is exceptionally effective at treating clubfoot.

Keywords: Clubfoot, McKay surgery, pin

Introduction

Clubfoot, also called congenital talipes equinovarus (CTEV), is one of the most frequent anatomical and visual birth abnormalities in children and is associated with significant disability [1, 2]. It can affect one or both feet, and the most frequent type is idiopathic CTEV, which means the etiology is unknown [3]. It might manifest as syndromic clubfoot much less frequently when other congenital abnormalities are present [1]. Around half of newborns with clubfoot have bilateral involvement, with unilateral deformity more regularly occurring on the right side [1, 4]. The prevalence of other congenital disabilities or chromosomal abnormalities in clubfoot patients varies significantly between studies and populations, ranging from 24% to 50% [5]. Disorders involving the nerve system comprise most of the recognized etiologies for clubfoot. Myelomeningocele and distal

arthrogryposis are the most common etiologies [6, 7]. Given the wide variety of etiologies for this condition, clubfoot most likely indicates a common pathway for disrupting the neuromuscular unit, including the nerve, spinal cord, brain, or muscle [8].

It is estimated that the global prevalence of clubfoot ranges between 0.6 and 1.5 instances per 1000 live births, with approximately 80% of all clubfoot cases occurring in low- and middle-income regions [9]. Male infants have nearly twice the frequency of clubfoot as female neonates [3].

Radiographic assessment and clinical examination of the affected foot are used to provide an appropriate diagnosis of clubfoot [10]. Ultrasonography is currently the most widely used prenatal diagnostic tool for detecting clubfoot [4]. Since the early 1980s, ultrasound has been

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used to detect prenatal anomalies, even if it was not first thought to be detailed enough to diagnose clubfoot [11]. Clubfoot is commonly detected in around 60% of cases during the prenatal period, and the detection rate is increasing. However, many factors influence the accuracy of this assessment, including gestational age, the physician's experience, equipment quality, and approach [12].

Surgical treatment is the only choice for patients who have failed conservative treatment as demonstrated by positive telescropy, forefoot adductus, and continuously tucked up heels [13, 14]. Over the years, surgeons have struggled to find the best treatment for congenital clubfoot abnormality. Different techniques have been suggested for clubfoot surgery [10, 13].

Douglas McKay developed a circumferential release of the lateral, medial, posterior, and plantar portions of the foot, which is now the Mayo Clinic's preferred exposure [15]. The advantages of this approach are that it provides excellent exposure to the subtalar joint, is beneficial in patients with severe internal rotation deformity of the calcaneus, and allows for increased visualization of the plantar, lateral, medial, and posterior structures, as well as simultaneous evaluation of the released structures in a frontal, sagittal, and transverse fashion [16]. The lateral extension of the incision provides direct access to the lateral structures, avoiding the hockey stick incision's inability to address lateral abnormalities [17, 18].

So far, a few studies have evaluated the results of McKay surgery in different populations. However, no studies have been done to compare the McKay surgery with pin versus without pin to the best of our knowledge. Our study aims to compare the outcomes of McKay surgery with and without pins in clubfoot patients.

Methods and material

Study design

This is a prospective clinical trial performed on children with clubfoot who were referred to Imam Reza Hospital in Kermanshah, Iran. The study population consisted of all children diagnosed with clubfoot that did not respond to plaster cast treatment and were candidates for

clubfoot surgery in 2016-2017. The study protocol was approved by the Research Committee (Ethics code: IR.KUMS.REC.1397.853, Iranian Registry of Clinical Trials (IRCT) code: IRCT-20180904040964N1).

Inclusion and exclusion criteria

Inclusion criteria were all patients with congenital clubfoot, diagnosis of clubfoot by radiological criteria and by expert orthopedics, candidates of McKay surgery and signing the written informed consent by the parents to participate in this study. The exclusion criteria were lack of consent, changing the surgical plan, any complications during surgery, other limb anomalies, having other congenital disorders including cardiac or pulmonary diseases, and contraindications for general anesthesia.

Study population

All patients that met the inclusion criteria entered the study using the census method. Demographic data of patients including age, gender, affected foot, family history, clubfoot severity and parents' education.

The Pirani scale [19] was used to assess the severity of clubfoot. Six clinical signs (three for the middle regions and three for the hindfoot) were scored on a scale from 0 to 3 based on this measure. Depending on the severity, each symptom was given a score of 0, 0.5, or 1 point (0 points were defined as no deformity; 0.5 implies a medium degree of deformity; one is a severe deformity). The severity of the malformation was determined by adding the points.

Surgical intervention

In this study, patients were randomly divided into two groups of 50 patients based on Random Allocation Software. In the first group, after ligament release and tendon extension, a pin was used to maintain the direction of the talonavicular joint. In the second group, no pin was used. In the second week, the cast was corrected, and in the sixth week, the pins were removed and the cast was removed to obtain further correction under general anesthesia, and in the twelfth week, the cast was removed. In contrast to the text technique, which uses the Cincinnati incision, we used a posteromedial incision in our surgical method. However,



Figure 1. A case of unilateral clubfoot before interventions.

the rest of the surgical method was identical to the text method.

Study variables and angle measurements

The method of examination before and after surgery was the clinical evaluation of the affected foot in terms of appearance and radiography of the ankle and foot, including all radiographic measurements of talocalcaneal angle in frontal and lateral view, as well as talo-first metatarsal angle before the operation, and the last postoperative radiograph was measured and recorded.

The varus under-correction, adduction under-correction, and valgus overcorrection tests were the key study variables that were evaluated as evidence of progress. These markers were used to track the patient's clinical progress. The talocalcaneal and talo-first metatarsal angles were used to assess under-correction and over-correction after the plaster was removed following surgery.

The talocalcaneal angle, commonly known as the kite angle, is the angle measured on a weight-bearing DP foot radiograph between lines drawn down the axis of the talus and calcaneus [20]. The normal range is 15-40. Between the calcaneal inclination axis and the mid-talar axis is the lateral talocalcaneal angle.

The normal talus-first metatarsal angle ranges from -10° (varus) to $+30^{\circ}$ (valgus), or 2 SD. The lateral talocalcaneal angle is defined by a line intersecting the longitudinal axis of the talus and a line parallel to the plantar surface of the calcaneus [21].

Follow-up

Every six months, radiographs were taken of the patients to monitor their progress. In cases of clinical suspicion of recurrence of deformity, patients underwent clinical examination and radiography at shorter intervals.

Statistical analysis

After collecting the study data, they were entered into SPSS software (version 25, IBM Corporation, Armonk, NY) and analyzed. Qualitative variables were compared using X² and quantitative variables were compared using Paired T-test. Quantitative variables had a normal distribution and a standard deviation was presented. In all tests, $P < 0.05$ were considered a significant level.

Result

Study population

In our study, 100 children diagnosed with clubfoot who did not respond to plaster cast treatment underwent McKay surgery with and without pins. Then the patients were divided into two groups of 50 people. One group underwent McKay surgery using a pin, and the other group did not use a pin. The mean age of the patients was 5.2 ± 2.6 months, with 79 boys and 21 girls. In addition, the majority of the patients were between the ages of 4 and 6 months, and there was a family history in 15 cases. In our study, 24% of patients had a unilateral clubfoot and the rest were bilateral. **Figure 1** shows a case of unilateral clubfoot before interventions.

Demographic data

Parents of 47% of patients had a diploma. There is also a significant relationship between age and type of surgery ($P = 0.0001$). The severity of the clubfoot was classified as a grade II (moderate) in 7 clubfeet and a grade III (severe) in 93 clubfeet. McKay surgery without a pin was more common in men than women and McKay surgery with a pin in women was more common. There was no statistically significant relationship between the type of surgery and gender ($P > 0.05$).

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Table 1. Frequency of variables based on surgery type

| Variables | | Type of surgery | | P-value |
|--------------------|----------------------|-----------------|-----------|---------|
| | | Without pin | With pin | |
| Gender | Male (%) | 41 (82%) | 38 (76%) | 0.461 |
| | Female (%) | 9 (18%) | 12 (24%) | |
| Affected foot | Unilateral (%) | 18 (36%) | 6 (12%) | 0.005 |
| | Bilateral (%) | 32 (64%) | 44 (88%) | |
| Family history | Yes (%) | 15 (30%) | 0 (0%) | 0.0001 |
| | No (%) | 32 (70%) | 50 (100%) | |
| Severity | Medium (%) | 4 (8%) | 3 (6%) | 0.695 |
| | Severe (%) | 46 (92%) | 47 (94%) | |
| Treatment outcome | Complete improvement | 5 (10%) | 8 (16%) | 0.041 |
| | Partial improvement | 45 (90%) | 42 (84%) | |
| Parents' education | Under diploma | 14 (28%) | 17 (34%) | 0.003 |
| | Diploma | 31 (62%) | 16 (32%) | |
| | University | 5 (10%) | 17 (34%) | |

Table 2. Frequency of complications based on surgery type

| Complications | | Type of surgery | | | | P-value |
|----------------------------|-----------|-----------------|---------|-------------|---------|---------|
| | | With pin | | Without pin | | |
| | | Frequency | Percent | Frequency | Percent | |
| Varus under-correction | | 0 | 0% | 3 | 6% | 0.002 |
| Adduction under-correction | | 0 | 0% | 2 | 4% | |
| Valgus overcorrection | | 8 | 16% | 0 | 0% | |
| Recurrence | Varus | 0 | 0% | 0 | 0% | |
| | Adduction | 1 | 2% | 0 | 0% | |
| Necrosis | | 4 | 8% | 0 | 0% | |

Relationships between variables

According to the results in **Table 1**, McKay surgery without a pin was more common in unilateral patients and McKay surgery with a pin was more common in bilateral patients. There was a significant relationship between the type of surgery and the affected foot. According to **Table 1**, there was a substantial relationship between clubfoot and family history.

Out of the patients who underwent McKay surgery without a pin, complete recovery was achieved in 45 cases and partial recovery in 5 cases. Also, in the group undergoing surgery with a pin, 42 cases of complete recovery and 8 cases of partial recovery were achieved. There is a statistically significant relationship between the type of surgery and treatment outcome. Additionally, there is a strong correlation between parental education and clubfoot disease. Most of the parents of the patients who

underwent McKay surgery had a university education.

Complications and further assessments

According to **Table 2**, there was a significant relationship between the type of surgery and the type of complications. Complications of pin surgery included valgus overcorrection in eight cases and one case, adduction recurrence and the group without pin, including varus under-correction in three patients and adduction under-correction in two patients and one case, necrosis were observed in part of the skin edges that did not need any special action. Also, none of the complications required revision and were corrected by casting. **Figure 2** shows the post-surgical outcome of a patient.

Discussion

Congenital clubfoot is one of the most common foot deformities in children [17]. The disease



Figure 2. Post-surgical outcome in a patient.

has been estimated to affect approximately one in every 1,000 live births [9]. The prevalence of clubfoot in boys is twice as high as in girls, and in 50% of cases it is bilateral. Rotation of the tibia and malformation of the tarsometatarsal and subtalar joints are standard in congenital clubfoot [17]. Clubfoot is a complicated malformation that affects the ankle, subtalar, and midtarsal joints. Clinically, the appearance of the clubfoot is very clear. There are four main components of clubfoot: cavus (high arch), equinus (foot pointed downward), forefoot adductus (forefoot turned inward), and heel varus (heel turned inward) [22]. In atypical cases or with neurological diseases, radiography should be part of the examination of the clubfoot before, during, or after treatment [10]. The treatment of the first phase of clubfoot is in the form of weekly serial casting (in the first months of life), and then once a week, plaster replacement is followed by manipulation [23]. The effect of manipulation and casting is 5 to 80% [8]. To correct the three-dimensional deformity sequentially, the deformity must be corrected step by step [7]. The first casting stage, after gentle manipulation, involves correcting the cavus by elevating the first metatarsal, which will adjust the alignment of the forefoot with the hindfoot [24]. Once the cavus has been sufficiently corrected, the forefoot will be abducted around the talus. The hindfoot varus will be corrected and the forefoot varus through the abduction of the forefoot [14]. Varus should not be corrected by applying direct pressure to the hindfoot. Pronation should also be avoided during casting because it may prevent calcaneus abduction and recreate a cavus deformity [4]. If the serial casting or manipulation treatments do not work, surgery may be required. The surgical correction is usually not performed until the

child is between six and nine months. After surgery, the foot is aligned in a more normal position to correct the clubfoot [25]. The surgical procedure usually entails releasing and lengthening the foot's tight tendons and joint capsule. Many surgeons prefer to separate the incisions into two parts: a posteromedial incision and a small lateral incision. However, only one circumferential incision is possible [13]. Different techniques have been suggested for clubfoot surgery. To the best of our knowledge, no studies have been done in this regard so far; in this study, we have compared the outcome of McKay surgery with and without a pin in clubfoot patients.

Our patient group consisted of 79 boys and 21 girls with clubfoot, whose mean age at surgery was five months. In our study, 24% of patients had a unilateral clubfoot, and the rest were bilateral. In our study, 24% of patients had a unilateral clubfoot and the rest were bilateral. The severity of the clubfoot was classified as a grade II (moderate) in 7 clubfeet and a grade III (severe) in 93 clubfeet. There is a significant relationship between the type of McKay surgery (with and without pins), age, treatment outcome, and kind of complications and recurrence. In the group with pins, 45 cases of complete recovery and 5 cases of partial improvement were found. In comparison, 42 cases of complete improvement and 8 cases of partial improvement were found in the group without pins. Of the most complications in McKay surgery with a pin, three were under-correction of varus, and one adduction was a recurrence. Also, there is a significant relationship between clubfoot disease and family history.

This study was conducted on pediatrics with the diagnosis of clubfoot and we conducted a clinical trial to assess the use of pin insertions. The main variables in this study were talocalcaneal angle and talo-first metatarsal angle. We evaluated frequencies of Varus under-correction, Adduction under-correction, Valgus overcorrection, etc., Recurrence and Necrosis in the study population. Unfortunately, we were unable to collect further data from patients such as qualitative variables and this could be considered as one of the limitations of our study. Another limitation of this survey is the restricted study population. We suggest that

further clinical research on larger populations should be conducted. It is also recommended that orthopedic surgeons pay attention to McKay surgery's beneficial use (both with and without pin) in patients with clubfoot.

Conclusion

Finally, it can be concluded that McKay surgery (both with and without a pin is highly effective at treating clubfoot). Because failure to treat clubfoot results in severe physical disability and the fact that McKay surgery without a pin is associated with a minor complication, this method is recommended for the treatment of clubfoot.

Disclosure of conflict of interest

None.

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