Modified Pelet Osteotomy in the Treatment of Juvenile *Hallux Valgus*

R. Ullot-Font, S. Cepero-Campá, D. Poggio-Cano and S. Lasurt-Bachs
Department of Orthopedic and Trauma Surgery. Sant Joan de Déu Hospital. Barcelona. Spain.

Purpose. Sixty-one cases of juvenile *hallux valgus* are presented that were treated surgically through a modified Pelet technique.

Materials and methods. Between 1996 and 2002, 37 patients were subjected to the above mentioned technique (30 females and 7 males). Mean age was 14 years (range: 9-19). Minimum follow-up was one year. In all cases a subcapital osteotomy of the first metatarsal was carried out according to the technique described by Pelet. The osteosynthesis material used was a bioresorbable rod. Weight-bearing was allowed at 24 hours.

Results. Healing was achieved at 5 weeks on average. In all cases an improvement was obtained in the intermetatarsal and *hallux valgus* angles, with good clinical results and few complications.

Conclusions. We believe that Pelet osteotomy is suitable for the treatment of juvenile and adolescent *hallux valgus* since it is a non-aggressive technique that can correct the most usual pathogenetic alterations seen in these patients.

Key words: *juvenile* hallux valgus*, first metatarsal osteotomy, Pelet, bioresorbable osteosynthesis.*

Osteotomía de Pelet modificada en el tratamiento del *hallux valgus* juvenil

Objetivo. Se presentan 61 casos de *hallux valgus* juvenil tratados quirúrgicamente mediante la técnica de Pelet modificada.

Material y método. En el periodo comprendido entre 1996 y 2002 se han revisado 37 pacientes, 30 mujeres y 7 hombres, con unas edades comprendidas entre 9 y 19 años, promedio de 14 años, a los que se les practicó dicha técnica. El seguimiento mínimo fue de un año. En todos los casos se ha llevado a cabo una osteotomía subcapital del primer metatarsiano según la técnica descrita por Pelet, colocando como osteosíntesis una barra de material biorreabsorbible. Se autorizó la carga a las 24 horas.

Resultados. Se ha conseguido la consolidación en un promedio de 5 semanas. En todos los casos se ha logrado una mejora de los ángulos intermetatarsiano y de *hallux valgus* con buen resultado clínico y pocas complicaciones.

Conclusiones. Creemos que la osteotomía de Pelet es una técnica adecuada para el tratamiento del *hallux valgus* juvenil y del adolescente ya que es capaz de corregir las alteraciones patogénicas más frecuentes en estos pacientes, al mismo tiempo que nos parece poco agresiva.

Palabras clave: hallux valgus *juvenil, osteotomía primer metatarsiano, Pelet, osteosíntesis biorreabsorbible.*

Corresponding author:
R. Ullot Font.
Servicio de Cirugía Ortopédica y Traumatología.
Hospital Sant Joan de Déu.
Passeig Sant Joan de Déu, 2.
08950 Esplugues. Barcelona. Spain.
E-mail: rullot@hsjdbcn.org

Received: August 2005.
Accepted: March 2007.

sIt is thought that more than 50% of adults who present with hallux valgus (HV) can recall that their deformity began in adolescence[1,2]. It is indeed true that during this early stage in life symptoms are generally not severe. Therefore, treatment, in most cases, will be directed towards the prevention of progressive deformity.

Conservative treatment is still the most common option in juvenile and adolescent HV. The pathogenesis and char-

acteristics of this condition as found in children and adolescents are quite different from those of adults. It is important to bear in mind these differences when deciding on the surgical treatment.

Accordingly, it has been suggested that the medial obliquity of the metatarsocuneal joint (MC) plays a significant role in the genesis of HV. This concept of primus varus metatarsal (PVM), as introduced by Truslow[3] in 1925, must be slightly modified, owing to the fact that it has been observed that conventional x-rays are not very reliable.

It has been confirmed that, in anatomic dissections, a minimum variation in the incidence of the ray beam markedly affects the apparent position of the MC4 joint. Some authors claim that the increase in the intermetatarsal angle (IMA) and the PVM are secondary to the increase in the HV angle (HVA)[5]. Likewise, other studies have proved that the correction of the HVA had the effect of progressively correcting the IMA and the PVM. It has been observed that most cases of early HV are associated to an increased distal metatarsal articular angle (DMAA) [1,6].

Another feature of juvenile HV is the roundedness of the head of the metatarsal, which can be contrasted to the flattened head that is frequently found in adults (fig. 1). This contributes to the onset and, particularly, the progression of the HV, since it reduces intrinsic resistance to lateral deviation. Other factors, such as hyperlaxity and proximal epiphyseal dysplasia, have also been considered collaborating factors.

There are several surgical procedures for the treatment of juvenile and adolescent HV, which testify to the difficulty of correcting it in the long term. Even though the approach to treatment of HV must be individual, our studies of the pathogenesis of juvenile and adolescent HV enable us to state that, in a great number of cases, the chosen surgical technique will have to be capable of correcting a PVM together with a DMAA, both increased.

Figure 1. *Juvenile hallux valgus x-ray. Note the rounded head of the first metatarsal and the increased distal metatarsal articular angle.*

MATERIALS AND METHODS

We carried out a retrospective review of 61 cases in 37 patients that had been operated for HV between 1996 and 2002. The surgical procedures were all carried out by the same team. In all cases the surgical technique was a first metatarsal neck osteotomy, following the technique presented by Pelet[7], plus internal fixation with a rod of resorbable material (composed of reinforced fibrous polylactic acid). In some cases, a lateral release was added by performing a section of the adductor of the first metatarsal.

This series is formed by patients of an average age of 14 (range: 9-19 years). 30 out of the 37 patients were female (78%) and 7 were male (19%); 24 patients had bilateral involvement and 13, monolateral. Of the 61 cases that underwent surgery, 53 were girls (87%) and 8 were boys (13%). 85% complained about pain at the level of the medial prominence and 65% manifested a difficulty with footwear. In all the cases initial treatment was conservative, based on advice with regard to hygiene and diet as well as a change of footwear. The average evolution from the first visit to the surgical procedure was 2.7 years. 32% of our patients (20 cases) presented with an open physis at the time of the intervention.

Minimum follow-up was 12 months. During the first year, all patients returned for re-evaluation and follow-up. By comparing patients' progress with the information in their medical records, we evaluated pain relief, patient satisfaction, and complications, as well as the patients' return to their everyday, including sports.

We performed anteroposterior and lateral weight-bearing x-rays during immediate post-op, and after periods of one month, six months and a year. The HVA, the IMA between the first and second metatarsal, and the DMAA or PASA were measured. We examined the position of the sesamoids, and classified them into a sequence from I to IV: grade I, the lateral sesamoid touches the lateral end of the metatarsal; grade II, it surpasses the end; grade III, when the medial sesamoid touches the lateral end of the metatarsal; grade IV when it surpasses the end.

The surgical technique is carried out with the patient in the supine position, with a flexed knee and a weight-bearing foot. There are cases in which surgery is initiated with a lateral release of the metatarsal from its insertion at the base of the proximal phalanx, the sesamoids, and the intermetatarsal ligament.

A longitudinal dorsal 3 cm incision is performed, centered on the longitudinal axis of the first metatarsal, from which the performance of the neck osteotomy is started, following the Pelet technique[7]. With an electric saw, we per-

form the transversal osteotomy, perpendicular to the metatarsal axis, extracapsular, and at neck level. A «V» is drawn, with a first line parallel to the diaphyseal axis at the center of the metatarsal, at a depth of 0.5cm, and a second line inclined towards the edge of the osteotomy (fig. 2).

At this stage, the head is lateralized, in such a way that it is fitted into the osteotomy that we described above. Cheilectomy is not necessary. This osteotomy enables corrections to be made on the three spatial planes; therefore, we could correct rotational deviations at this stage, if it were necessary.

This, together with the correction of the DMAA that this kind of osteotomy enables, makes it a highly versatile technique. The translation of the head usually entails the re-centering of the sesamoids. Once a correct position has been confirmed, we pass on to osteosynthesis. For this, we use the resorbable rod described above (fig. 3). A 3 mm drill is used and the rod is placed with an inserter. The bone surface is riveted using a thermal device. The periosteum is reconstructed and the sheath that surrounds the extensor hallucis longus is medialized. Immobilization is achieved by means of a soft bandage, which will keep it in the correct position. The bandage should be changed every 15 days and removed after a period of 6 weeks. After the first 24 hours, if tolerance is acceptable, the patient is allowed to walk wearing an orthopedic HV sandal.

Figure 2. *Pelet-type neck osteotomy.*

Figure 3. *Introduction of the resorbable rod.*

RESULTS

During follow-up, we recorded the patients' degree of recovery, as well as their capacity to walk, relapses and complications. We regarded as satisfactory the cases of those patients who were able to return to their everyday activities, including sports, without any relapses. The cases that required reintervention or the use of an offloading orthosis were considered unsatisfactory. 35 (94.5%) out of the 37 patients were asymptomatic, leading a normal life and doing sports, without a relapse in a one-year period. None of the cases presented any difficulties related to footwear after surgery. Two patients (5.5%) were in the unsatisfactory group due to relapse of the deformity and transfer metatarsalgia, which required an offloading insole.

Radiological findings

The average pre-surgical HVA in our patients was 32° with a range of between 25 and 47°. The average HVA after a post-op 12-month period was 18.2°, hence, the average HVA correction was 13.7°. An analysis of the evolution of the HVA during the first year showed that there was a marked correction in the immediate post-op period (average HVA in immediate post-op, 9.1°) (fig. 4). This correction decreased partially until the sixth month, and remained stable afterwards (fig. 5).

The average pre-surgical IMA was 12° and, twelve months later, 8.5°. The evolution of the IMA measured throughout the first year showed a progressive decrease up

Figure 4. *Post-op x-ray.*

to the sixth month, which subsequently returned to similar values to those of the immediate post-op period.

The measurements of the DMAA showed an angle higher than 10° in 66% of our patients. The average post-op DMAA was 14.4°, and 12 months later it was 5° (average correction, 9.6°).

Articular congruence was observed in 56% of our patients. This high percentage of congruent articulations, in spite of the severe HVA deviations, are due to the increase in the DMAA. Thus, on measuring DMAA in patients with an HVA greater than 30°, we found that those that maintained articular congruence had an average DMAA of 17°, while those that showed a degree of incongruence had a DMAA of 9°.

30% of our patients had an open growth plate at the time of the surgery. We compared the results and evolution of these patients during the first year and did not find any differences in the average angles obtained through measurements at healing, 6 months and I year (fig. 6).

Concerning the complications we faced, there were two cases of erythema and intense tumescence at the metatarsophalangic level (pseudoarthritis). This general condition was attributed to a negative reaction to the resorbable material of the rod[8,9]. This kind of pseudoarthritis is more frequent with internal fixation devices of polyglycholic acid, being present in 5.3% of the cases, whereas with acid polylactic it is present in only 0.2%. There was one case of a cheloid scar.

There were two cases with unsatisfactory results. One patient presented with a recurrence of the valgus condition, which was treated with Akin osteotomy (proximal phalanx medial wedge osteotomy). Another patient presented with a

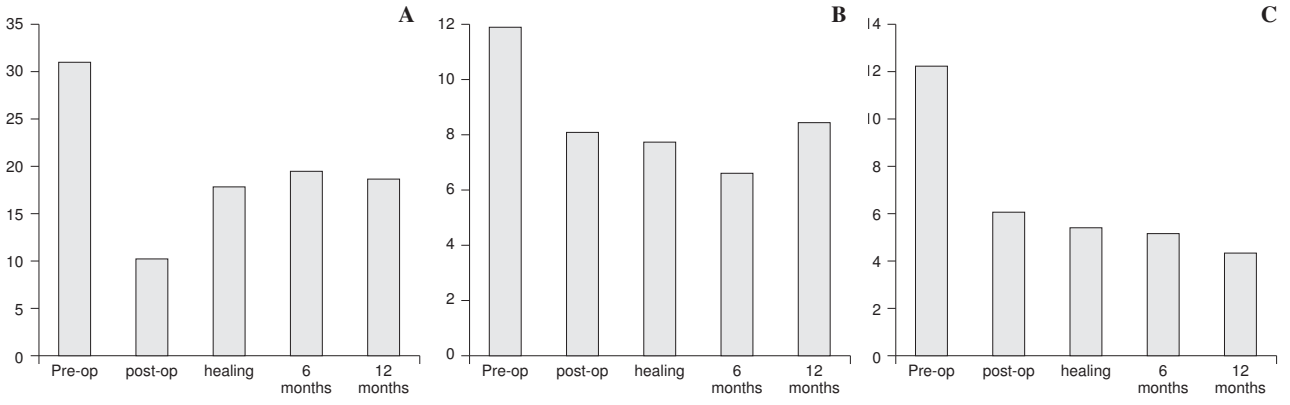

Figure 5. *Evolution of pre-op and post-op angles and healing at 6 and 12 months. (A) Evolution of the* hallux valgus angle*. (B) Evolution of intermetatarsal angle. (C) Evolution of the distal metatarsal articular angle.*

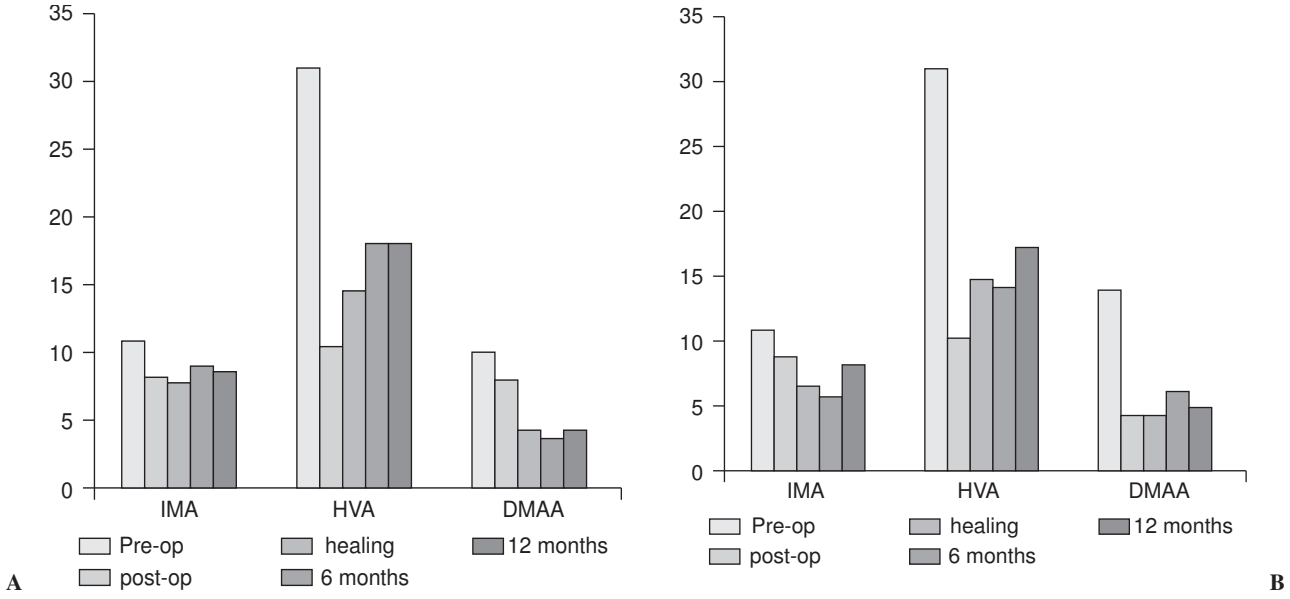

Figure 6. *Evolution of the intermetatarsal angle (IMA), hallux valgus angle (HVA) and distal metatarsal articular angle (DMAA) in the groups with open (A) and closed (B) growth plate.*

transfer metatarsalgia to the second metatarsal, accounted for by the excessive shortening of the first ray, which was compensated by a metatarsal offloading insole.

There were no cases of septic necrosis of the metatarsal head or infections. Nor were there any cases of pseudoarthosis or delayed healing. On the whole post-op pain was readily tolerated.

DISCUSSION

Multiple techniques for the treatment of juvenile hallux valgus (JHV) have been described in the literature. None, however, can be considered ideal. This leads us to agree, once again, with the maxim that affirms that JHV treatment must be individual.

Nevertheless, the study of the JHV pathogenesis and natural history suggests various principles to ensure successful surgeries. It seems to be evident that a great number of patients present with PVM[1], even though its role is not quite clear, since some works show that its onset is secondary to the valgus deviation of the finger. In his works, Antrobus[5] confirms that the PVM is progressively corrected when the HVA and the IMA are corrected. The published series also observe a relationship between the early onset of HV and an increased DMAA[2,6,10].

Our experience confirms this observation, since 66% of our cases had a DMMA superior to 10° and an average DMMA of 14.4°, due to which it is probable that the distal articular obliquity of the metatarsal is a significant factor in the genesis of JHV. Furthermore, this fact has a clinical and radiological implication, since it enables the observation, even in major deviations, of a satisfactory articular congruence and not a real instability, as happened in some instances of HV with a later onset. In our review, we found that the average DMMA in patients with an HVA of over 30° who maintained articular congruence was 17°, while in patients with a certain degree of articular incongruence the average DMMA was 9°.

In conclusion, it is possible that primary deformity in many of our JHV patients derives from the articular metatarsophalangeal orientation, and that in a small percentage the etiology of the deformity stems from an MC instability, probably motivated by the frequent hyperlaxity of these patients together with PVM. In these cases, in which severe hyperlaxity with MC and PVM instability are observed, Myerson[4,11] suggests performing a modified Lapidius technique[12]. In virtually all the remaining cases we will find a marked HV, with a satisfactory articular congruence, an increased DMAA and a moderate PVM. In most of these cases distal extra-articular osteostomies are performed, with or without lateral releases. The Chevron[13-16] osteostomy is widely used with satisfactory results that have been published. If we take into account the pathogenic factors mentioned above, we must resort to its biplanar variant in a high percentage of the cases, if we wish to obtain an adequate correction. This osteotomy does not enable the correction of rotational deformities, and the plantarization or elevation of the metatarsal head, though possible, is difficult. A technique that is frequently used in JHV is the Mitchell osteotomy. However, it has been shown that it shortens the metatarsal and should therefore not be used in cases of short metatarsals[15,17,18].

We believe that the Pelet osteotomy is not more complex than other neck osteotomies, although it *does* require a learning curve. This osteotomy has a satisfactory intrinsic stability. In his article, Pelet provides a precise indication for performing this osteotomy: PVM with lateral obliquity of the distal articular surface of the metatarsal. The conclusions of our experience match those of other series[15] in that they also assert that the Pelet osteotomy, in contrast to others, enables the correction of deformities in any of the spatial planes, ensures corrections and facilitates early active mobility due to its intrinsic stability. Additionally, this osteostomy has the capacity of correcting the factors most frequently involved in the etiopathogenesis of JHV (DMAA, MPV).

The use of resorbable material in internal fixation seems to be a most favorable option in the case of children and adolescents, since it prevents a second surgical stage for extracting material and does not seem to entail significant complications, except for the cases of pseudoarthritis we described above, which were easily solved, in our experience. The bibliography registers a lower frequency of occurrence of this negative reaction when polylactic acid is used than when ploy glycholic acid is used[8,9].

In conclusion, the development of HV in children and adolescents is relatively infrequent. Many of these cases may be treated with a conservative technique[19,20]. HV is more frequent in girls and has a bilateral presentation. Surgery should be used only in severe cases that present with pain and difficulty with footwear, deformity being the last reason for deciding on surgical intervention. Although follow-up time in our series is short, Pelet osteotomy seems to be an effective technique for the correction of HV with increase of DMAA and PVM. It is also advantageous vis-à-vis other techniques on account of its versatility, intrinsic stability and capacity to correct the pathogenic factors most frequently involved. The presence of open growth plates does not seem to affect short-term results. The use of resorbable internal fixation of polylactic acid has unequivocal advantages in respect of comfort, complication reduction and the avoidance of the extraction of osteosynthesis material.

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Conflict of interests: We, the authors, have not received any economic support to carry out this study. Nor have we signed any agreement with any commercial firm to receive benefits or fees. On the other hand, no commercial firm has provided nor will provide economic support to non-profit foundations, educational institutions or any of the other non-profit organizations that we are members of.