

# Long-term Results of Keller-Brandes *Hallux Valgus* Resection Arthroplasty in Patients over 50 Years with Metatarsophalangeal Osteoarthritis

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**Purpose.** To analyze the long-term clinical, radiological and functional results of a significant number of patients operated on for *hallux valgus* with the Keller-Brandes technique and to identify factors that may lead to a poor prognosis.

**Materials and methods.** A clinical and radiological review was made of a group of 30 patients operated on for 55 instances of *hallux valgus* using the Keller-Brandes technique with a minimum follow-up of 8 years. Their mean age at the time of surgery was 62 years.

**Results.** Patients subjected to a resection arthroplasty showed a reduction in their metatarsophalangeal angle from 36.9° to 25.4° over a mean follow-up period of 9.6 years. At the same time, the intermetatarsal angle went from 14.9° to 11°. Reduction of the sesamoid-metatarsal head articulation was achieved in 65% of cases. Subjective results were excellent in 20% of patients, good in 38.2%, fair in 23.6% and poor in 18.2%. Radiological recurrences were 36% and residual metatarsalgias 24%. There was one single case (2%) of a cock-up deformity (2%) and no cases at all of residual varus. None of the patients had to be reoperated for any of the above mentioned complications.

**Conclusions.** In our experience, the long-term clinical and radiological results of the Keller-Brandes operation in patients over 50 years of age can be considered acceptable and show a low complications rate provided that the technique is applied carefully. For this reason, it should still be recommended as the technique of choice for patients over 50 years of age with low functional demands and degenerative joint disease.

**Key words:** *hallux valgus*, resection arthroplasty, Keller-Brandes.

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## Resultados a largo plazo de la artroplastia de resección (Keller-Brandes) en el *hallux valgus* en pacientes mayores de 50 años con artrosis metatarsofalángica

**Objetivo.** Conocer los resultados clínicos, radiológicos y funcionales a largo plazo de un número sustancial de pacientes intervenidos de *hallux valgus* mediante la técnica de Keller-Brandes, así como tratar de identificar factores relacionados con un mal pronóstico.

**Material y método.** Se han revisado clínica y radiológicamente 30 pacientes intervenidos de 55 *hallux valgus* mediante la técnica de Keller-Brandes, con un seguimiento mínimo de 8 años. Su edad media en el momento de la cirugía fue de 62 años.

**Resultados.** Los pacientes intervenidos de artroplastia de resección presentaron una reducción del ángulo metatarsofalángico a los 9,6 años de seguimiento medio de 36,9° a 25,4°, mientras que el ángulo intermetatarsiano se corrigió de 14,9° a 11°. Se consiguió la reducción de cabeza metatarsiana-sesamoideos en un 65%. Los resultados subjetivos fueron excelentes en un 20%, buenos en un 38,2%, aceptables en un 23,6% y malos en un 18,2%. Hubo un 36% de recidivas radiológicas y un 24% de metatarsalgias residuales, con una sola deformidad en *cock-up* (2%) y ningún caso de varo residual. Ningún paciente requirió ser reintervenido por ninguna de dichas complicaciones.

**Conclusiones.** En nuestra experiencia, los resultados clínicos y radiológicos a largo plazo de la intervención de Keller-Brandes en pacientes mayores de 50 años pueden ser considerados aceptables, con una baja tasa de complicaciones siempre que se realice mediante una técnica cuidadosa. Por ello debe seguir recomendándose como técnica de elección en pacientes mayores de 50 años, con bajas demandas funcionales y cambios articulares degenerativos.

**Palabras clave:** *hallux valgus*, artroplastia-resección, Keller-Brandes.

*Hallux valgus* (HV) is probably the most frequent deformity of the foot and the musculoskeletal system. It consists in a deviation in valgus of the first toe with pronation, and is generally associated with a deviation in varus of the first metatarsal with prominence of the medial eminence. It is frequently accompanied by a progressive subluxation of the metatarsophalangeal joint. In X-rays this can be seen as an increase in the HV angle and the intermetatarsal (IM) angle. HV is frequently associated with secondary effects in other parts of the forefoot. These include: hammer toes, metatarsalgia, subluxation or dislocation of the metatarsophalangeal joints, which may be corrected during the same operation.

Over the last 100 years more than 130 different surgical techniques have been described (Table 1). This large number of techniques indicates that there is no single procedure applicable to all these deformities and, therefore, many of them are severely deficient. Surgical techniques can be divided into procedures that act on soft tissues, osteotomies, arthrodesis, arthroplasties and combined procedures.

Arthroplasty-resection was first described by Davies-Cooley in 1887. This technique gained in popularity and spread thanks to Keller in the USA in 1904 and Brandes in Germany in 1929. It consists in exostosectomy of the first metatarsal and resection of the base of the proximal phalanx (Fig. 1). Subsequently, in 1967, Lelievre modified the technique including fibrous wiring, with a plicature of the medial capsule that corrects both the varus of the metatarsal and the valgus of the toe. Therefore this resection arthroplasty is known as the “Keller-Brandes-Lelievre technique”. It is a simple technique with random results, it sacrifices the joint, which does not seem to be quite the right thing to do in feet with a healthy metatarsophalangeal joint, and due to this fact the indications for this procedure are currently limited.

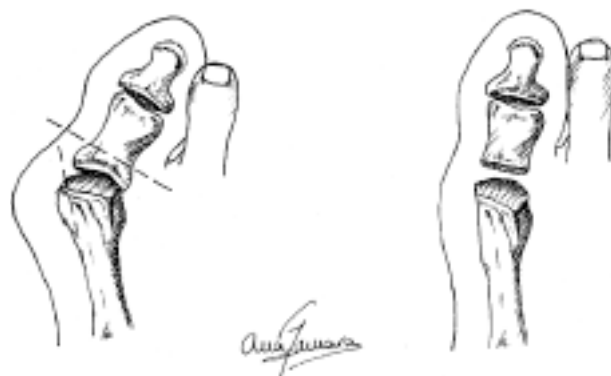


Figure 1. Diagram of the Keller-Brandes-Lelievre technique.

This type of surgery must be proposed in patients of an advanced age, with a sedentary life-style, who have an Egyptian foot with metatarsophalangeal arthritis. It is an alternative procedure to arthrodesis or the use of prosthesis. This technique must not be used in young patients or patients with a healthy metatarsophalangeal joint. Neither should it be used in more elderly patients if they carry out functionally demanding activities.

The most frequent complication of Keller's arthroplasty is transfer metatarsalgia. This is usually due to excessive shortening due to resection of more than one third of the proximal phalanx; this causes an abnormal support on the first ray.

Another less frequent complication, but a more specific one of this process, is cock-up deformity (hyperextension of the MTP and flexion of the IPI) caused by detachment or section of the tendon of the short flexor. This can be treated by dorsal capsulotomy and lengthening of the extensor tendon<sup>2</sup>, or in more severe cases, by metatarsophalangeal arthrodesis.

Table 1. Surgical techniques used for treating *hallux valgus*

	Description	Indications
Akin	Osteotomy of the base of the PF	Interphalangeal <i>Hallux valgus</i>
McBride	Capsulorrhaphy of the MTP + transposition of the adductor tendon to the medial edge of the first MT	Slight deformity MTP subluxation
Exostosectomy	Isolated resection of the medial prominence	Localized prominence with very little deformity in <i>hallux valgus</i> . Bed-ridden patient Ulceration
Chevron	Distal V shaped osteotomy, with lateralization of the head of the MT	Slight or moderate deformity
Mitchell	Transverse distal MT osteotomy	Slight or moderate deformity
Lapidus	Arthrodesis of the metatarso-cuneiform	Problems in the metatarso-cuneiform joint (excessive mobility, arthritis, varus)
Proximal osteotomy		Severe <i>hallux valgus</i> without great arthritis
Keller-Brandes	Resection of the base of the PF	Slight to moderate deformity with MTP arthritis Activities of a low functional demand
MTP Arthrodesis		Advanced MTP arthritis, RA, neuromuscular disease, rescue of other failed procedures

RA: Rheumatoid arthritis; PF: Proximal phalanx; MT: Metatarsal; MTF: Metatarsophalangeal.

A slight phalangeal resection can cause painful ankylosis, and even *hallux rigidus*, whose correction may be attempted by further resection. On the other hand, excessive resection results in an unstable toe with shortening, lack of strength and recurrence of the deformity.

The aim of this study is to determine the clinical, radiological and functional results in the long term of a substantial number of patients that underwent this surgery, as also to try to identify the factors related to a poor prognosis, so that these may help us to adjust the indications for this procedure.

## MATERIALS AND METHODS

To assess the results obtained over the long term by means of the Keller-Brandes-Lelievre technique we carried out a retrospective descriptive study of clinical histories of 97 patients operated between 1990 and 1997.

The inclusion criteria for this study were patients over 50 years of age, with a diagnosis of non-secondary HV, operated using the Keller-Brandes-Lelievre technique. The exclusion criteria were the presence of *hallux rigidus*, rheumatoid arthritis or other causes of secondary HV and any previous surgery of the first toe. We also excluded from the study patients with diagnosed cognitive deterioration, due to the impossibility of carrying out a subjective assessment.

Initially 97 patients were included in the study. A revision of the clinical histories of these patients made us further exclude 25 due to lost or misplaced documents. Eight patients died between the date of operation and this study and a further 15 could not be located by telephone. Of the 49 patients that complied with inclusion criteria, 19 refused to be included for a number of reasons, none of which were related to the operation; therefore we reviewed 30 patients, 61% of the final amount that complied with the inclusion criteria. Of these, 25 (83%) had both feet operated on at the same time, so we were therefore able to include 55 cases in the study.

The operations were all carried out by the same surgical team, using a standardized technique. Surgery was performed using low regional intraspinal anesthesia with ischemia of the limb either at the ankle or the thigh. A medial approach was used over the MPJ and the incision was made directly down to the bone. A capsular flap with a proximal base was created and the capsule was detached from the base of the proximal phalanx.

Subsequently, a careful removal of periosteum of the head of the metatarsal and base of the phalanx was performed and an exostectomy of the first metatarsal. The phalanx was then dislocated, approximately a proximal third of the phalanx was resected and the sesamoids released from the lateral aspect of the metatarsal. Part of the

joint capsule was resected and Lelievre's fibrous wiring was carried out to correct the varus of the metatarsal. This can be achieved to a greater or lesser degree depending on the possibilities of reduction of the first metatarsal at the metatarso-cuneiform joint.

In one case only was it necessary to perform temporary fixation using a Kirschner nail, which was kept in place for 4 weeks. Finally the skin was sutured with a "mattress" suture using silk and a careful cushioned bandaging of the foot in slight plantar flexion with neutral abduction-adduction was performed. Early load-bearing was allowed 24 hours after surgery. The patients remained hospitalized for a minimum of 48 hours with iv prophylactic antibiotics; control X-rays were carried out on entry and the bandages were changed during the first 24-48 hours. The stitches were removed after 2 weeks.

Measurements were carried out on the dorsoplantar X-rays taken with early and late load-bearing during the pre-operative and postoperative period (8-15 years postoperatively) of the metatarsophalangeal angle (HV), IM, metatarsal distal joint (DMAA) of the degree of subluxation of metatarsal head with reference to the sesamoids, of the percentage of resected phalanx and the degree of arthritis of the metatarsophalangeal joint according to Regnaud<sup>4</sup>.

The subluxation of the metatarsal with reference to the medial sesamoid was established at 0 to 3 degrees as described by Smith et al<sup>5</sup> in 1984, grade 0 is no displacement between the medial sesamoid and the axis of the first metatarsal, grade 1 is superposition of at least 50% of the sesamoid over the metatarsal axis, grade 2 is superposition of more than 50% and grade 3 is a metatarsal axis with complete medial displacement that goes beyond the sesamoid, that, we must remember, remains in place.

The amount of resected phalanx was calculated after measuring the total length of the phalanx before and after surgery, since it is known that both X-rays have the same focal distance and are therefore comparable.

To perform a clinical assessment, all the patients were interviewed using a validated questionnaire based on the *American Orthopedic Foot and Ankle Society Scale for Metatarsophalangeal or Interphalangeal Hallux*<sup>6</sup>. This scale on a total of 100 points, assesses pain (40 points), limitation of activity (10 points), footwear requirements (10 points), mobility of the metatarsophalangeal joint (10 points) and interphalangeal joint (5 points), metatarsophalangeal joint stability (5 points), presence of a corn (5 points) and alignment (15 points). Results were considered as: over 93 points, excellent; from 83-92 points, good; from 66-82 points acceptable, and below 66 points, bad (Table 2).

All data was processed and analyzed using the statistical software SPSS version 12.0. Student's "t" test was used to compare paired data with the same value measured dur-

**Table 2.** AOFAS<sup>6</sup> clinical assessment scale for *hallux valgus*

<b>MTP and IP scale for the first toe (100 points)</b>	
Pain (40 points)	
1. None	40
2. Slight, occasional	30
3. Moderate, daily	20
4. Intense, present almost all the time	0
Function (45 points)	
Limitation of activity	
1. No limitation of activity	10
2. No limitation of daily activities, such as work or leisure time activities	7
3. Limitation of daily and leisure time activities	4
4. Significant limitation of daily activities and leisure activities	0
Footwear requirements	
1. Fashionable, conventional shoes, without insoles	10
2. Comfortable footwear, insoles necessary	5
3. Orthopedic footwear	0
MTP mobility (dorsiflexion plus plantar flexion)	
1. Normal, slight restriction (75° or more)	10
2. Moderate restriction (30-74°)	5
3. Significant restriction (less than 30°)	0
IP mobility (plantar flexion)	
1. No restriction	5
2. Significant restriction (less than 10°)	0
MTP-IP stability (in all directions)	
1. Stable	5
2. Clearly unstable, possibility of dislocation	0
Corn related to MTP and IP	
1. No corn or asymptomatic corn	5
2. Symptomatic corn	0
Alignment (15 points)	
1. Good, <i>hallux</i> well aligned	15
2. Acceptable, certain amount of asymptomatic deviation	8
3. Poor, evident symptomatic deviation	0

AOFAS: American Orthopedic Foot and Ankle Society; IP: interphalangeal; MTP: Metatarsophalangeal.

ing different times of follow-up and Pearson's correlation coefficient was used for the direct comparison of quantitative variables. Statistical significance was  $p < 0.05$ .

## RESULTS

The mean follow-up was 9.6 years, with a minimum of 8 years and a maximum of 15. Of the 30 patients, 25 were women (93%) with a mean age at the moment of surgery of 62 years (range 53-74) and 72 at review. Of the 30 patients, 25 (83%) had both feet operated simultaneously in the same operation. Of the remaining 5, 4 only had their left foot operated and only one their right foot operated.

Of the 55 feet that underwent surgery, 29 (52.7%) simultaneously had surgery on some other toe, from the 2nd to the 5th, the most frequent procedure was on the 2nd toe (hammer toe) (26 feet, 47%), followed by 5th metatarsus in varus (tailor's bunion or bunionette) (6 cases, 11%).

According to data from preoperative X-rays (Table 3), patients could be classified in slight HV (HV < 20° and IM

**Table 3.** Preoperative and Initial and final postoperative x-ray data

	Pre-op	Initial post-op	Final post-op
HV angle	36.9° (16-62°)	12.2° (-26-40°)	25.4° (0-50°)
IM angle	14.9° (9-26°)	10° (4-22°)	11° (5-16°)
DMAA	17.1° (12-35°)	20.1° (5-45°)	21.8° (12-45°)
Sesamoid dislocation degree	2.49	1.04	1.27
Resected phalanx (%)		28.5% (14-46%)	

DMAA: distal metatarsal joint angle; HV: *hallux valgus*; IM: intermetatarsal.

< 11°) 3. 6% (2/55); as moderate (HV 20-40° and IM 11-16°) 58.2% (32/55); and as severe 38.2% (21/55).

After surgery average the results seen were: metatarsophalangeal angle 12.2°, IM angle 10° and average metatarsal-sesamoidal head incongruence 1.04. According to these data an average initial reduction of the metatarsophalangeal angle of 24.7° was obtained, or in other words, 67%. As to the IM angle, it was initially reduced in 4.9°, in other words, 33%. The degree of dislocation of the metatarsal with reference to the sesamoids changed from 2.49 to 1.04. All these reductions were statistically significant ( $p < 0.001$ ).

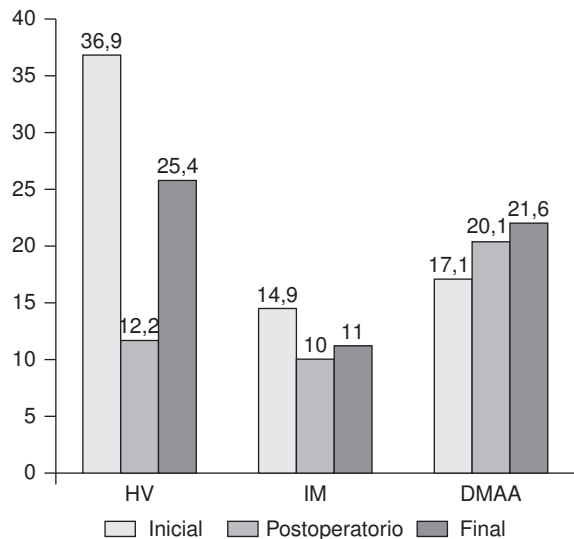
These results were achieved with an average resection of the proximal phalanx of 28.5%. In 22% of cases (12 de 55) the resection was greater than a third of the total length of the phalanx.

At the end of follow-up, the mean value of the measured angles was 25.4° for the *hallux* angle, 11° for the IM angle, 21.8° for the DMAA angle and an average metatarsal-sesamoidal dislocation of 1.27.

During the 9.6 years of mean follow-up the metatarsophalangeal angle (HV) changed from 12.2° to 25.4°: there was a loss of reduction of 13.2°, or in other words, a decrease of 53.4% (statistically significant,  $p < 0.001$ ). However, the IM angle changed from 10° to 11°, with only a loss of the initial reduction achieved of 20%. This was not statistically significant (Fig. 2).

The degree of medial metatarsal-sesamoidal dislocation changed from an initial 1.04 to a final 1.27 final (on a scale of 0 to 3)<sup>5</sup>. This increase of the degree of dislocation was statistically significant ( $p < 0.01$ ) (Table 3). A significant association ( $p < 0.05$ ) was also found between the IM angle and the degree of metatarsal-non-sesamoidal dislocation, both during the initial postoperative period as during final follow-up. Therefore, the greater the reduction of the IM angle, the more probable the reduction in the lack of congruence between the metatarsal head and the sesamoids (Fig. 3).

Clinical results assessed according to the AOFAS scale showed a mean of 80.7 points out of 100, with 34 out of 40



**Figure 2.** Mean values of early and late preoperative and postoperative X-ray angles. DMAA: Distal metatarsal joint angle; HV hallux valgus; IM: intermetatarsal.

for pain, 34 out of 45 for functionality and 12.7 out of 15 for alignment (Table 4). In 11 cases (20%) excellent subjective results were obtained (AOFAS total > 93 points); in 21 cases (38.2%) results were good (83-92 points); in 13 cases (23.6%) results were acceptable (66-82 points), and in 10 cases (18.2%) results were bad (less than 66 points).

Patients with an initially high intermetatarsal angle had worse clinical results on the AOFAS scale. Moreover, the decrease during the initial postoperative period of the MTP

and IP angles correlated with subjective clinical improvement (statistically significant results,  $p < 0.05$ ).

An increase in the percentage of proximal phalanx resected correlated with a lower score in the functional part of the scale (statistically significant  $p < 0.005$ ); however, this did not seem to affect total points.

As to complications, these were seen in only one case in which there was superficial infection of the surgical wound, and resolved with oral antibiotics, not requiring any further treatment. Moreover, one case of spontaneous ankylosis of the metatarsophalangeal joint was found (Fig. 4), this was an X-ray finding that did not affect the patient's functionality.

In 20 cases there were pathological conditions of adjacent toes seen during follow-up, although only 7 of these required surgical treatment. No residual *in varus* deformity was observed and only one cock-up (2%) deformity was seen. Recurrence, determined by X-ray, defined as a MTP angle greater than  $30^\circ$ , was 36%. Residual metatarsalgia was found in 13 cases (24%). None of the 55 cases studied required reoperation of their *hallux*.

## DISCUSSION

Having obtained clinical and x-ray follow-up data of the 61% of cases that complied with the inclusion criteria for this study can be considered a good result in a long term review (8 to 15 years' follow-up). A considerable number of patients could not be included due to the loss of their



**Figure 3.** X-ray images: preoperative (A), initial postoperative (B) and final (C) of the same patient. Note the formation of a "neoarticulation" at the base of the distal phalanx at 9 years of evolution.



**Table 4.** Clinical results according to the AOFAS<sup>6</sup> scale

	Mean	Range
Total	80.7/100	50-95
Pain	34/40	20-40
Function	34/45	17-40
Alignment	12.7/15	0-15

AOFAS: American Orthopaedic Foot and Ankle Society.

**Figure 4.** Spontaneous ankylosis of the MTP joint, which was an X-ray finding and did not affect the patient's functionality.

clinical histories, death or change of domicile; however, these reasons should not lead us to relieve that the results are biased, since these factors were neither caused nor by nor related to the process we are studying.

The patients were mostly women (93%), as in other studies<sup>7,8</sup>, and the mean age was comparable to that of other studies in the literature<sup>9,10</sup>. The clinical and radiological situation previous to surgery was also comparable to that seen by other authors<sup>9</sup>.

In our series we saw an important initial reduction after surgery of the MTP angle (from 36.9° to 12.2°, a reduction of 67%); however, over the time of follow-up, a large part of the achieved reduction is lost, and this finally reaches 25.4°. This can be due to low reliability of X-rays carried out during the early postoperative period used to assess the MTP angle, since the joint continues to possess laxity and

in 12 cases an initial *varus* deviation was seen of up to -26°, which causes an unrealistically low average. In none of these cases was this *varus* deviation maintained in subsequent reviews.

As to the IM angle, significant initial reductions of almost 5° are seen, which in this case are maintained with no significant variation during the almost 10 years' follow-up. These results agree with those seen by Viladot<sup>9</sup>, who also achieves lasting reduction. However, other authors, such as Lahm<sup>10</sup> or Zembsch<sup>11</sup>, present series in which there is no reduction of the IM angle, in fact there is even progression. In our opinion this discrepancy is due to the systematic performance in our series and in that of other authors in our area<sup>9</sup> of Lelievre's fibrous wiring. In 1989 Vitek<sup>12</sup> published a series in which he compares patients that underwent arthroplasty-resection with patients with associated fibrous wiring, and was able to show a greater reduction of the IM angle in patients that had undergone associated fibrous wiring.

Arthroplasty-resection was also effective in the reduction of dislocation between the metatarsal head and the sesamoids. It was seen that this correction was achieved more frequently and consistently in cases in which there was a greater reduction of the IM angle, which would confirm that it is not the sesamoids that are dislocated, but that these remain in their position and it is the metatarsal that suffers *varus* displacement. The percentage of cases with metatarsal dislocation with respect to the medial sesamoid (Smith<sup>5</sup> degrees 2 and 3) went from an initial 96.3% to 18.2% after surgery, and was 30.9% at the end of the study.

As was to be expected, the DMAA was not significantly altered during the long period of observation. Keller-Brandes' surgical technique does not alter the orientation of the joint surface of the metatarsal, since it does not include any procedure on the bone.

Clinical results base don the AOFAS scale show 58% of excellent to good results and only 18% of poor results, with a mean score of 80.7 points out of 100. And 55% were free of pain and only 31% had occasional pain. Only 14% complained of daily pain. These results are comparable with those obtained in series that assessed other techniques for treating HV in which long-term follow-up was carried out. Fokter<sup>13</sup> reviewed 153 patients on which he had performed a Mitchell osteotomy and obtained 64% excellent to good results, 22% satisfactory results and 14% poor results. Schneider<sup>14</sup> published a study of 112 cases of Chevron's osteotomy with a final score of 88 points on the AOFAS scale.

In a systematic review of the evidence published on surgical treatment of HV, Ferrari et al<sup>15</sup> concluded that there is not sufficient evidence to show clinical differences between Keller's arthroplasty and distal osteotomy. It must be pointed out that only 21 studies complied with the require-

ments necessary to be included in this metaanalysis, as many were of carried out using small samples and deficient methodologies.

The small number of complications seen in our series is striking. And it must be highlighted that none of the 55 cases included in the study required reoperation. Only one case of a superficial infection was reported and no neurological or vascular complications were reported.

As to residual deformity, no cases of varus deformity were seen. The frequency of X-ray recurrence was 36%, similar to that seen by other authors. However, in these cases there was no correlation with subjective poor clinical results. Only one case of a cock up deformity was found (2%), compared with a frequency of this deformity described in the literature<sup>10,11,16</sup> of 6%. As to the presence of residual metatarsalgia, the incidence in our series was 24%, in comparison with that found by other authors that report up to 50% and even 75%<sup>7</sup>.

In our series we described a 28% average phalangeal resection, and in only 22% of cases was the resection greater than one third of the total length and in no case did it reach 50%. However, other authors<sup>10</sup> recommend a resection of one third to one half the length of the phalanx. It has been shown that larger resections are the cause of metatarsalgia transfer and cock-up deformity. This could be the reason for the low incidence of these complications in our series in comparison with others.

In our experience long term clinical and radiological results of the Keller-Brandes surgery may be considered acceptable, as long as a careful technique is used, with special care being taken in soft tissue reconstruction and carrying out a resection of less than one third the total length of the proximal phalanx.

In conclusion, arthroplasty-resection is considered an aggressive technique, since it sacrifices the metatarsophalangeal joint; however, it allows good functionality and is effective in improving pain, and can therefore continue to be employed as a useful technique in the treatment of HV in elderly patients and those that have degenerative changes of the metatarsophalangeal joint of the first toe of the foot.

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