

## Original article

## Clinical course of the quintus varus supraductus osteotomy in postoperative patients subjected to the LP-INR surgical approach

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**ABSTRACT. Objective:** to evaluate the clinical course of patients subjected to the osteotomy designed at the National Rehabilitation Institute (LP-INR) with a memory staple to treat the congenital quintus varus supraductus deformity, from December 2002 to August 2009. Moreover, to show that the LP-INR osteotomy decreases weight bearing under the 5th metatarsal head, descends the phalanx, spares the metatarsophalangeal joint, and prevents relapses and pain. **Material and methods:** the study was conducted from December 2002 to August 2009 and included 51 patients with quintus varus supraductus deformity and 78 feet; 33 patients were males (64.7%) and 18 were females (35.2%), the Maryland clinical scale was applied at postoperative month six. The AOFAS scale was applied in the preoperative and postoperative periods to assess pain, gait and alignment. **Results:** the Maryland scale showed excellent results in 42 patients (84.3%), good results in 3 patients (5.8%), fair in 3 patients (5.8%) with a score of 75 to 50, and poor in 3 patients (5.8%). The AOFAS scale score for the forefoot was 55 + 8 preoperatively and 90 + 5 postoperatively. The Student t test was statistically significant in the preoperative and postoperative periods < 0.05. **Discussion:** the LP-INR osteotomy for the treatment of the congenital quintus varus supraductus deformity provides appropriate

**RESUMEN. Objetivo:** Valorar la evolución clínica de los pacientes a quienes se les realizó la osteotomía diseñada en el Instituto Nacional de Rehabilitación (LP-INR), con grapa de memoria para la deformidad del quinto dedo supraducto congénito en el periodo comprendido de Diciembre del 2002 a Agosto del 2009. Por otro lado demostrar que la osteotomía LP-INR disminuye el apoyo bajo la cabeza del 5to metatarsiano, desciende la falange conserva la articulación metatarso falángica, evita la recidiva y el dolor. **Material y métodos:** Se llevó a cabo de Diciembre de 2002 a Agosto de 2009, en 51 pacientes, 78 pies, masculinos 33 (64.7%), femeninos 18 (35.2%), pacientes con deformidad del quinto dedo en supraducto, se aplicó la escala clínica de Maryland a los 6 meses de postoperatorio. Escala de la AOFAS en el preoperatorio y postoperatorio para dolor, marcha y alineación. **Resultados:** Maryland excelente en 42 pacientes (84.3%), bueno en 3 pacientes (5.8%), regular en 3 pacientes (5.8%) de 75 a 50 puntos y pobre 3 (5.8%) pacientes. La escala de AOFAS para antepié preoperatorio 55 + 8 y postoperatorio 90 + 5. Con t Student estadísticamente significativo en el preoperatorio y postoperatorio < 0.05. **Discusión:** La osteotomía LP-INR para el tratamiento del quinto dedo supraducto congénito provee una adecuada alineación del quinto dedo con disminu-

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**alignment of the 5<sup>th</sup> toe with decreased load on the 5<sup>th</sup> metatarsal head and avoids broad resections that result in both cosmetic and functional alterations.**

**Key words: osteotomy, toe, foot, technique, pain, course.**

**ción de la carga de la cabeza del quinto metatarsiano, evita resecciones amplias que condicionan alteración tanto estética como funcional.**

**Palabras clave: osteotomía, dedo, pie, técnica, dolor, evolución.**

## Introduction

Prior to the studies conducted by Maceira in 2003 on weight bearing and gait kinematics, it was thought that in the human foot load distribution occurred by means of the metatarsals, which unevenly increased weight bearing. It is known that the 5<sup>th</sup> radius of the foot has a different mobility; the first one is the most mobile and strong one due to the musculature that attaches to it, followed by the 5<sup>th</sup> metatarsal with an unloaded foot. It was thought that the 1<sup>st</sup> and 5<sup>th</sup> metatarsals descended, due to the action of the musculature located underneath the central metatarsals, forming an arch whose width is shorter than the one found in a loaded foot. With the arch under static weight bearing, the former would be reduced as a result of the weight bearing of all the metatarsal heads; however, gait biomechanical studies conducted by the former author (rockers or fulcrums)<sup>1</sup> show that the weight bearing occurs simultaneously with the 5 metatarsal heads to prevent uneven loads that cause pain and hyperkeratosis or corns in the plantar region over the metatarsal head.<sup>2</sup>

The clinical application of gait analysis helps understand how pain, keratoses and toe deformities occur. Some alterations extrinsic to the metatarsal anatomical region may result in anterior foot pain, and other intrinsic ones may produce pain in areas different from the primary site of involvement of the metatarsals.<sup>2</sup> Applying Morton's theories, Martorrell states that the load born by the metatarsal heads performs an alignment, which is based on the dynamic balance between the angle that the metatarsals form with the horizontal and the transfer of a determined load to each metatarsal head. This transfer does not occur through a limited rigid surface, but rather by means of the plantar pad that reduces the pressure per square centimeter; the alignment is normal when all the heads bear their corresponding weight units at the same height.<sup>3</sup>

Biomechanics: The medial or internal column of the foot is composed of the first cuneiform and the first radius; this unit has a considerable motion potential in the sagittal plane. The lateral column is composed of the cuboid and the 4<sup>th</sup> and 5<sup>th</sup> metatarsals, and it is also mobile. The central column is composed of the 2<sup>nd</sup> and 3<sup>rd</sup> wedges with their corresponding radii; the stability of this column is crucial for the maintenance of the longitudinal arch, and its motion capability at the proximal level is virtually nil, mainly concerning the second metatarsal, due to its proximal anatomical locking mechanism among the three cuneiforms.<sup>4</sup>

In a standing position, the heads of the five metatarsals are in contact with the ground, so there is no anterior transverse arch, but at the level of the tarsometatarsal line there is a transverse arch that reminds one of the architecture of a Roman arch whose key lies in the second ray. The old hypothesis of the physiologic support in three points (calcaneus, first metatarsal head, 5<sup>th</sup> metatarsal head) has been ruled out; this situation corresponds to the middle ray insufficiency syndrome, which usually has an iatrogenic origin. During bipedestation, the inclination of the shaft of each metatarsal with respect to the ground decreases from the first to the 5<sup>th</sup> one.<sup>5</sup>

The balance of load sharing among the five rays depends on their appropriate alignment in the frontal, sagittal and transverse planes. The subtalar joint directly controls the overall alignment on the frontal plane. Upon static plantigrade weight bearing, the metatarsal inclination angle is the major factor when overloading of some or all of the radii occurs, but under dynamic conditions this parameter is not that important.<sup>1</sup>

Congenital toe deformities are often difficult to treat.<sup>6</sup> The quintus varus supraductus deformity is often times congenital; the hereditary influence of this deformity has not been clearly defined, but it seems to be linked to the «X» chromosome or to an autosomal dominant pattern. The deformity is frequently rejected by physicians and, if not treated, may lead to more serious toe pathology.<sup>7</sup>

The quintus varus supraductus consists of a toe in medial direction, with rotation and hyperextension due to extensor tendon retraction leading to dorsomedial dislocation of the metatarsophalangeal joint<sup>8</sup> due to the action of the extensor tendons and the flexion of the 5<sup>th</sup> toe. Deviated from their trajectory, the latter become stressed as the strings of a bow and deform the toe and its metatarsal, leading to displacement of the 5<sup>th</sup> metatarsal head to a plantar position and to further elevation of the proximal phalanx of the 5<sup>th</sup> toe, leading to supraductus (*Figure 1*).

This condition is usually bilateral and the deviation of the toe is more frequent than that of the metatarsal, with dorsal dislocation, and the supraductus in external rotation with respect to its longitudinal axis is more common. Thus the dorsal aspect and the nail are externally oriented, while the plantar aspect and the pulp face the inner part of the foot (*Figure 2*). This leads to keratosis on the dorsal portion of the interphalangeal joint. The relapsing deformity is due, in part, to the retraction of the dorsal soft tissues,

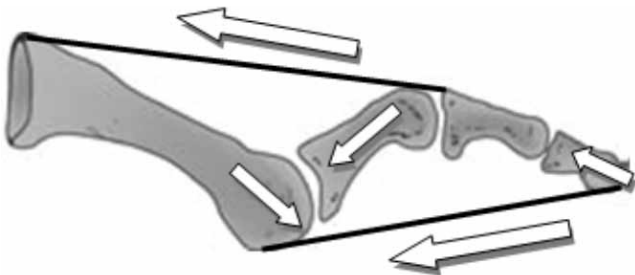
such as the extensor tendon and the skin.<sup>8</sup> The quintus varus supraductus also tends to shift medially and to be located on the 4<sup>th</sup> toe, leading to pain and plantar hyperkeratosis under the 5<sup>th</sup> metatarsal head, as well as difficulties for wearing standard footwear.<sup>9</sup>

Its natural course is benign, as 50% of patients do not report pain; painful symptoms occur in approximately half of all patients.<sup>9</sup>

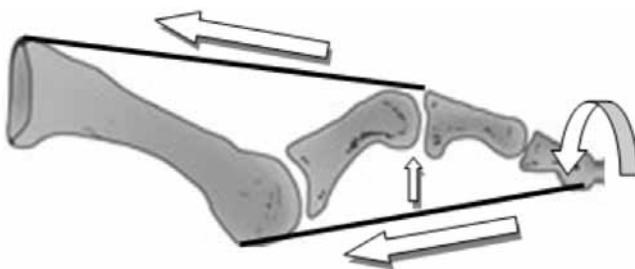
According to Cockin, this is a familial congenital malformation which also accounts for functional disability in a certain proportion of cases, but as pain is often absent, many patients with this defect do not require treatment.

In fact, they present for cosmetic reasons.<sup>10</sup> Symptomatic patients are usually adolescents or young adults reporting discomfort due to the dorsal callosities or hyperkeratosis leading to improper fitting of the standard footwear. The anatomical lesions involve only the soft tissues, so it is difficult to reduce the deformity due to the depth of the tissues affecting the dorsal surface or the toe;<sup>11</sup> in theory, there is no associated bone lesion. Often times this deformity does not resolve spontaneously, so if it involves pain, surgical treatment is justified.

Several surgical techniques have been described for the correction of this deformity, like the amputation of the 5<sup>th</sup> toe or the soft tissue release proposed by Lantzounis in 1940, which involves the distal detachment of the 5<sup>th</sup> toe extensor tendon, passing it through a hole in the 5<sup>th</sup> metatarsal. Lapidus, in 1942, split the extensor tendon over the 5<sup>th</sup> metatarsal, going from the distal to the proximal portion of the phalanx, and suturing it to the 5<sup>th</sup> toe abductor.



**Figure 1.** Type of deformity due to the retraction of the extensor and flexor tendons (Lateral view).



**Figure 2.** Type of deformity with external rotation of the toe with respect to the longitudinal axis (Lateral view).

Goodwin and Swisher, in 1943, combined the extensor tendon elongation with capsulotomy of the 5<sup>th</sup> metatarsophalangeal joint with a dorsal incision. Stamm (1948) and Willson (1943) performed extensor tenotomy with dorsal capsule release and «V-Y» plasty to release the skin tension. In 1959, Duvries performed extensor tenotomy, capsulotomy and skin release with an incision over the 4<sup>th</sup> interdigital space without good results.<sup>11</sup> Tenolysis of the 5<sup>th</sup> toe extensor is another surgical technique.<sup>12</sup> Bone tissue surgery was also described by Gocht and Debrunner in 1925, who enucleated the proximal phalanx through a lateral incision in the 5<sup>th</sup> metatarsal, same as Straub did in 1951. Ruiz Mora removed the proximal phalanx through a plantar elliptical incision that resulted in the plantar position of the 5<sup>th</sup> toe of the metatarsophalangeal capsulotomy through a dorsal and medial release, thus prolonging the extensor and the skin Z-plasty.<sup>13,14</sup>

McFarland in 1950 and Scrase in 1954 performed excision of the proximal phalanx plus syndactylization of the 4<sup>th</sup> and 5<sup>th</sup> toes, dividing the 5<sup>th</sup> toe extensor. Initially, Hohmann described in 1951 a condylocephalic osteotomy with displacement of the distal fragment in a plantar and lateral direction in the 1<sup>st</sup> metatarsal, for the correction of hallux valgus. Later he applied that same concept to the 5<sup>th</sup> metatarsal head, performing a metatarsal neck osteotomy with displacement of the distal fragment in a plantar direction and immobilization with a cast.<sup>15</sup>

Kelikian, in 1965, revisited the syndactylization of the 4<sup>th</sup> and 5<sup>th</sup> toes and Zanolli stabilized the correction obtained by suturing the distal end of the 5<sup>th</sup> extensor tendon to its abductor muscle.<sup>16</sup> Butler's 5<sup>th</sup> metatarsal arthroplasty uses a dorsal and a plantar skin incision with good results.<sup>17</sup>

One of the most widely used techniques for structured deformities is the one by Viladot, which consists of releasing the capsular structures of the metatarsal head and the proximal end of the phalanx with resection of the 5<sup>th</sup> metatarsal head, applying tension sutures to the abductor of the 5<sup>th</sup> toe to fix it to the upper articular flap, as a fibrous cerclage.<sup>18</sup> In children the management consists of extensor tenotomy, with release of the dorsal and medial capsule and syndactylization; in adults partial or complete resection of the proximal phalanx of the 5<sup>th</sup> toe is performed. McKeever in 1959 reported that major resection of the 5<sup>th</sup> metatarsal, together with amputation of the 5<sup>th</sup> toe finally ended up in the proximal to medial displacement of the 5<sup>th</sup> metatarsal due to the complete removal of the distal metatarsal, as well as the resection done between the 2<sup>nd</sup> and 3<sup>rd</sup> parts of the distal portion of the metatarsal, without amputating the 5<sup>th</sup> phalanx.

Zwierzchowski in Poland has provided surgical treatment for the correction of quintus varus supraductus using combined techniques, such as the transfer or the long extensor of the 5<sup>th</sup> toe with subcapital osteotomy to correct the 5<sup>th</sup> metatarsal (Assman and Lapidus procedure), with apparently good cosmetic and functional results.<sup>19</sup>

At the Neuromuscular Deformity and Foot Pathology Service, National Rehabilitation Institute, several sequelae of the surgical treatment of quintus varus supraductus have been revised and observed. One of them is the sequela of the Ruiz Mora technique that consists of the shortening of the 5<sup>th</sup> toe plus stiffness, and the dorsal position of the phalanx, causing plantar hyperkeratosis under the head of the same.<sup>20</sup> Butler's plasty produces the same deformity caused by the retraction of the scar tissue in the dorsal and plantar incisions during the «V-Y» plasty, which in the short or medium term causes the relapse of the deformity.

At our service, the patients with quintus varus supraductus report pain and inability to wear footwear, as well as painful hyperkeratosis under the 5<sup>th</sup> metatarsal head.

Considering the record of the Hohmann osteotomy of the 5<sup>th</sup> metatarsal with respect to the displacement of the metatarsal head to correct the hallux, as well as the foot biomechanics, it was decided to implement an original surgical technique that was named LP-ISR osteotomy (López-Parra, National Rehabilitation Institute), consisting of osteotomy of the 5<sup>th</sup> metatarsal head plus capsular release and extensor tenotomy, as well as memory staple fixation for the deformity of the congenital quintus varus supraductus. This leads to decreased weight bearing on the 5<sup>th</sup> metatarsal head and a descent of the phalanx to preserve the metatarsophalangeal joint, without the need of performing broad resections and avoiding deformity relapse and pain. This paper intends to review the clinical course of patients who underwent this treatment with a minimum follow-up period of 6 months during a 6-year period.

## Material and methods

This is a retrospective, longitudinal, descriptive, non-comparative clinical trial done from December 2002 to August 2009, in 51 patients (33 males, 18 females), and 78 feet (21 left, 15 right, and 21 patients with bilateral involvement or 42 feet), with a mean patient age of 15 years (range 15-35 years). The inclusion criteria were patients with quintus varus supraductus deformity of a congenital origin, with pain, inability or difficulty to wear normal footwear, and plantar hyperkeratosis at the level of the 5<sup>th</sup> metatarsal head, who accepted surgical treatment. The exclusion criteria were patients with quintus varus supraductus with a different etiology, with arthrosis at the level of the 5<sup>th</sup> metatarsophalangeal joint, with a history of surgery of the 5<sup>th</sup> toe, and who did not accept surgical treatment. The clinical Maryland scale was applied at the 6<sup>th</sup> postoperative month (excellent: 100 points, good: 89-75 points, fair: 75-50 points, and poor: less than 50 points) and the AOFAS scale for the forefoot with the Wilcoxon sign. The preoperative and postoperative data were compared using the Student t test for pain, gait and alignment. The radiographic measurements considered the Fick angle for the 1<sup>st</sup> and 5<sup>th</sup> metatarsals and the Davis-Hatt-Templeton angle for the 5<sup>th</sup> metatarsal.

**Surgical technique:** Under peridural block, and/or block of the lateral popliteal sciatic nerve, and ischemia of the involved limb, extensor tenotomy of the 5<sup>th</sup> toe was performed in the dorsal region, behind the head, with a scalpel blade # 11 or 64 for percutaneous surgery. An incision was performed along the lateral border over the head of the 5<sup>th</sup> metatarsal, and dissection was performed by planes. The articular capsule was identified and longitudinally incised, detaching it from the metatarsal head in a dorsal and plantar direction until complete release was achieved. The bone-cartilage junction was identified and there an osteotomy was performed with a small saw, from dorsal to plantar, at the bone-cartilage junction, parallel to the joint (*Figure 3*), with the oscillating saw. A cut was also performed from dorsal to plantar, with a 20°/25° inclination with respect to the metatarsal axis, being careful so as not to cut the plantar cortex (*Figure 4*). Once the cut was made, the osteotomized bone was removed and the osteotomy was closed with a drape clamp, preventing a fracture or cutting the plantar cortex because upon release of the metatarsal head from the articular surface, the latter would end up being totally loose, rendering its manipulation difficult. Once the osteotomy was closed, the holes to place the memory staple (MEMODYNE® No. 8 o 9 and/or SOLUSTAPLES® staples) were drilled; the staple was placed (*Figure 5*); in the case of the MEMODYNE®, the electrocoagulator was used in the mid part of the staple for appropriate compression (*Figure 6*). Once the osteotomy was stabilized, the descent of the toe was confirmed as well as the presence of enough room for the proximal phalanx and suturing by planes was performed (articular capsule, subcutaneous cell tissue and skin). After placing a compressive bandage, the patients were allowed to walk with footwear the following day. Ten days later the stitches were removed, and patients continued to use a bandage, gauze, and tie-shaped adhesive tape with hyperflexion of the 5<sup>th</sup> toe for another 15 days. The use of regular footwear was allowed 3-4 weeks after the surgery (*Figure 7*).

## Results

The same surgical technique, performed by 3 surgeons, was used in all patients. The Maryland scale was applied; excellent results were reported in 42 patients (84.3%), good



**Figure 3.** Distal dorsal osteotomy parallel to the articular surface.

in 3 patients (5.8%), fair in 3 patients (5.8%) and poor in 3 patients (5.8%). The AOFAS scale was applied to assess pain in the forefoot, gait and alignment preoperatively ( $55 \pm 8$ ) and postoperatively ( $90 \pm 5$ ). The statistical assessment with the Student t test was significant both preoperatively and postoperatively ( $<0.05$ ) for pain and alignment.

The plantar hyperkeratosis of the 5<sup>th</sup> metatarsal head improved in 42 patients (82.3%); painless hyperkeratosis was found in 6 patients (11.7%). Bone healing was complete at 6 weeks in 39 patients (76.47%), and at 8 weeks in 12 patients. Complications occurred in 2 patients with varus healing secondary to inappropriate staple placement or staple loosening, and one valgus healing that led to a relapsing deformity.

Radiographically, the preoperative Fick angle in the lateral view assessing the tilt angle of the 5<sup>th</sup> metatarsal was  $15^\circ$ - $40^\circ$ , with a mean of  $35^\circ$ .

The postoperative result was  $0^\circ$  to  $15^\circ$ , with a mean of  $5^\circ$ . The preoperative Davis-Hatt-Templeton angle was  $110^\circ$ - $145^\circ$ , with a mean of  $125^\circ$ , while the postoperative result was  $75^\circ$ - $90^\circ$ , with a mean of  $85^\circ$ .



**Figure 4.** Proximal dorsal osteotomy with  $20^\circ$ - $25^\circ$  of inclination.



**Figure 5.** Placement of the memory staple.

## Discussion

The quintus varus supraductus deformity is congenital and, in most cases, bilateral. It begins with pain at the level of the dorsum of the proximal interphalangeal joint of the 5<sup>th</sup> toe, as well as in the plantar region at the level of the 5<sup>th</sup> metatarsal head in the young adult patient. It causes disability for activities of daily living because of the pressure exerted by the footwear in the above mentioned regions of the 5<sup>th</sup> toe, as well as the plantar hyperkeratosis underneath the head of the 5<sup>th</sup> metatarsal.

Any surgical intervention involving the metatarsals may cause an elevation of their distal end, bone shortening and a combination of both. Most techniques achieve predomi-



**Figure 6.** Closure of the osteotomy through compression with a memory staple.



**Figure 7.** Preoperative and postoperative X-rays.

nantly one of the two mentioned effects. The floating toes cannot touch the ground during static bipedestation, which represents an important functional impairment with probable overload of the metatarsal head.<sup>2</sup>

Many techniques have been used to correct the quintus varus supraductus deformity, with apparently appropriate outcomes, mainly as a result of the soft tissue release. In the international literature each author advocates his own surgical technique, as is the case of the Zanolli procedure consisting of tenodesis of the 5<sup>th</sup> toe extensor tendon, he reports excellent results with apparent pain relief in all patients;<sup>8</sup> Tawil and Kelilian use a dorsal «Z»-plasty for medial retraction and dorsal capsulotomy of the metatarsophalangeal joint, plus tenotomy of the toe extensor, with apparently good short- and medium term results with a low recurrence rate of the deformity.<sup>15,16,21</sup> Concerning the results of phalangectomy, the Ruiz Mora technique has been commonly used with apparently good results in the long term. However, from the cosmetic perspective it involves a shorter toe with increased deformity, leading to patient dissatisfaction.<sup>20</sup> Butler arthroplasty has had excellent to good results, despite the broad soft tissue release and the absence of external immobilization; however, sequelae have been reported in patients, but all of them have been able to use standard footwear.<sup>22,23</sup> Syndactylization of the 4<sup>th</sup> space is another technique that is not accepted by patients in our setting for cultural reasons, unlike other countries, where it is considered as a simple technique, as it relieves pain and avoids radical amputation of the 5<sup>th</sup> toe.<sup>20</sup> Hohmann designed an osteotomy going through the neck of the 5<sup>th</sup> metatarsal, described for the 5<sup>th</sup> varus toe, displacing the metatarsal head in a palmar direction, fixing it only with soft tissues without any internal fixation.<sup>15</sup>

According to the biomechanical concept of the 5<sup>th</sup> metatarsal and measuring the Fick and Davis-Hatt-Templeton radiographic angles, the latter were found to be increased in a plantar direction, leading to overload of the 5<sup>th</sup> metatarsal. Therefore, the plantar displacement of the metatarsal head further increases the overload. The LP-INR osteotomy for the treatment of congenital quintus varus supraductus provides appropriate alignment of the 5<sup>th</sup> toe, with the respective diminution of the load on the 5<sup>th</sup> metatarsal head, avoiding broad resections leading to both cosmetic and functional alterations, since upon shortening the articular space, the proximal phalanx can descend, and the elevation of the metatarsal head diminishes the overload on it.

There is no consensus as to what is the best treatment; there may be several types of deformities and their treatments are discussed. However, being familiar with the deformity is important because early treatment is often necessary to achieve a successful outcome.<sup>3</sup>

In the case of the congenital quintus varus supraductus, even more important than the treatment is to know the cause. The latter is usually pain due to a mechanical conflict with the footwear; the cause may not be symptomatic if it does not affect the toe directly, but the deformity may persist.

In our case, the use of the LP-INR technique, same as for most of the authors mentioned in this paper, led to patients who were satisfied with the outcome and who would advise other patients to undergo the same surgery because of its good short- and medium-term results; moreover, it is not radical surgery as the proximal phalanx is spared, there are no retractile scars because of the type of approach used, and it reduces the pressure that occurs under the 5<sup>th</sup> metatarsal. It is possible to say that the assessment considering pain and the comparative preoperative and postoperative alignment was statistically significant.

This is a simple and effective surgical technique that reduces complications and requires less immobilization time, involves early weight bearing and rehabilitation and, therefore, a prompt and more effective resumption of daily life and work activities.

The condition of achieving a stable result seems to be based on a complete and spontaneous correction of the deformity at the end of the operation.<sup>21</sup>

As Dr. Viladot has said, a properly indicated intervention will lead to a good outcome, despite the execution errors that may occur; but a poorly indicated intervention will, in the best of cases, lead to leaving things as they were.<sup>2</sup>

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