Role of Prosthetic Alignment and Heterotopic Calcifications in Total Ankle Arthroplasty

Daniel S. Villena, Pablo Valenti, Jonathan Verbner, Pablo Sotelano, María Gala Santini Araujo, Leonardo Conti, Ana C. Parise, Marina Carrasco

Foot and Ankle Medicine and Surgery Sector, Orthopedics and Traumatology Service "Prof. Dr. Carlos E. Ottolenghi", Hospital Italiano de Buenos Aires, Autonomous City of Buenos Aires, Argentina

ABSTRACT

Introduction: The main objective of this work is to evaluate the relationship between the formation of heterotopic calcifications and the alignment parameters of the prosthesis. **Materials and Methods:** The population under study comprised 31 patients. The radiographic alignment variables evaluated were alpha and beta angles, the talar center of rotation, and the percentage of posterior coverage of the tibia in the immediate postoperative period and after 2 years. The clinical evaluation variables were: VAS, AOFAS, and the SF-36 questionnaire to evaluate quality of life at the end of follow-up. **Results:** The most frequent etiology of osteoarthritis was post-traumatic (67.7%). In the immediate postoperative period, the mean alpha angle was 88.7° (range 82-92.6°; SD± 2.61); the mean beta angle was 84.46° (range 78°, 62-91.40°; SD ±3.59). The alignment of the tibial component in the anteroposterior plane was neutral in 25 patients (80.6%), valgus in 6 (19.4%), and varus in none. At 2 years of follow-up, 96% presented heterotopic calcifications. An improvement was verified both in the AOFAS (pre/post 31.90/80.94) and in the VAS scales (pre/post: 8.7/1.97) (p<0.05). **Conclusions:** No relationship was found between heterotopic calcification and worse functional outcomes or pain, except for quality-of-life parameters (SF-36) such as physical condition, emotional limitation, and general health perception, which worsened as the degree of calcifications around the prosthesis increased.

Keywords: Alignment, heterotopic calcifications, quality of life

Level of Evidence: IV

Rol de la alineación de la prótesis y las calcificaciones heterotópicas en la artroplastia total de tobillo

RESUMEN

Introducción: El objetivo principal fue evaluar la relación entre la formación de calcificaciones heterotópicas y los parámetros de alineación de la prótesis. **Materiales y Métodos:** La población estaba formada por 31 pacientes. Se evaluaron variables radiográficas de alineación, como ángulos alfa y beta, centro de rotación astragalino y el porcentaje de cobertura posterior de la tibia en el posoperatorio inmediato y a los 2 años. Las variables de evaluación clínica fueron: la escala analógica visual y la escala de la AOFAS, y el cuestionario SF-36 para evaluar la calidad de vida al final del seguimiento. **Resultados:** La etiología más frecuente de la artrosis fue la postraumática (67,7%). En el posoperatorio inmediato, el ángulo alfa promedio fue de 88,7° (rango 82-92,6; DE ± 2,61); el ángulo beta, de 84,46° (rango 78,62-91,40; DE ± 3,59). La alineación del componente tibial en el plano frontal fue neutra en 25 pacientes (80,6%), en valgo en 6 (19,4%) y en varo (0%). A los 2 años de seguimiento, el 96% tenía calcificaciones heterotópicas. Mejoraron los puntajes en la escala de la AOFAS (preoperatorio/posoperatorio: 31,90/80,94) y en la escala analógica visual (preoperatorio/posoperatorio: 8,7/1,97) (p <0,05). **Conclusiones:** No se halló una relación entre calcificaciones heterotópicas y peores resultados funcionales ni de dolor, excepto en los parámetros de calidad de vida (SF-36), como el rol físico, la limitación emocional y la percepción de la salud general, que empeoraron a medida que aumentó el grado de calcificaciones alrededor de la prótesis.

Palabras clave: Alineación; calcificaciones heterotópicas; calidad de vida.

Nivel de Evidencia: IV

Received on August 2nd, 2022. Accepted after evaluation on September 18th, 2022 • Dr. DANIEL S. VILLENA • dsvillena@hotmail.com https://orcid.org/0000-0001-5742-1226

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INTRODUCTION

Heterotopic calcification (HC) is a frequent phenomenon after a total ankle replacement: the published incidence oscillates between 3.8% and 82%,[1] and can even reach 100%.[2] The cause remains unclear. Some authors have linked it to age, male sex, surgical time, the osteoarthritis's etiology, and the prosthesis's lack of bone coverage.[3-5]

One theory,[3] based on Wolff's law, suggests that the ankle's larger misalignment could generate more tension in the surrounding soft tissue and, hence, more calcification. In turn, these neoformations could impact functional clinical outcomes. However, little is known about the relationship between prosthesis alignment and HC formation.

The main objective of this study was to evaluate the relationship between HC formation and the alignment parameters of the prosthesis. The secondary objectives were evaluating the relationship between the HCs and assessing clinical outcomes.

MATERIALS AND METHODS

This retrospective series presents >18-year-old patients who underwent a third-generation ankle arthroplasty between 2007 and 2018. Patients with incomplete clinical or radiographic records, <2 years of follow-up, and revision surgeries were excluded.

The demographic variables evaluated were sex, age, body mass index, and comorbidities.

Clinical analysis

Before the operation, the history of surgeries on the same ankle or foot, and the etiology of osteoarthritis were assessed. We also used the visual analog scale (VAS) for pain and the AOFAS scale (*American Orthopaedic Foot and Ankle Society*) before surgery and after two years. At the end of follow-up, quality of life was evaluated with the SF-36 health survey. The patients who suffered some kind of complication during follow-up, as well as the indicated treatment, are specified.

Radiographic analysis

Weight-bearing anteroposterior and lateral ankle radiographs were taken before surgery and in the immediate postoperative period (week 4), and after one and two years. All radiographic measurements were taken by three orthopedists.

The radiographs' angle parameters were evaluated in the immediate postoperative period, and after one and two years, to assess potential changes through time.

To study prosthesis alignment in the frontal plane, the alpha angle was taken[6] (varus: >92, valgus: <86)[7]; for tibial inclination in the lateral radiograph, the beta angle was used[6]. The positive value was set at <86°, while diminutions (>92°) were considered negative values.[7]

The position of the center of rotation of the talus, the offset of the prosthesis, was evaluated in relation to the longitudinal axis of the tibia in the lateral projection[8]; it can be placed ahead of the axis of the tibia (positive), behind it (negative), or in the center (neutral) (Figure 1).

The size ratio between the tibial component of the prosthesis and the tibia itself was also analyzed, using an adaptation we have developed for the Hintegra® prosthesis, based on those created by other authors.[3,5,9] The aim was to quantify the degree of posterior coverage or lack thereof.

The size ratio of the tibia and the tibial component of the prosthesis (coverage) was assessed in the lateral radiograph of the immediate postoperative period. Two lines parallel to the tibial component were drawn: one from the posterior edge of the tibial component's anterior wall to the component's posterior edge (line A), and the other up to the tibial line's posterior cortex (line B). The ratio was measured based on both lines (line A/line B x 100), resulting in the coverage percentage. It is considered to be 100% when both edges of the tibia and the tibial component are aligned along the vertical axis. Any value exceeding 100% is considered an over-coverage (the prosthesis protrudes posteriorly), while any value below 100% is an under-coverage (the tibia protrudes posteriorly).

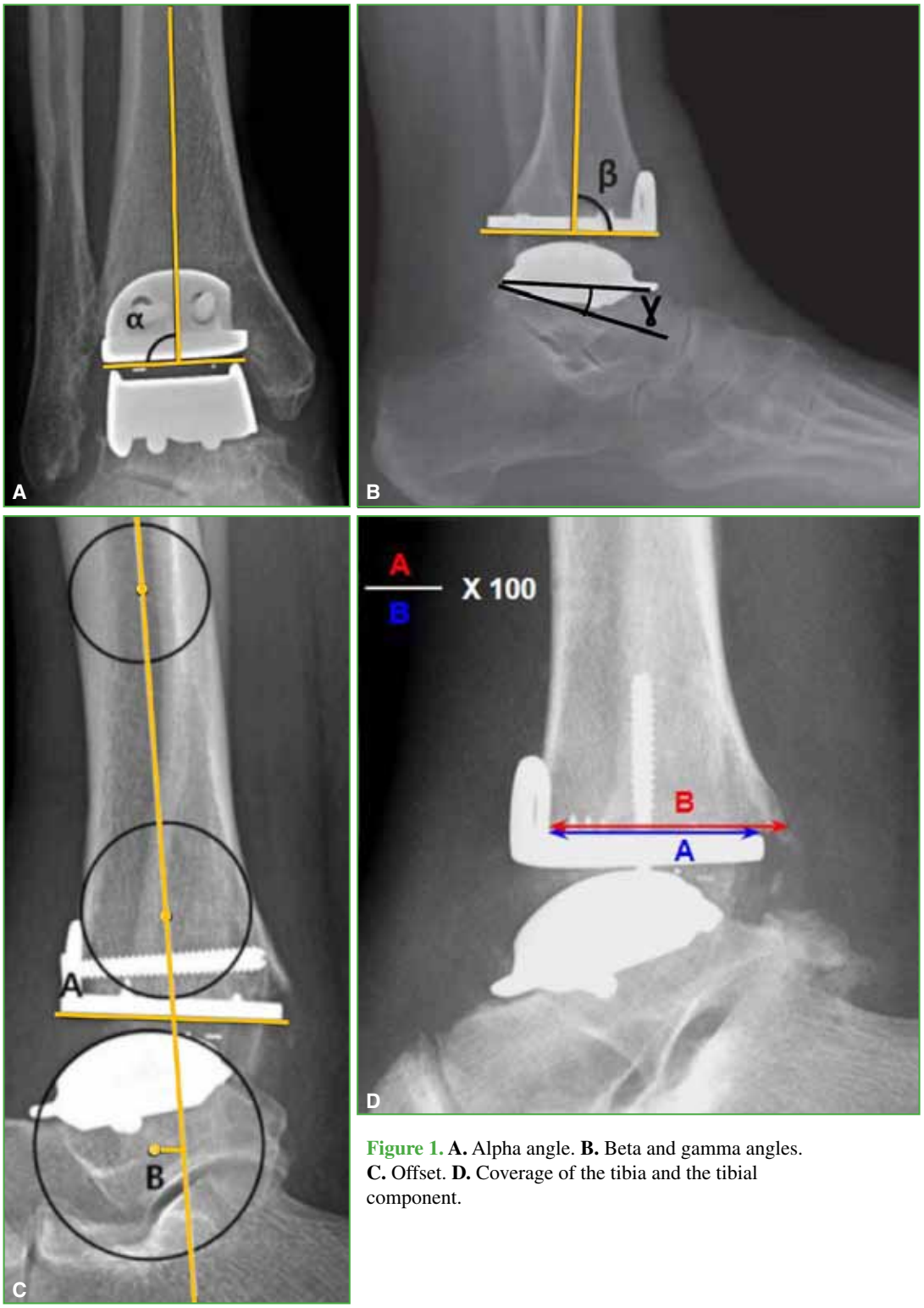

Figure 1. **A.** Alpha angle. **B.** Beta and gamma angles. **C.** Offset. **D.** Coverage of the tibia and the tibial component.

HC was defined as any bone neoformation in the postoperative radiographs (anteroposterior and lateral) after six weeks of surgery.[3] Said calcifications were evaluated with radiographs one and two years after the intervention. These radiographs were compared to those of the immediate postoperative period, with the aim of ruling out the presence of postoperative remnant osteophytes and distinguishing them from those neoformations. In the lateral projection, they were evaluated using Brooker's classification (as modified by Choi *et al.*[10]) for the posterior compartment, and Jung *et al.*'s[11] classification for the anterior compartment. With the purpose of describing them in the anteroposterior plane, we have developed a topographic classification as an attempt to standardize their description in this plane (Figure 2).

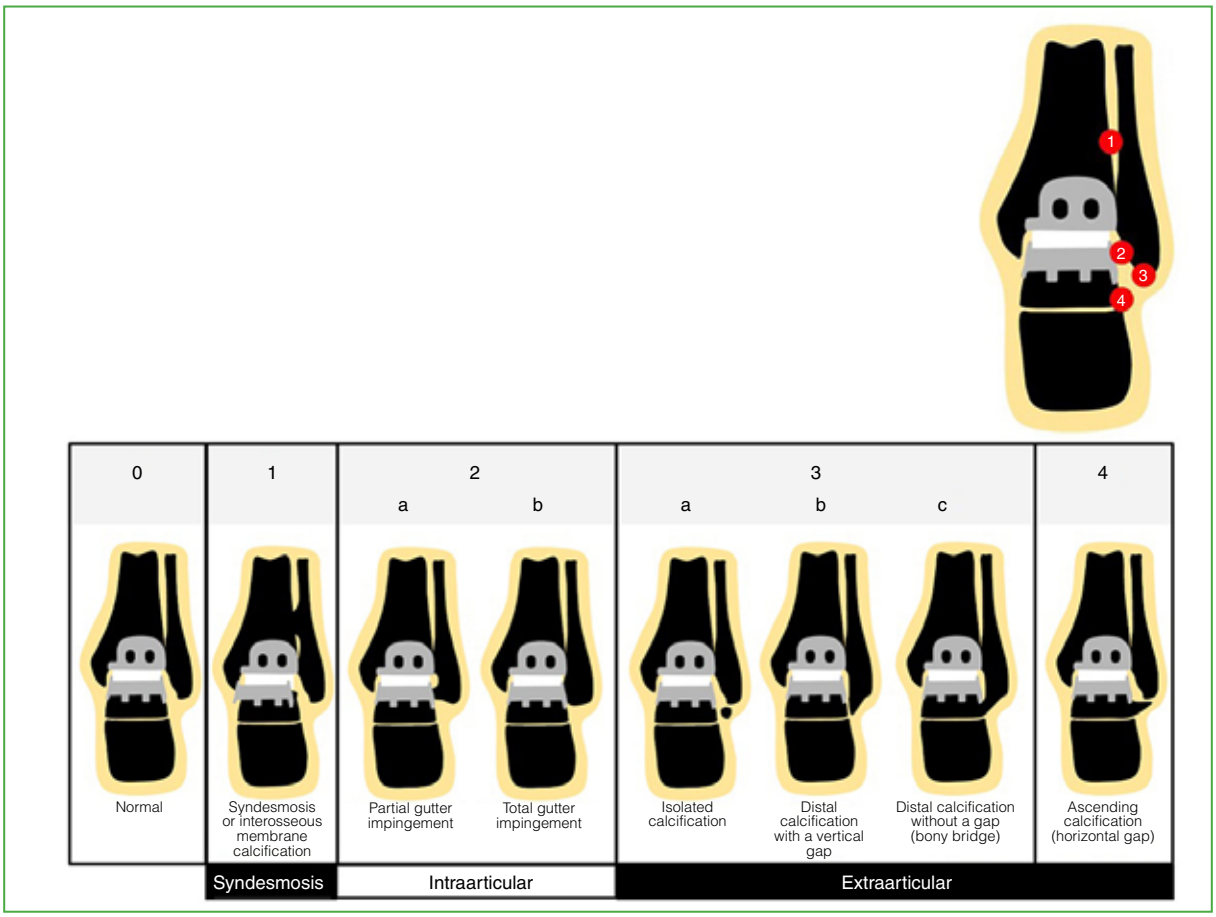

Figure 2. Descriptive classification of heterotopic calcifications in the coronal plane.

We propose a topographic classification of HC associated with ankle arthroplasty which seeks to describe the position of said calcifications in the coronal plane. Since the independent impact of each bone neoformation's position on clinical outcomes is unknown, this classification does not describe severity.

It is divided into four zones that can be subdivided. The zones are numbered incrementally from the most proximal, which is the syndesmosis (zone 1), ascending through the gutter (zone 2) and the inframalleolar region (zone 3), until the most distal, which is the talar (zone 4). In turn, medial calcifications were called M and lateral calcifications were called L. The patients with two or more ossifications are described independently, with their respective nomenclature. Calcifications in zones 1 and 2 are considered intra-articular, while those located in zones 3 and 4 are considered extra-articular. Within zone 2, we propose one subtype that compromises the gutter partially (a) and a second subtype that compromises it totally (b). In turn, zone 3 was subdivided into ossifications with no direct contact with other bones, in isolated form (a); those which continue towards the tip of the malleolus (b); and those which form a complete bony bridging between the malleolus and the talus (c).

Surgical technique

All arthroplasties were performed with the same third-generation prosthesis model (Hintegra®, Integra, Plainsboro, New Jersey/New Deal, Lyon, France). The surgeries were practiced by the same surgical team. Additional procedures were added to the original technique when necessary (ligament reconstruction, Achilles tendon lengthening, etc.).

Statistical analysis

Regarding descriptive statistics, the absolute and relative frequencies of qualitative variables were calculated and entered into double-entry tables, calculating them by column. The mean, median, and standard deviation of the quantitative variables were also calculated.

The relationships between categorical variables were investigated using Pearson's X^2 test, whenever possible; when not possible, Fisher's exact statistical was calculated in the 2x2 tables.

To analyze the difference between quantitative variables, we used the nonparametric Mann-Whitney U test for independent samples and the Kruskal-Wallis test for larger groups; in both cases, this was due to the impossibility of supposing the normality of data distribution.

The SPSS, Windows v. 22 program was used for statistical analysis, and the Excel program, to draw graphics and tables. A $p = 0.05$ value was considered statistically significant.

RESULTS

Out of 61 patients treated with total ankle arthroplasty in our Center, 30 (49%) did not complete the follow-up, which left a total of 31 for the study. The average age was 55.8 years (range 87-32, SD ± 14.6). There were no bilateral cases. Fifteen (48.4%) arthroplasties were performed on right ankles and 16 (51.6%) on left ankles.

Three patients (9.7%) were diabetic; three (9.7%) were smokers; and four (12.9%) had rheumatoid arthritis. The average body mass index of the population was 27.9 kg/m^2 (SD ± 4.3). Nineteen (61.3%) had previous ankle surgeries.

The most frequent etiology of osteoarthritis was post-traumatic (67.7%; 21 cases).

Additional procedures were performed on 16 patients (51.6%): six (19%) on bone tissue and 10 (23.3%) on soft tissue.

Five patients (16.1%) suffered complications: two (6.4%), an intraoperative fracture of the inner malleolus, which required fixation during the surgery itself, and three, postoperative complications: a fracture of the medial malleolus which required reduction and osteosynthesis, one wound dehiscence which improved with topic treatment, and one stress fracture of the fifth metatarsal which was treated with a Walker boot. No cases required revising the arthroplasty.

Prosthesis alignment

In the immediate postoperative period, the average alpha angle was 88.7° (range 82-92.6; SD ± 2.61) and the average beta angle was 84.46° (range 78.62-91.40; SD ± 3.59).

The alignment of the tibial component in the frontal plane was neutral in 25 (80.6%) patients; out of the rest, six (19.4%) were valgus and 0 (0%), varus. Regarding the alignment in the sagittal plane (beta), it was neutral in 14 (43.4%) patients and positive in 17 (54.8%); there were no negative values.

Regarding the center of rotation of the talus in relation to the longitudinal axis of the tibia (offset), the alignment was neutral in nine (29%) patients, ahead of the axis in 22 (71%), and none behind.

In 19 (61%) patients, a lack of posterior coverage was observed in the immediate radiograph, with an average coverage of 95.26% (range 84-104.17).

The aforementioned variables suffered no statistically relevant modifications throughout the two years of follow-up (Table 1).

Table 1. Immediate postoperative alignment in the anteroposterior and lateral planes

Prosthesis alignment	
Alpha angle (mean)	88.69°
Beta angle (mean)	84.74°
Varus	0%
Valgus	19%
Neutral	25%
Negative offset	0%
Neutral offset	29%
Positive offset	71%

Heterotopic calcifications

The prevalence of HC in the sagittal plane after one year was 0% in the anterior region and 80% in the posterior; the latter increased significantly, up to 96%, after two years of follow-up. Furthermore, not only the incidence but also the degree of calcification increased (Table 2).

Table 2. Heterotopic calcifications in the lateral plane

Heterotopic calcifications in the lateral plane		
	1 year	**2 years**
Brooker 0	19.4%	3.2%
Brooker 1	16.1%	12.9%
Brooker 2	22.6%	6.5%
Brooker 3	29%	32.3%
Brooker 4	12%	45.2%
Jung 0	93.5%	93,5%
Jung 1	6.5%	6,5%
Jung 2	0%	0%
Jung 3	0%	0%
Jung 4	0%	0%

In the coronal plane radiograph, based on the descriptive classification proposed in this study, 22 patients (70.9%) had HC one year after surgery and 29 (93.5%), two years after surgery (Table 3).

Table 3. Heterotopic calcifications in the coronal plane

Heterotopic calcifications in the coronal plane		
	1 year	**2 years**
0	29.03%	6.50%
M3b	22.65%	19.40%
M2a	12.83%	9.70%
M2b	6.45%	12.90%
M3a	6.45%	3.20%
1	3.23%	3.20%
L2b	3.23%	3.20%
L3a	3.23%	3.20%
L3b	3.23%	3.20%
M3a	3.23%	3.20%
M4	3.23%	3.20%
L2a	3.23%	12.00%
M3c	0.00%	16.10%

Functional outcomes

A statistically relevant improvement was obtained both in the AOFAS scale score (preoperative/postoperative: 31.90/80.94) and in the VAS score (preoperative/postoperative: 8.7/1.97) (Table 4).

Regarding the SF-36 survey, very good results were achieved on pain, and the social and emotional roles, and good results on the physical role, vitality, and general health perception.

Table 4. Clinical evaluation

Clinical evaluation			
	Preoperative	**Postoperative**	**p**
AOFAS scale	32	81	<0.005
VAS	9	2	<0.005

AOFAS = American Orthopaedic Foot and Ankle Society; VAS = visual analog scale.

Correlations

Patients with primary osteoarthritis presented a higher proportion of elevated stages of posterior HC one and two years after the surgery. The proportion of posterior HC was higher in women two years after the surgery, yet both correlations were statistically irrelevant ($p > 0.05$). Higher age was linked to elevated stages of posterior HC two years after surgery, with a statistically significant difference ($p < 0.05$).

No relationship was observed between the tibia's posterior coverage and elevated stages of HC one and two years after surgery; these differences were statistically irrelevant (p >0.05).

Regarding alignment parameters, it was observed that the greater the misalignment in the coronal plane (alpha angle), the greater the degree of HC in the posterior compartment after two years (p >0.05). In the sagittal plane, as the beta angle diminished (augment of lateral tibial inclination), the degree of posterior HC after two years increased. However, both differences were statistically irrelevant. Although we found a relationship between valgus misalignment and elevated stages of HC one year after surgery, this difference was not statistically significant.

There was no statistically relevant relation between AOFAS scale scores and elevated stages of posterior HC. It was observed that the VAS score diminished with the increase of elevated stages of posterior HC two years after surgery, but these differences were statistically irrelevant (p >0.05).

Regarding the SF-36 survey, the average for physical role is lower in elevated stages of posterior HC after two years; emotional limitation and general health perception are lower in elevated stages of posterior HC after two years, and the differences were statistically relevant in the three variables (p <0.05).

71% of the patients had HC in the anteroposterior plane one year after surgery, and 93.5% after two years. 19% presented HC in more than one location after two years.

DISCUSSION

HC is a frequent phenomenon after a total ankle arthroplasty. It has been related to certain demographic variables and personal precedents. Lee *et al.*[12] state that there are no differences regarding sex, age, body mass index, the cause of osteoarthritis, and previous surgeries. For their part, Valderrabano *et al.*[13] hold that HC is more frequent in patients with post-traumatic osteoarthritis, while Manegold *et al.*[3] found no link between sex or the etiology of osteoarthritis and said ossifications. On the contrary, Choi and Lee[9] observed that the incidence of HC doubled for the male sex. In our study, HC was more frequent in the female sex (p >0.05). Although the most common etiology for osteoarthritis in our patients agrees with the publications (post-traumatic)[13], no direct relation with the HC was found (p >0.05).

In our study, HC prevalence was 6.5% in the anterior region and 80% in the posterior; the latter increased significantly, up to 96%, after two years of follow-up, coinciding with Manegold *et al.*:[3] from 86.4% (76/88) (p = 0.002) to 99% (87/88) after three years of follow-up. Besides, in our series, not only the incidence of HC increased, but also its stage (Table 2).

Published reports on HC in ankle arthroplasty are disparate, since some authors do not distinguish between different locations. Most studies are limited to analyzing posterior HC mainly.[12] It is communicated that, often, HC appears as an amorphous shade noticed in the radiograph, from the first month after the surgery onwards.[12] Jung *et al.*[11] published that they could detect HC (in the anterior compartment) from week six on. In 2011, based on a series of 90 operated ankles, Choi and Lee[9] informed that 31 ankles had HC, 30 of which appeared during the first year after surgery. Likewise, some studies revealed that HC appeared within two years after ankle arthroplasty.[9] Lee *et al.*[12] affirmed that the published prevalence of these HC usually oscillates between 3.8% and 82%, and communicated a 25% (20 out of 80 patients) of postoperative HC in a series of patients who had been fitted with a Hintegra® prosthesis. Natens *et al.* found a prevalence of 42% in 26 patients. In the study by Valderrabano *et al.*[13], 63% of patients had HC; San Giovanni *et al.* communicated an 82% incidence with the Mobility® prosthesis, all of them in the ankle's posterior region. None of those patients required treatment because they presented neither symptoms nor friction syndrome in the ankle.

Regarding posterior HC, it has been published that 40.6% of patients who underwent an arthroplasty with Hintegra® had HC: one case (7.7%), Brooker class 1; two cases (15.4%), Brooker class 2; and 10 cases (76.9%), Brooker class 3.[10] For their part, Haymanek *et al.*[14] observed a 100% of posterior HC (79 patients) at the end of follow-up and informed that classes 2 (31.6%) and 3 (51.9%) were the most relevant, followed by classes 1 (13.9%) and 4 (2.5%). Lee *et al.*[12] published that 25% of their patients operated with Hintegra® presented posterior HC: four Brooker 1 (20%), five Brooker 2 (25%), four Brooker 3 (20%), and seven Brooker 4 (35%). Kerkhoff *et al.*[15] found a 71.6% (73 ankles) incidence in the posterior compartment. In a study with 107 patients, King *et al.*[5] observed 86% of posterior bone growth 18 months after surgery. In our series, the percentage of posterior HC was 80%, with a greater prevalence of the higher stages (Brooker 4), coinciding with the publications of the previously cited authors; in turn, this prevalence increased significantly, up to 96%, after two years of follow-up.

The presence of anterior HC in ankle arthroplasty has also been scarcely studied. Lee *et al.*[12] have explained that, being less frequent, they are less studied and published. These authors analyzed a series of 80 arthroplasties, with only three cases (3.75%) of anterior ossification. In our series, only two patients (6.5%) had anterior HC at the end of follow-up. It could also be the case that the typical anterior wall of the tibial component in the Hintegra® design precluded the formation of said anterior calcifications.[12] So much so that King *et al.*,[5] comparing two populations operated with the Hintegra® and the Salto Talaris® prostheses, observed a greater number of anterior ossifications in patients with the Salto Talaris® prosthesis.

Regarding ossifications in the frontal plane, the scarce studies that mention the incidence of HC in the anteroposterior plane indicate that the prevalence is 56.8% in the medial zone.[15] Lee *et al.*[12] divided the ankle into four quadrants and detected HC in the posteromedial quadrant in five cases (25%); in the posterolateral quadrant, in five cases (25%); in the anteromedial and posterolateral quadrants, in two cases (10%); and in the anterolateral and posteromedial quadrants, in only one case (5%).

Based on the descriptive classification proposed in this study, 22 patients (70.9%) presented HC in the first year after surgery, increasing to 29 patients (93.5%) in the coronal plane after two years; the medial zone was the most frequent location.

As regards the analysis of the ankle's axis, Choi *et al.*[10] found a neutral alignment in 84% of their 32 patients operated with the Hintegra® prosthesis, while 12% were varus and 3%, valgus. King *et al.*[5] add that more prostheses were used with a positive slope (beta angle) than with neutral or negative slopes in the sagittal plane. Haytmanek *et al.*[14] obtained an average alpha angle of 87.8 and an average beta of 87.5. Manegold *et al.*[3] inform that frontal neutral alignment was obtained in 84.1% of cases, while 14.8% were varus and only one prosthesis (1.1%) was valgus. Two-thirds of the patients (59/88; 67%) presented a neutral alignment of the sagittal slope. Although this study found a correlation with the lack of alignment in the anteroposterior plane (varus), it was not statistically relevant.

In our case, with regards to the alignment of the tibial component in the frontal plane, we obtained an anatomical alignment in 25 (80.6%) patients; six (19.4%) were valgus and no case was varus. As for the alignment of the tibial component in the sagittal plane (beta), it was neutral in 14 (43.4%) patients and positive in 17 (54.8%); there were no negative values. Regarding the center of rotation of the talus in relation to the longitudinal axis of the tibia (offset), the alignment was neutral in nine (29%) patients, ahead of the normal axis in 22 (71%), and none behind the axis.

The study of the lack of posterior coverage in the tibia has garnered interest lately, as a consequence of theories that suggest that lack of posterior coverage in the tibial cut would yield greater bone exposure, predisposing to the appearance of posterior ossifications.[11,16] This would explain why they are so frequent in this location.[12] Different ways to measure it according to the various prosthesis models have been described, so there is no standardized measuring method as of yet, making it difficult to compare.

In 2013, King *et al.*[5] reported a mean tibial coverage of 89% (range 73-100) with the Salto Talaris® model, and a negative correlation between the degree of tibial coverage and the formation of hypertrophic bone. In 2011, Choi and Lee[9] analyzed 90 ankles operated with the Hintegra® model and informed that 10 components (11.1%) were small; 79 (87.7%), optimal; and one (1.2%), big. However, they found no significant link between the HC and the degree of coverage. In our series, there were four (12%) cases of over-coverage, eight (25.8%) of normal coverage, and 19 (61%) of under-coverage. The average total coverage was 95.26%. Coinciding with the findings of the cited authors, we have found no significant relationship between lack of coverage and posterior osteogenesis.

In relation to the position of the talar axis of rotation, we had a lower proportion of cases with posterior offset than those published. In a series with the Hintegra® prosthesis, there were eight (25%) cases with neutral offset, 21 (65%) anterior cases, and three (9.4%) posterior cases.[10] Other series inform 27 (30.7%) neutral cases, 28 (31.8%) anterior cases, and 33 (37.5%) posterior cases.[3] In our series, the offset was neutral in nine (29%) patients, anterior in 22 (71%), and posterior in no patients.

As for pain improvement (VAS) after arthroplasty, Jung *et al.*[17] published that the mean pain score diminished from 8.3 to 2.0 in patients with the Hintegra® model. Choi *et al.*[10] communicated an average VAS score of 7.63 prior to surgery and 2.13 after surgery in 22 patients with arthroplasties using the Hintegra® model.

Some authors[9,11] found no association between the degree of HC and clinical outcomes (with neither the VAS nor the AOFAS scores). In our series, a statistically significant improvement was obtained in the VAS score (preoperative/postoperative: 8.7/1.97), with a trend similar to those published and a slight reduction in the VAS score with the increase of advanced stages of posterior HC after two years, although this was not statistically relevant ($p > 0.05$).

It has been extensively described that the AOFAS score improves after ankle arthroplasty. Various authors have published that the AOFAS score improved between the preoperative and postoperative periods, from 46.50 to 81.84, and from 45.7 to 85.2.[10,11] In our series, we observed a statistically relevant improvement of the AOFAS score (preoperative/postoperative: (31.90/ 80.94). As published in some studies,[9,15,18,19] we found no relation between the presence of HC and worse AOFAS scores ($p > 0.05$).

Although the articles that use the SF-36 survey to evaluate the quality of life after a total ankle arthroplasty are scarce,[20,21] we found that the average for physical role is lower in the elevated stages of posterior HC, and that the emotional limitation and general health perception are lower in elevated stages of calcifications, with statistically relevant differences in the three variables ($p < 0.05$).

In a 2020 systematic review,[2] it was stated that the rate of reoperation owing to HC in patients with ankle arthroplasty was 7.2% (range 0-32). Valderrabano *et al.*[13] communicated one of the highest rates of reoperation due to HC, which amounted to 34.2% of the 63% of detected HC in their patients. Other authors published lower rates of reoperation, such as Lee *et al.*[12] (2.5%) and Overley *et al.*[1] (2.3%). In our series, there were no reoperations owing to symptomatic ossifications, just as informed by King *et al.*[5]

The causes of HC formation in arthroplasties are still unknown.[11] It has been proposed that the excessive dissection of soft tissue, bone traumatisms, the excess of remnant bone debris during surgery, and the appearance of hematomas could be the origin of said ossifications.[12,22] Some authors hold as well that ankle misalignment after arthroplasty could predispose to these bone neoformations[1], and that they could be provoked by chronic tension in the ligaments.[2] Based on our experience, our findings and published data, we believe that the factors that predispose to the appearance of such calcifications depend not so much on the patient's variable, but on the variables inherent to the surgical technique and the prosthesis model.

The weaknesses of our study were the small number of patients, which, in some cases, precluded us from making statistical relation inferences; the impossibility to evaluate the range of motion and its relation to the degree of calcifications; and the retrospective design. The tomographic assessment of the HC would be more precise than the radiographic. Regarding the strengths, there are few studies that relate prosthesis alignment with the development of HC. Most evaluations and classifications are described in the sagittal plane, neglecting the coronal plane. We also propose a descriptive classification for the HC in the coronal plane, as there are no publications that deal with this.[23] Our classification will possibly garner the interest these ossifications deserve in future studies.

CONCLUSIONS

In this study, we detected a high rate of HC two years after surgery, without a clear connection between the different parameters of prosthesis alignment and HC formation. No relation between the presence of HC and worse functional or pain outcomes was found, except for some quality of life parameters (SF-36) —i.e., physical role, emotional limitation, and general health perception— which became worse as the degree of calcifications around the prosthesis increased.

The proposed classification will be useful to describe HCs in the anteroposterior plane, thus enabling their study. We observed that their prevalence is high and that they have been hitherto underestimated, perhaps because there is no classification that allows their proper study.

Conflict of interest: The authors declare no conflicts of interest.

P. Valenti ORCID ID: https://orcid.org/0000-0001-6946-4127
J. Verbner ORCID ID: https://orcid.org/0000-0001-7040-2097
P. Sotelano ORCID ID: https://orcid.org/0000-0001-8714-299X
M. G. Santini Araujo ORCID ID: https://orcid.org/0000-0002-5127-5827
L. Conti ORCID ID: https://orcid.org/0000-0003-2333-5834
A. C. Parise ORCID ID: https://orcid.org/0000-0001-7308-3693
M. Carrasco ORCID ID: https://orcid.org/0000-0002-1251-4936

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