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Special Article

Müller-Weiss disease: the state of the art

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Abstract

Müller-Weiss disease generates complex biomechanical changes in the feet, and although it is a rare disease, its true prevalence is not known. In addition to the low population incidence, some cases remain asymptomatic, which contributes to the disease being underdiagnosed or even unknown by the general orthopedist. Its most striking clinical feature results from the combination of paradoxical flatfoot with insidious midfoot pain, resulting in different degrees of difficulty for ambulation and progressive collapse of the plantar arch. Treatment begins with the conservative approach, and surgical treatment is indicated when failure occurs. In this review, we intend to clarify the subject, as misunderstandings or delays in diagnosis negatively impact treatment outcomes by worsening anatomical changes and functional deviations that arise from these issues. There are few studies on this disease, most of them being case series, which highlights the need to concentrate on performing multicenter studies that can collaborate in clarifying the numerous issues involving this deformity. In summary, Müller-Weiss disease is rare and complex, with its etiological characteristics and treatment still lacking consensus in the literature. Due to the absence of validated therapeutic algorithms, we continue to adopt individualized treatment for each foot, tailored to the specific characteristics of each patient.

Level of evidence V; Therapeutic studies - investigating the results of treatment; Expert opinion.

Keywords: Necrosis, Avascular, of Bone; Flatfoot; Tarsal bones; Review literature; Treatment.

Introduction

Müller-Weiss disease (MWD) is a rare condition that affects the navicular bone, resulting in progressive collapse and deformity of the plantar arch[1,2]. Its etiology is not completely understood, but it is believed to be multifactorial[3], involving both genetic factors (previous anatomical deformities such as metatarsal adduct and hindfoot varus) and biomechanical factors (athletes with exhaustive training in high-impact sports and requiring rapid and successive changes of direction in childhood and adolescence as occurs in tennis, football, etc.)[4], as well as nutritional aspects, such as environmental stress (wars, droughts, floods) and epidemics (consumer diseases, malnutrition) with individual action during childhood and, in some cases, adolescence[2,3,5-7].

Therefore, including this disease in the differential diagnosis for patients presenting with painful foot complaints and progressive deformity of the plantar arch is crucial[8]. Early diagnosis and appropriate treatment are essential to prevent complications and improve the quality of life for affected patients.

State of the art

Although evidence of MWD was found in Ancient Egypt[9], only in 1927 Walter Müller described it in a patient with severe tarsal navicular deformities. The radiographic changes characterized by sclerosis, thinning, and bone fragmentation, were attributed to compressive forces in the tarsus[1,2]. In the same year, the Austrian radiologist Weiss[10] described two other similar cases, and from then on, the disease became known as Müller-Weiss disease, although Schmidt[2,6] published a similar case about a patient with endocrinopathy. Müller in 1928[11] proposed that clinical and radiographic changes began in childhood due to some congenital defect, not associated with trauma, based on the

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finding of histologically normal tarsal navicular. However, in 1927, Weiss, who had worked with Robert Kienböck, believed that the main cause of the disease was osteonecrosis of the tarsal navicular[12].

In 1939, Brailsford[13] considered trauma an important factor in the development of the disease and coined the term "listhesis navicularis" to describe the displacement of the bone fragments after their fragmentation. Other synonyms, such as "adult tarsal scaphoiditis" or "bipartite navicular bone," have been used with less historical importance[13].

The prevalence and incidence of the disease remain unknown. It is more common in females, in the proportion of at least 2:1, reaching up to 9:1[2,3,5,6,12,14-23]. Bilateralism is more frequent than unilateralism[2,5,6,12,14,18,19,21,22]. It usually affects individuals between the fourth and sixth decades of life[2,5,6,12,14,15,16,19,21-25], although Maceira and Rochera find patients between 13 and 91 years of age, with a mean of 47.6 years at the time of diagnosis[3]. Doyle et al.[7] present a series of 12 cases[7], where a 14-year-old case was described, showing that although adolescents can be affected, it is an exception to the rule.

Still, in epidemiology, WMD affects patients with high body mass indexes[2,5,6,11]. Fornaciari et al.[26] report a mean body mass index of 29.6 kg/m^2, with a mean of 27 kg/m^2[14].

In the study by Molina et al.[27], it was found that obese patients with MWD presented unsatisfactory functional results, with reduced levels of quality of life. Although statistical significance was only in the SF-12 score, both in the physical and mental domains, this suggests that the trend of the patient's nutritional aspect warrants further observation and study.

In 2004, Maceira and Rochera[3] presented the largest case series in the literature, including 121 patients (191 feet), and proposed the cause of the disease as the combination of delayed navicular ossification—mainly due to a nutritional deficiency associated with intense environmental stress, such as wars and extreme poverty or the presence of endocrinopathies—with the abnormal distribution of tarsal weight-bearing compressing the navicular lateral portion by the talus head against the lateral cuneiform. This condition is associated with the subtalar joint varus and may be associated with the presence of a short first metatarsal that can lead to insufficiency of the first radius and abnormal lateralization of forces during gait overloading the second radius and the navicular lateral portion[2,6,12,14,22,28].

The navicular is the last tarsal bone to ossify, between two years in girls and four years in boys, and a failure in ossification can lead to higher shearing forces at the lateral cuneiform level[2].

The navicular is perfused by two arteries. The dorsalis pedis supplies the dorsal and lateral face of the bone, while the medial plantar artery supplies the plantar face of the navicular. The arterial supply has a circumferential pattern resulting in a centripetal that has a decreased blood supply, which may further reduce with age and may develop into osteonecrosis of the central third of the navicular or stress fractures[12,21], but not of its lateral portion as occurs in MWD[2,6,29].

Considered the cornerstone of the medial column of the foot, the navicular bone contributes to the integrity of the medial and transverse longitudinal arches of the foot. When fragmentation of the dorsolateral portion occurs with navicular collapse, progressive deformity and malalignment of the midfoot and hindfoot are installed, since any lateral displacement of the compression forces in the navicular can lead to greater flattening and bone fragmentation. With its collapse, there is secondary lateral displacement of the talus head and the consequent hindfoot varus[30]. With the advance of the disease, more collapse and fragmentation of the navicular result in the direct articulation of the talus with the lateral cuneiforms, creating sufficient space to allow plantar flexion of the talus head and, consequently, the paradoxical varus planus foot[2,3,12,21,30].

Hetsroni et al.[15] evaluated the distribution of plantar pressure in patients with MWD, demonstrating an increase in midfoot pressure, especially in the most lateral portion, associated with a reduction in toe pressure[3,15]. This pattern may contribute to the notable phenomenon of patients with MWD not developing hallux valgus[3,29],. Additionally, it appears to reflect an attempt by the plantar fascia to compensate for midfoot collapse through a realignment mechanism involving toe dorsiflexion[15].

Over the last century, other etiological possibilities have been proposed, such as trauma, congenital dysplasia, osteonecrosis associated with autoimmune conditions such as rheumatic diseases, systemic metabolic diseases such as diabetes, smoking, use of corticosteroids, alcohol, hematological diseases and abnormal evolution of Köhler disease[2,3,5,12].

The differential diagnosis involves Köhler disease, although it is unilateral in 75% to 80% of cases, affecting mainly male patients aged three to seven years, and being a self-limited pathology. In contrast, MWD is more often bilateral, affecting substantially more females and having a more dramatic evolution with progressive pain and deformity[2,5,21,31,32].

Secondary navicular osteonecrosis, post-traumatic, either by direct trauma, stress fracture, or pathological, that is, associated with diseases such as rheumatoid arthritis, systemic lupus erythematosus, or renal failure, usually causes unilateral involvement and systemic changes compatible with the underlying pathology[33]. Charcot arthropathy, on the other hand, is associated with an insensitive foot, usually due to peripheral neuropathy, especially in patients with Diabetes Mellitus[2].

Several pathologies can evolve into acquired flatfeet, such as progressive collapsing foot deformity, trauma, tarsal coalition, and neurological diseases, among others that, in general, occur with valgus flatfeet, not varus or neutral as occurs in MWD. Rheumatic diseases can evolve in some cases, with paradoxical flatfoot being an important differential diagnosis[8].

Tan et al. describe a single case with histology compatible with osteonecrosis[31]. Subsequently, this histological finding was observed by Singh and Ferrero in 2014, in a case of navicular necrosis associated with Mee lines (striated leukonychia) in the nails of the first and second toes affected, generating the hypothesis of temporary arterial occlusion; however, the histology compatible with navicular osteonecrosis was not evidenced in any other study in the literature[34], although another study concluded that the MRI findings are compatible, but not specific for osteonecrosis[35]**.**

Histological studies found degenerative and reactive changes in bone[14] and navicular cartilage[36], as well as reductions of bone trabeculate, medullary fibrosis, and degenerative changes in the anatomopathological study described by Viladot et al.[37].

Mohiuddin et al.[6] propose that MWD is a sequelae of undiagnosed or underdiagnosed navicular stress fractures with the hypothesis that the central third of the navicular (hypovascular) is subjected to maximum shear stresses[6]. However, this theory does not explain the fragmentation of the lateral third, and there are no reports of MWD complicating navicular stress fractures[2].

Although Maceira and Rochera[3] and Monteagudo and Maceira[28] suggest the participation of environmental and social factors as predisposing, Doyle et al.[7] did not identify them in the etiopathogenesis.

The disease pathogenesis remains uncertain. Maceira and Rochera[3] suggest the delay in ossification is associated with abnormal forces distributed through the foot as prerequisites of the disease. Thus, we have a chondral structure more vulnerable to plastic deformity, leading to a deformed navicular bone. The delay in ossification may be due to extrinsic nutritional deficit (malnutrition, low socioeconomic status) or intrinsic (endocrinopathies, gastrointestinal diseases that interfere with nutrient absorption)[3,19,28].

In addition to the delay in ossification, there must be an excessive compression force on the lateral half of the navicular, between the talus head and the cuneiform, which may occur due to the primary varus of the subtalar joint, shortening of the first radius due to brachymetarsis (congenital or acquired) of the first metatarsal or deformities such as mild or undiagnosed congenital clubfoot. The hypermobility of the first radius also leads to lateralization of the load forces during gait overloading the second radius and the most lateral portion of the navicular[3,6,28].

Normally, the axial forces with the foot in plantar flexion transit through the first and second metatarsal-cuneiform joints, moving from the medial to the lateral half of the navicular that then suffers the pressure of the talar head.

However, the forces from the second metatarsal and intermediate cuneiform undergo less resistance, generating a maximum stress zone in the central third of the navicular, lateral to the center of the talar head. This area also has less vascular supply, which can generate stress fractures and consequent bone fragmentation, especially in the dorsolateral region of the navicular[2,3,6,28].

As the condition evolves, a space is created that takes the talus head to a plantar flexed position, clinically generating the paradoxical flatfoot in which the calcaneus assumes the stick position while the medialization of the cuboid occurs and the retroversion of the fibula in relation to the tibia with consequent external ankle rotation[3,6].

Although paradoxical flatfoot is the classic clinical manifestation associated with MWD, this deformity may arise as a result of other diseases not related to WMD or the most prevalent congenital deformities[38].

Initially, the clinical symptoms consist of chronic mid- and hindfoot, dorso-medial edema, and, in the most advanced stages, the paradoxical flatfoot. Secondary to the hindfoot varus, external tibial torsion occurs, generating anterior knee pain and later arthrosis[3,12,30]. It should be noted that there are reports of MWD with neutral calcaneus[23] or even some cases with valgus flatfoot, according to five cases included in the Haller et al. series[35] although the paradoxical flatfoot is the classic finding of the disease, it is not, however, a pathognomonic finding, according to Aebi et al.[38], which draw attention when finding varus flatfoot without associated MWD. Although Welck et al.[19] reinforce the obligation of the hindfoot varus to establish the MWD, Wong-Chung et al.[22] demonstrated through radiographic goniometry (talocalcaneal angle in AP incidence (Kite), talo-first metatarsal angle (Méary) and calcaneal moment-arm (Saltzman), obtained in the evaluation of 68 feet diagnosed with MWD the occurrence of hindfoot varus in only 33% of patients, determining that the finding of the paradoxical flatfoot is not a finding that defines the disease.

The diagnosis is clinical and radiographic. Maceira and Rocheira[3] propose a radiographic classification based on the lateral incidence in orthostasis. The degree of deformity is measured using the metatarsal talus - I angle (the angle formed between the talus long axis and the first metatarsal in the lateral incidence in orthostasis and whose normal value ranges from 0 to 10 degrees; above this value, the angular vertex pointing to the sole of the foot indicates the flatfoot). The stages are descriptive, and the symptomatology may not correspond to the degree of radiographic deformity. There are four stages described (Figure 1):

- Stage I: no radiographic change or, if it occurs, it is minimal; in nuclear magnetic resonance, there may be intraosseous edema, and a mild varus of the subtalar joint may occur;
- Stage II: a dorsal angle of the Meary angle occurs with dorsal subluxation of the talar head;
- Stage III: compression or division of the navicular with loss of the longitudinal arch, reduction of the space between the talar head and the cuneiforms, clinically the hindfoot is in varus, and the Meary angle is neutral;
- Stage IV: paradoxical plano foot occurs with equine hindfoot and plantar angulation of the Meary angle;
- Stage V: complete extrusion of the navicular with the formation of the talocuneiform joint.

Wong-Chung et al.[39], in 2023, analyzing 95 cases, suggested the categorization of WMD into three groups with similar radiographic characteristics to allow more accurate comparisons of the results of different forms of treatment. Unfortunately, neither the Maceira classification nor the classification proposed by Wong-Chung can inform or predict the prognosis of the different degrees of WMD. We hope that combining these two approaches, complemented by new studies, can help determine factors or parameters that correlate with the best therapeutic outcomes for these patients.

In addition to the radiographic findings already described, we can detect some others such as the formation of large dorsal osteophytes in the midfoot; navicular in the form of a "comma" or hourglass due to the collapse of its lateral half[6,12,17,19,35]; lateral or dorsolateral fragmentation of the navicular[3,6,12,17,19,35]**;** enlargement of the tarsal sinus indicating hindfoot supination [6,12,19,30]; reduction of the talocalcaneal angle[12,19,30], degenerative changes in the talar head; medialization of the cuboid in relation to the calcaneus (Figure 2); hypertrophy of the second metatarsal due, probably, to the lateralization of the compressive forces from the first to the second metatarsal, absence of the index plus metatarsal formula with a secondary shortening of the first metatarsal favored mainly by the internal rotation of the medial portion of the navicular[3,6,12,19,30,32].

Despite the clinical and radiographic criteria proposed by Maceira and Rochera[3], the diagnosis is challenging, partly due to the lack of knowledge of the disease and the wide variation of radiographic findings, generating some controversy in the literature, Ahmed et al.[40,41] describe seven adolescent patients using as inclusion criteria the radiographic presence of the navicular "in comma" and clinically of flatfoot with hindfoot in neutral or with mild valgus, a detail in disagreement with much of the literature, where the hindfoot of patients with MWD is in varus, in addition to being young and obese patients, while the literature mentions a very rare involvement in young people with low body mass index as emphasized by Myerson[42].

Weight-bearing computed tomography allows the evaluation of the relationship between the midfoot and the hindfoot, allowing a dynamic analysis of the regions involved and the deformity under the effect of the weight-bearing on the foot involved, playing an important role in the reconstruction planning[19]; however, it is not an easily accessible exam in the Brazilian reality, and it is possible to rely on this resource in very few services at the moment. Computed tomography, especially with three-dimensional reconstruction, has its place in preoperative planning, allowing the verification of osteoarthritis in adjacent joints, analysis of possible fracture lines, measurement of the shortening of the medial column, and evaluation of bone quality and stock[5,19,21,25]. Mayich[25],

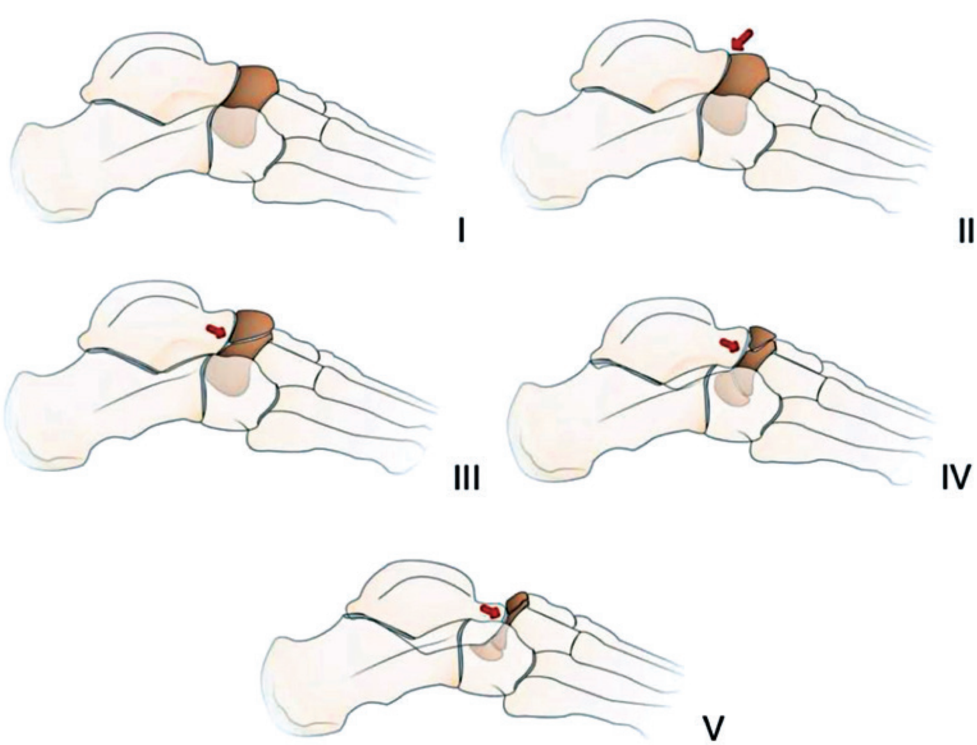

Figure 1. Classification of Maceira (authors' collection).

based on the findings of computed tomography, adds the presence of subtalar arthrosis in stage IV of the Maceira and Rochera classification[3].

Nuclear magnetic resonance aids in the differential diagnosis of conditions like stress fractures, osteonecrosis, or infection. It also enables the evaluation of soft tissues, such as the spring ligament and posterior tibial tendon, and is highly sensitive in detecting bone edema, early signs of perinavicular arthrosis, and potential hidden stress fractures[12,21,30,33,35].

Regarding treatment, many authors initially propose non-surgical treatment for periods ranging from 2 to 60 months[2,3], during which non-hormonal anti-inflammatory drugs, support or accommodation orthoses[41], activity restriction, or even a cast immobilization without weight-bearing[5,12,14,25] are used.

For the success of the non-surgical treatment, Mayich[25] alerts to the importance of six factors: (1) patient guidance for understanding the pathology and engagement with the proposed treatment; (2) modification of physical activities, replacing high-impact activities on the midfoot by swimming or cycling, for example; (3) reduction of body weight to minimize overload in the midfoot; (4) modification of footwear with the use of a convex-rigid sole (blotter); (5) use of semi-rigid insoles with support of the medial arch custom-made to fit the patient; (6) consider rigid orthoses for patients who are not candidates for surgery and have not responded to the other measures.

In general, the purpose of orthoses treatment and alteration of shoes in conservative treatment is to reduce the mobility of the midfoot[30] with the discharge of the talonavicular joint in the phase of the detachment of the calcaneus during gait. Thus, Fernández de Retana et al.[43] recommend semi-rigid insoles supporting the medial longitudinal arch, with satisfactory evolution in many cases. Perisano et al.[21], as well as Monteagudo and Maceira[28] and Hermena and Francis[30], mention the possibility of using insoles with a valgus wedge in the hindfoot, in addition to the rigid support of the medial arch with symptomatic improvement in about 80% of the cases. Ruiz-Escobar et al.[4] use insoles with total pronator wedge, that is, from the hindfoot to the forefoot in the retrocapital region of the fourth and fifth metatarsals, correcting, in addition to the hindfoot varus, the relative supination of the forefoot, with good results in ten feet described, avoiding surgical procedures in seven feet. In more advanced cases with talonavicular arthrosis, rigid orthoses can be important in controlling peritalal movement and generating symptomatic relief[2].

Many studies, however, suggest little response to non-surgical treatment[12,19,26,31,44].

According to most of the literature, the severity of the symptoms and not the deformity determines the surgical indication, although most surgical patients are in stages III, IV, or V. Surgical procedures aim to obtain a plantigrade foot, with pain relief, restoration of the medial longitudinal arch and the plantar cavus, as well as the Meary angle[5,6,12,25,30,45].

Liu et al.[23] highlight the importance of using computed tomography and nuclear magnetic resonance imaging in surgical planning, especially in Maceira stage IV, allowing the identification of adjacent joint arthrosis, and thus ensuring

Figure 2. Patient 1, classic findings in the right foot, navicular in "comma" with tapering of the lateral portion, index minus, and medialization of the cuboid.

the best procedure for each case. Wong-Chung et al.[22] use radioisotope emission tomography, the so-called Single Photon Emission Computed Tomography (SPECT-TC), to guide the surgical indication.

Arthrodesis aims to achieve the goals of surgical treatment on feet with painful and degenerative joints, while reconstruction procedures aim to achieve goals by realigning the axes of the foot in joints without degenerative arthropathy.

There are several proposed surgical procedures:

- Percutaneous decompression of the navicular[46];
- Isolated talonavicular arthrodesis[16,26,29,47-50];
- Osteosynthesis of the navicular[33];
- First ray arthrodesis (talo-navicular-cuneiform)[20,24,43,51-53];
- Double arthrodesis (talonavicular and calcaneal cuboid)[23];
- Open or arthroscopic triple arthrodesis[16,20,54];
- Allograft interposition arthrodesis[31];
- Calcaneus valgus osteotomy[3,45,55];
- Resection of the diseased navicular bone and reconstruction of the medial column with femoral head bone graft[31];
- Resection of the diseased navicular bone and filling the gap with an autologous spongy graft from the iliac crest[44];
- Associated techniques (talonavicular or talonavicular-cuneiform arthrodesis and calcaneus osteotomy)[43,49].

All these procedures, in general, require the use of autologous, allogeneic, structural, or morselized grafting, depending on the case and the surgeon's preference, with good results reported[6,16,24,36,43,44,51,56].

All techniques can also be associated with calcaneus tendon elongation[6,43] and/or calcaneus valgus osteotomy if significant residual varus is detected[3,28,49].

Isolated talonavicular arthrodesis is a good option in cases where the subtalar and calcaneal-cuboid joints are preserved[26,29,57] (Figure 3). However, this procedure has the highest rates of consolidation failure [43,51], although Cao et al.[57] reported a 100% success rate in their series of 16 patients who used 4.0 mm cannulated screws to fix the fusion area. Samim et al.[12] warn of the high risk of pseudarthrosis in isolated talonavicular arthrodesis since the navicular-cuneiform joint is not addressed.

Furthermore, triple arthrodesis does not improve the symptoms resulting from changes in the navicular-cuneiform joint and may require the extension of arthrodesis to the medial cuneiform[7,12,20] (Figure 4). The procedure can be performed openly or arthroscopically, according to the description by Lui et al.[54], highlighting that the cases submitted to this technique did not present significant deformity or signs of navicular-cuneiform arthrosis.

In the study conducted by de Alcântara Jones et al.[58] in 2022, a group of 26 patients (31 feet) were followed over a 19-year period (1994-2013). During this follow-up, there was

Figure 3. Patient 2 underwent bilateral isolated arthrodesis with consolidation.

a significant incidence of pseudarthrosis in the procedures of talonavicular arthrodesis and triple arthrodesis of the foot as a treatment for sequelae of MWD, reaching about 30%. Despite this failure rate in consolidation, the improvement in pain intensity in most of the cases analyzed was clear, in addition to similar clinical-functional results with autologous tricortical grafting of the iliac bone and the navicular bone itself as a bone source.

Osteosynthesis of the navicular, in turn, is rarely possible due to the loss of bone stock in the more advanced stages of the disease[5,43].

Talo-navicular-cuneiform arthrodesis has the best results in the studies[12,21], and can be performed with low-profile screws or plates, with allograft[31] or autograft[43], or associated with complementary osteotomy in the talonavicular with base resection wedge to elevate the plantar arch as proposed by Cao et al[51].

According to Zhang et al.[20], triple and talo-navicular-cuneiform arthrodesis provide excellent results, and it is important that, even if the surgeon opts for triple arthrodesis, the navicular-cuneiform joint should be included in the fusion if it has degenerative changes.

Sometimes the reduction of the talonavicular joint can be hampered by the large ligament retraction in the subtalar, requiring the release of this joint through the tarsal sinus[36].

The isolated calcaneal valgus osteotomy has been used with good and excellent results in 15 of the 18 patients in the Monteagudo and Maceira series[28]. Li et al.[45] report the absence of poor results in 14 feet treated by gliding osteotomy associated with calcaneal lateral wedge resection, even in more advanced stages, that is, Maceira III, IV, and V, with a mean follow-up of 3.7 years (ranging from 1 to 8.5 years) without the need for complementary surgeries.

As for the synthesis material to be used in the fixation of arthrodesis, the choice depends directly on the amount of bone stock present, so in the stages of Maceira II and III, where there is more favorable bone stock, except, in the lateral portion of the navicular, the screws and staples provide a good fixation, while in stages IV and V, with greater bone involvement, the use of more rigid synthesis material is indicated, often requiring the use of structural bone grafting, and it may be unnecessary to use synthesis if the graft is placed under pressure that provides the ideal stability[43]. According to Kitaura et al.[52], it is preferable to use rigid plates with a robust profile to perform talo-navicular-cuneiform arthrodesis as a way to improve the consolidation rate and the outcome of patients with this type of indication.

Tan et al.[31] describe in their study the debridement with excision of the navicular and reconstruction of the medial column of the foot using remodeled femoral head allograft, whose advantage would be the reduction of local and general morbidity by dispensing with the collection of autologous graft. However, they highlight the possibility of osteolysis and absorption. On the other hand, Levinson et al.[59], using a vascularized free bone graft from the medial femoral condyle to reconstruct the medial column of the foot, showed excellent evolution after an 18-month follow-up.

Figure 4. Patient 3, fixed talo-navicular-cuneiform arthrodesis with locked plate associated with cannulated screws. Consolidated arthrodesis.

For all the procedures mentioned here, it is recommended to use immobilization without weight-bearing for a period ranging from 8 to 12 weeks[6].

There are few reports of the early stages of MWD treated with percutaneous navicular decompression[15,29,46]. Janositz et al.[46] describe the case of an 18-year-old patient who was followed for eight years after surgery and who evolved with a complete remodeling of the worked area, which could be proven by MRI studies. Tosun et al.[44] reported resection by curettage of the affected bone and filling the navicular failure with an autologous spongy graft from the iliac crest. However, identifying the disease in its early stages is rare, leaving little room for this technique to be used[12,30].

Calcaneus osteotomy by sliding or wedge resection is indicated in the presence of a significant varus to adjust the load axis of the foot during gait. This procedure helps restructure the medial arch and lateralize the calcaneus after osteotomy[2,40,45]. The procedure can be performed alone or associated with joint fusions[45,49].

Some studies propose decompression through serial drilling or simple resection of the affected area in Maceira stages I or II[46], isolated talonavicular arthrodesis in moderate III and IV stages, and talo-navicular-cuneiform arthrodesis, double or triple arthrodesis in stage V[29]. Mayich[25] recommends talo-navicular-cuneiform arthrodesis already in stage III and triple arthrodesis from stage IV (Figure 5).

Molina et al.[27] reported a significantly favorable difference in surgical treatment considering the evaluation of quality of life, agreeing with studies in the literature[2,45]. Regarding age, Harnoongroj et al.[60] concluded that young patients have worse results with non-surgical treatment than those submitted to surgical procedures.

Molina et al.[27] study is the only one in the literature that draws attention to the deterioration of quality of life, especially in obese patients, regardless of other factors such as sex, race, age, and socioeconomic conditions, alerting to the need for multidisciplinary monitoring, including nutrology and clinical specialties to control any metabolic and endocrinological disorders that may result in increased BMI.

Finally, an accurate understanding and diagnosis are essential to enable more population studies that can provide a comprehensive understanding of the disease's progression. This will help identify the most effective treatment methods to ensure optimal quality of life and foot function for patients, particularly in light of the rising prevalence of obesity in Brazil and worldwide.

Thus, it is concluded that WMD is a rare and complex disease, and its etiological characteristics and treatment, in the most varied forms, still lack consensus in the literature. Therefore, the treatment to be followed must be individualized for each foot affected, respecting the context and characteristics of each patient.

The "State of the art" on this pathology contributes to the diagnostic elucidation and the determination of the best way to approach the carrier of this *sui generis* pathology.

Figure 5. Patient 4, with signs of involvement of all peri-navicular joints preoperatively, underwent triple arthrodesis.

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