Introduction

Contents

K. Klaue, *The Foot*, https://doi.org/10.1007/978-3-662-64001-2_1

1

This book should provide the reader with Ariadne's thread, from the symptoms through to the surgical solution. The reader should be driven by an interest in logical thinking and rational handling. Remaining attentive to this process, the reader will be entertained by the history of pathology while learning about pathogeny. This is "Edutainment", a concept found in schools and professional training. The reader will notice some repetition in the book. There are concepts which merit repeating when discussing clinical examination and surgical correction. The intention is to outline a specific aspect of the pathological significance found during clinical examination and which is raised again when describing the surgical treatment. By combining entertainment with education, the reader is made aware of the continuous evolution in knowledge and teaching following the concept of lifelong learning.

The approach to foot and ankle pathology begins with the inquiring and focused case history. This dialogue raises suspicion in the search for diagnosis and is therefore followed by the focused clinical examination. The clinical exam is divided into different sections, the study of the statics of the lower limb being, in most cases, fundamental. This usually leads the physician, in more than 90% of the cases, to a reliable diagnosis. The reader is then referred to the eventual paraclinical evaluation (conventional radiographs) or more sophisticated exams such as computerized tomography (CT), magnetic resonance imaging (MRI), scintigraphy or combined exams such as Pet-CT, SPECT-CT or SPECT-MRI. From here the reader moves on naturally to the surgical orthopaedic treatment which is a rational and generally complex, multifactorial correction. The approaches to traumatic pathologies which include mainly fractures and tendon ruptures are treated in the subsequent chapter. This chapter deals with the most common traumatic lesions and therefore may seem incomplete at first sight. In those selected injuries, we emphasize the essential aspects of the treatment which may not correspond automatically to anatomical restoration. We aimed to present one approach to treatment which is based on a logical reflection to achieve long-lasting painless function. The operative techniques of the single steps to achieve surgical corrections are then reviewed within the next chapter. The chapter starts with a comprehensive list of the surgical approaches thus emphasizing the relevance of the soft tissue structures including vascular supply and nerves at risk. Crossing the soft tissues to reach the injured structures requires a desire to achieve the least "expensive" trajectory. At this point, we would remind the reader of Bernhard Georg "Hardi" Weber's teaching of "MiniMax" meaning the minimal surgical investment to a maximal mechanical and functional effect. A critical view onto the so-called "minimal invasive techniques" is thus often indicated. To complete the manual, the chapter titled "Complex reconstructions" describes a vision of orthopaedic surgical reconstructions of the foot and ankle and includes additional factors that may puzzle the surgeon. In the first subchapter, the reader will find the judicious association of hind- mid- and/or forefoot operations treating cavus and planus feet with or without stabilizing soft tissue correcting means. The following subchapter deals with the complexity of the multifactorial aspects of the diabetic foot. The third subchapter demonstrates the unique difficulty of treating complications after previous surgical interventions. Finally, we attempt to demystify the oldest surgical actions known to man, amputations, insisting on the final function rather than on anatomical integrity.

Throughout the manual, the reader should find an answer to most of the practical questions which arise when preparing and executing surgical corrections about the foot and ankle. More precisely, this manual adheres to the principle that says "question everything", asking "why?" for any step on the path to diagnosis and particularly for anything related to

the treatment. Being a critical thinker should be one of the characteristics of the orthopaedic surgeon. He/she should be aware that the orthopaedic surgeon, besides being etymologically the doctor of growing children, shares with the common family doctor the capacity of managing musculoskeletal issues, mental health and social concerns as a whole over generations of patients. In an inquiring way, this book avoids the ambiguous suggestions introduced by the words "you can also do this, you might do that" which is of no help to the surgeon who is looking for a fully rational path to improve his treatment of pathological conditions. Rational surgery on the foot and ankle results in a list of procedures which can correct the orientation, the stable load-bearing ability and the propulsive function of the complex osteo-articular framework of the foot and ankle.

References to further reading within the book is noted by ***(A)*** medical history, Anamnesis ***(E)*** clinical examination, ***(R)*** Radiological Screening, ***(O)*** basic surgical orthopaedic treatment, ***(F)*** surgical treatment of traumatic lesions, ***(T)*** operative techniques and ***(C)*** complex reconstructions. Figures and Illustrations are noted by Arabic numbers. The references are thus specified by the chapter (letter: ***A, E, R, O, F, T, C***) and the figure number.

1.1 General Considerations

Bipedalism first appeared in the phylogeny of mankind about 3–4 million years ago [1]. Recent research suggests that the rigidity of the longitudinal arch of the foot, which is specific to our species, has been part of the very early time of phylogeny [2,3]. This evolution, although obviously helpful for the further development of the species, was a real mechanical challenge to the foot and ankle. ***The support polygon, by means of the horizontal surface over which the centre of mass of the body must lie, to achieve static stability***

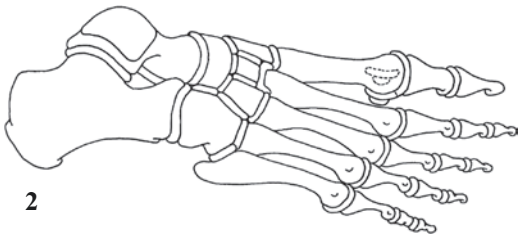

1

was drastically reduced from the quadruped and balance was preserved progressively while narrowing the gait pattern. The foot and ankle became the location of the most frequent trauma: the sprained ankle. It also demonstrates a slow (and sometimes insufficient) adaptation of the anatomical structure to its new function: the unstable first ray [4]. More precisely, instability is considered to be a symptomatic clinical-pathological entity demonstrating insufficient joint alignment during function and as such, instability is a subjective notion. We would therefore distinguish instability from hyperlaxity which may occur and remain asymptomatic throughout life and as such is an objective observation. Instability can therefore occur without hyperlaxity. Instability usually causes pain and/or apprehension and if not treated, may lead to articular lesions and destruction.

The foot has a structure inherited from the hand. As the weight-bearing and walking organ, it is therefore very young with a short adaptation period. From a prehensile organ, the hand, with its high articular mobility and

a low duty in carrying weight, the foot became a structure designed to act with a low articular mobility and with a high duty in force transmission.

From the ankle joint to the tip of the toes there are ***28 bones joined at about 32–36 joint surfaces***.



2

3

The very quantity suggests that not all of these joints are essential for normal function. In fact, in this manual we will often refer to "essential" and "adaptive" joints [5]. Essential joints may be defined by their indispensable role for a specific task in walking or running while adaptive joints are defined by a low arc of motion, linking bones by a tremendously strong ligamentous system assisted by intrinsic and extrinsic [6] muscles. Those many essential and adaptive joints might explain why we can move slowly or softly or at a brisk pace.

If we want to introduce some priorities in the surgical treatment of foot and ankle disorders, we should put the stability of the body during stance and gait first. In this way, we aim to achieve a judicious balance between a multi-articular frame and a number of extrinsic muscles. Instability due to foot and ankle pathology might be corrected by re-orienting osteotomies and/or by fusing adaptive joints together with muscle tendon transfers in order to achieve an equilibrated muscular system (motor propulsion and active suspension).

1.2 Anamnesis

Ideally, the podologic patient who suffers from foot pain should be seen first by his/her family physician who would exclude the major "extrinsic pathologies" such as compressive neuro-radiculopathies of the lumbar spine or dermatologic diseases. Rheumatoid polyarthritis is believed to start with the signs of destructive arthropathies at the feet in the majority of the cases [5].

The medical history must be inquiring, the examiner taking the role of a detective. The chronology of the symptoms and the speed of progression is relevant. During the interview, the medical professional should ask questions indirectly, avoiding suggestions.

1.2.1 Subjective Disorders

1.2.1.1 Pain

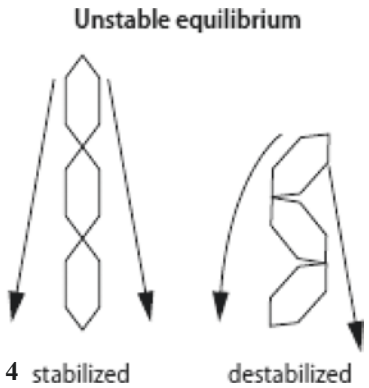
The great majority of reported disturbance is pain. Pain can have many aspects that guide the examiner to a related pathology. Pain can be elicited by simple weight-bearing in conditions linked to static disorder or while walking or running in pathological conditions involving muscles, tendons and joints. It can be significant when moving after rest, can occur during weather changes or can move under different barometric conditions (mountains, air traffic) guiding the diagnosis towards a degenerative disease. Pain can, conversely, increase during activity which would lead the diagnosis towards an osteo-articular malo-

rientation or a musculo-tendinous problem. Pain can also arise without weight-bearing and at night which may be linked to a neurological problem. Pain can have different characteristics. Pain can be reported as sharp or precisely located in a joint problem, dull in a degenerative disease, or wandering, diffuse, inconstant, burning, including "electric discharges" in neurological diseases. Precisely located plantar pain very often indicates a local overload and thus an osteoarticular imbalance of the foot. It may also indicate a malalignment of the whole lower limb.

Pain might be linked to footwear. For the Foot and Ankle surgeon, it is essential to know if the pain occurs barefoot, either standing or walking. There are typical locations of pain due to irritating footwear, such as the medial aspect of the first metatarsal head, the lateral aspect of the fifth metatarsal head, the lateral basis of fifth metatarsus, the medial process of the navicular bone and at the level of the insertion of Achilles tendon. When considering pain linked to footwear the adaptation of the footwear to the particular anatomy of the foot must first be discussed. Orthopaedic surgery should be limited to (re)establish painless and free function without footwear. Surgical treatment aimed at adapting the foot to footwear should be classified under the practise of plastic and aesthetic surgery.

1.2.1.2 Instability

Instability is a subjective feeling experienced by the patient. Hyperlaxity is an objective sign which can be assessed by the examiner. Instability might be linked to hyperlaxity but this is not always the case. As mentioned above, stable alignment might be the main aim in restoring undisturbed foot and ankle function. Instability is perceived either as pain and/or apprehension. It is often linked to traumatic lesions of the ligamentous entity of a local osteo-articular unit. It may also be linked to a failure of the muscular balance around the foot and ankle. In the forefoot, failure of the intrinsic musculature may be involved. The alignment of the osteo-articular structures in the forefoot and midfoot follows the rules of an unstable equilibrium which is stabilized by a specific musculature [6]. As such, ***a minute imbalance of muscular antagonists***



causes a slight deformity which, in fact, tends to increase any imbalance.

As mentioned above, stable alignment might be the main aim in restoring undisturbed foot and ankle function. Instability is perceived either by pain and/or apprehension. The patient often reports a trauma in the past.

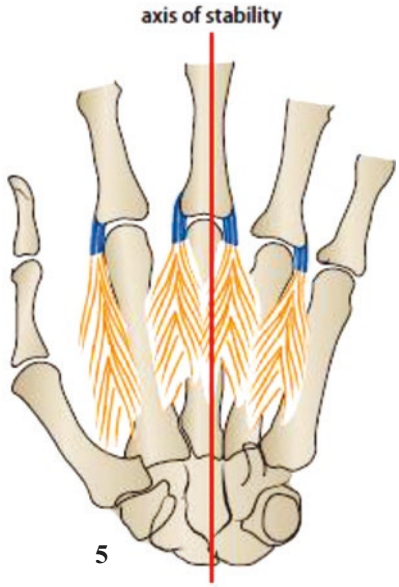
In the hind foot, the instability causes pain either lateral, at the antero-lateral corner of the upper ankle joint or medial, at the level of the posterior tibial tendon and/or anterior to the medial malleolus. Apprehension is most critical when dealing with hindfoot instability.

In the mid-foot, pain due to instability might be centred within the sinus tarsi and/or the medial aspect of the navicular bone.

In the forefoot, instability might cause pain at the level of the tarso-metatarsal (TMT) joints and/or at the plantar level of the metatarsal heads**.** Static buttress and dynamic push-off are basically influenced by the mobility of the TMT joints and the relative length of the metatarsi.

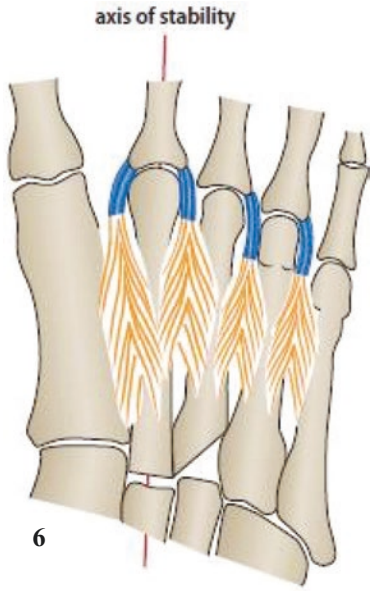
1

During evolution, the ***central axis of the foot has shifted from the third ray (hand)***



5

to the second ray (foot).



6

This evolution is seen in the anatomic position of the interosseus musculature.

Since the recent time of homo erectus existence (about 3–4 million years), there has been insufficient time to adapt the holding structures (ligaments) to the mechanical duty of the first plantar ray. In the hand, the first metacarpus is not bound by ligaments to the second metacarpus which allows the prehensile function of the hand. In the foot too, the first metatarsus lacks a ligamental hold to the lateral metatarsi. This characteristic jeopardizes the stability of the foot in weight-bearing, walking, running and jumping. Instability of the first TMT joint reduces the antero-medial buttress of the foot and overloads the adjacent rays. The patient suffering from an unstable first ray complains about a plantar ***"hazelnut" at the level of the central (2 (andlor 3)) metatarsi***


7

while walking barefoot [4].

Despite the presence of the intermetatarsal ligaments in between the lateral sesamoid bone and the fifth metatarsus, intermetatarsal instability may occur and play a role in the pathogeny of perineural fibrosis of the peripheral plantar nerves. It is probable that "Morton's neuroma" [7] may be caused by the alternating pressure of the metatarsi against the nerve. This might be especially relevant between the third and fourth metatarsi due to

the anatomic ***separation between the "navicular" and the "cuboid" forefoot***

8

and where the intermetatarsal mobility is highest. This causes the nerve and surrounding tissue to thicken, undergo fibrosis and to be destroyed.

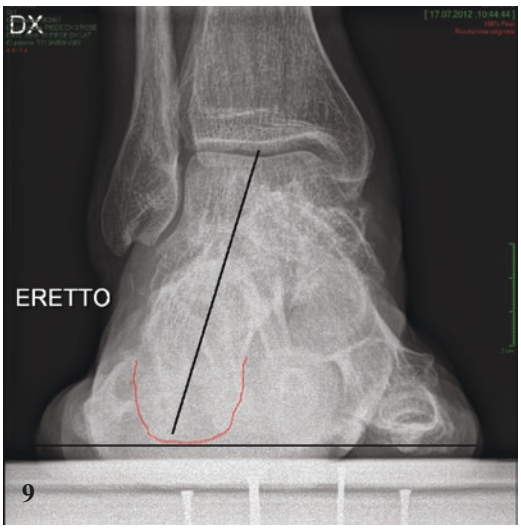
1.2.1.3 Impaired Function

The function of the feet is to give the body stability while standing, walking and running, though due to the bipedalism of the human species, functional stability is, in fact, a real challenge. The most frequent trauma encountered in clinical practise is the sprained ankle. Impaired function might be due to recurrent sprains or other post-traumatic conditions. A considerable number of people, however, suffer from a morphological disposition causing a state of dynamic imbalance of the foot thus impairing function. Such unfavourable morphology originates either from a congenital disposition or, more rarely, from progressive degeneration. In addition, inflammatory (polyarthritis) and metabolic (diabetes mellitus) diseases rank among the primary causes of foot imbalance by destructive means. A limited gait perimeter is the most important functional factor which should be assessed and treated by the foot and ankle surgeon.

1.2.2 Relevant Parameters

It is essential to assess the **time** and consequently the chronological progression of any pain, instability or impaired function. Long-term progression of pain or impaired function might correspond to joint degeneration and progressive misalignment. Short-term progression or that beginning with an acute event might be related to a cartilaginous, bony, ligamentous or capsular lesion. Previous surgery of the lower limb or trauma which changes length or angulation of the osteo-articular structures changes the weight-bearing pattern of the foot which might be unable to compensate.

The patient might indicate precisely the **localization** of the pathology easing the pathway to diagnosis. On the other hand, he/she might indicate diffuse pain or at a distance from the primary disorder. The levers of the foot are complex and include the heel and the metatarsus. The longitudinal levers include a number of joints. All of those joints must be oriented and stabilized by the combined effect of connective tissue and muscles. These levers, besides being multi-articular, are oriented in a ***helicoidal fashion***, starting at the (posterior) heel in a ***slight oblique plane*** (valgus talus-calcaneus) and ending in a perfectly ***horizontal plane***



9

at the metatarsal heads that we call the **anterior heel**.

The whole construction is dynamically held by 10 extrinsic muscles and tendons optimizing the path to gait. Any defect of a lever, which may be due to joint hyperlaxity, misalignment or defective muscle, can cause pain, instability and impaired function at a certain distance from the pathology.

Symptoms depend upon **physical activity**. The relation between musculo-skeletal activity and pain, instability or impaired function, will inform about the origin of the disorder. Physical activity clarifies such information. If running and/or jumping causes trouble, walking and standing alone might not cause any discomfort. Change of the gait perimeter is a reliable factor in assessing foot function. Pain at rest is difficult to interpret and may be related to neurological, inflammatory or metabolic disorders. Micromotion of an arthrotic joint (which includes an inflammatory component) causes pain at rest. The first path after rest (e.g. morning) often corresponds to the first painful stress to an arthritic joint.

Barometric dependence of pain is typical for degenerative joint diseases but may also be linked to the mechanical interference between occasional osteosynthetic material (plates and screws) and bone.

Footwear may influence foot pathologies. The most striking impact is that of high-heeled shoes [8]. Chronic use of such shoes causes all kinds of pathologies logically following the overload of the anterior heel, instability of the hindfoot and shortening of the calf musculature.

Previous surgery of the foot and ankle changes the natural path of pathology and is therefore a challenging parameter for the surgeon in improving pain, instability and impaired function. The contralateral foot might help in finding the cause of the disorder. Previous re-orienting procedures (osteotomies and arthroplasties) located proximal to the ankle may influence foot function.