Sport Orthotics (Einlagen)

Sport-shoe-orthotics work and are a treatment of first choice (1). Research shows that orthotics reduce the pain levels and improve stability coordination (8). Orthotic services for sport may need to be differentiated into two elementary groups. One group are sportspeople, which have a physical challenge and the second group are sportspeople that do not have any symptoms in every day life activities but may have complains during or after a sport activity.

The first group has a disability and/or symptoms in every day life and are often using orthotics or special footwear already. These disabilities may range from moderate foot deformities and/or pain to a serious deformity and/or disability. The more serious foot and ankle conditions and deformities often will need custom-made orthopaedic footwear. For those sports people their existing needs have a very high priority when constructing an orthotic or custom-made shoe for sports purpose. A detailed assessment of their existing condition and treatment needs to made and put into the sport context for that person. Here the aim is often to facilitate sport at all.

The second group are sports people, which do not present with an obvious deformity and may have only symptoms during or after a sports activity. These sports people range from a leisure sports to competitive level. This article relates to the second group but some conclusion may be drawn for the first group as well. In sports for the second group, foot conditions are in principle not pathological and we can find variations of the normal foot that could be seen as lower arched or higher arched (1). For those people a detailed analysis of their movement during their actual sports activity is desirable. Often such an assessment in the actual sports environment is not practical or impossible. A simulated sports environment is very useful for a sports related motion analysis and should by used by the medical grade footwear practitioner prior to providing any form of treatment.

Motion analysis for medical grade footwear practitioners

The simplest form of a motion or gait analysis is simply an empiric assessment. Such an assessment of motion or gait is performed automatically as soon as one sees the patient. It includes an observation of the overall movement, abilities and limits of a person in an informal way by simply observing how a person moves. A more formal approach is to follow and the person is asked to walk up and down the shop or a particular walkway. While this forms the basis of a clinical motion

assessment, the observation by the naked eye is not sufficient for fast movements like running.
Many sport activities have a significant running component and therefore a treadmill can be a useful tool for such an assessment process. It allows observing the runner at a known speed and does not take a very large amount of space. The naked eye of the observer will not be able to see the fast running motion on a treadmill and video recording is essential. The video pictures are played back in slow motion and sections that show biomechanical details should be viewed on a frame-by-frame basis. This basic use of the video camera can already be very useful as it allows seeing details of the movement that the naked eye would not be able to detect. The result depends on the experience of the observer and can vary in reliability.
More advanced systems record the videos into the computer and use motion analysis software. There is a variety of software solutions on the market from simple support for the observer to fully scientific usage. Such a process allows a more detailed and quantifiable motion analysis. Some of these high-end software solutions are very costly and not practical in a clinical setting for the medical grade footwear practitioner. However, a meaning full motion analyses cannot rely on the eye of the observer but needs a systematic standardised approach (2). It is needed for orthopaedic shoe technology and for a meaning full service for sports people. However, it is no substitute but an addition to the normal clinical examination by the medical grade footwear practitioner, including a palpation of the plantar side of the foot.

The sport shoe
Before the design of the orthotic can be started, the shoe of the sports person needs to be investigated. Often an unsuitable shoe is listed as the cause for the symptoms (3). In the past, impact absorption was seen as the significant factor for shoes by various authors over the years. That led to many manufactures building and consumers buying shoes too soft. Recently symptoms at the tendon achillis are connected with shoes that are too soft and do not provide a sufficient rear foot support (4). However, impact absorption is still one of the functions of the sport shoe but it should not be overrated. A suitable and stable sport shoe is the basis for all orthotic treatment. A new sport shoe may need to be purchased or modified as part of the treatment process. Recently software is available that can assist in the choice for a running shoe for the needs of an individual runner.

The sport orthotic (Einlagen) – Material

In the classical requests for orthotics, correcting and supporting (5) are seen as key elements and the materials of choice was typically very hard and rigid. Sport orthotics need to considerer the need of the sports person for a flexible material. Rigid materials should be kept to a minimum to not hinder the desired movement. In recent years, the understanding of the foot as a sensory organ (6) has lead to development of sensor motoric orthotics (7) using soft and flexible materials. The material choice is influenced by the space available in the shoe. An optimum fit between foot-orthotic-shoe brings a better performance (1). Common materials are EVAs, which are available in a great variety, foam systems or a combination of those common materials as the key elements. Additional components are added based on the requirements of the individual. The weight of the orthotics is of significant interest to the sports person but the weight of the person needs to be considered to choose material and a construction method appropriate to the weight of that person. As with the shoe, too soft can be a disadvantage.

The sport orthotic (Einlagen) – construction

The basis for the orthotic construction is a footprint, clinical data from the assessment process including motion analysis and foot impression foam or a plaster cast negative. Instead of the impression foam or plaster cast a scanner and computer could be used. The cast is turned into a positive cast and is modified to prepare it for a vacuum forming process. The footprint as well as other clinical information gathered during the assessment process is taken into account when changing the shape of the cast. Corrective or supportive elements, like a raised medial longitudinal support, may be shaped into the cast positive or added later from the top onto the orthosis base depending on the requirements and work Process. For the sport use such elements typically need to be kept less prominent compared to non sport use. In particular, the metatarsal dome will need to be kept much lower and soft if it is uses at all. Further, the shape of the shoe needs to be considered. Picture A will show a modified cast.
The finished cast should have a smooth surface for the vacuum process, because any unevenness will show in the moulded material. EVA is a heat mouldable material. Typically, EVAs will need a temperature of about 110 to 150 degrees centigrade to become mouldable. Temperatures may vary depending on the material used. After the material is cut to size, it is placed in an oven that holds that temperature reasonable well. The oven is the preferred heat source as it allows to heat the material not only on the surface but all the way through. The hot material is formed in the vacuum former. It will hold the shape of the cast after it cooled down. A layer of a reinforcement material can be added if required. It is imperative that the construction and the material choice reflect the desired

outcome. Very soft EVA materials may compress during the vacuum process. Extra care is needed for such materials to avoid loosing the material properties. Such soft EVA materials are likely to not withstand the pressure during use and should only be used selectively.
Additional support elements may be placed on top of the orthotic. Picture B shows some of these elements. By adding elements from the top, it will allow to place a variety of materials close to the foot. A soft metatarsal dome and a medial or lateral longitudinal support in a firmer material for example. We like to use OVA, a polyurethane based material, as it is available soft, medium soft and firm and it keeps its shape for a very long time. In shaping those elements, we consider the anatomical features and the desired outcome. We shape these elements to include sensomotoric concepts. I have often seen orthotics made where the corrective-supportive elements are placed without much concern to detail and are pressing on muscles. That could hinder the function of those muscles and is not desirable. Things that look the same are not automatically the same.
The finished top shape can then be covered by using a full-length flexible material. Full length is the preferred choice for the sport application, as it will make sure that the orthosis will sit firmly in place and will not move in side the sport shoe.

On delivery the fit into the footwear must be checked and if required optimised. While the top side of the orthotic will have to fit the foot, the bottom side will need to fit the shoe. Picture C shows an orthotic from the bottom view. The sport orthosis optimise the fit between the mass product sport shoe and the individually variable shape and function of the foot (1).
A review process is an essential part of any form of service provision.

Picture A

Cast (gips) positive ready for modification.
The elements to be modified are highlighted. Blue on the right (medial) side of the picture is the medial longitudinal support with the circle indicating the hight point. Blue on the left side is the lateral cuboid support. The red line indicates the need for space for the plantar facia and the black colour shows the contours of the metatarsal dome. It need to be noted that those elements are kept at a lower profile in a sport orthotic compared to a non-sport orthotic. This is particular true

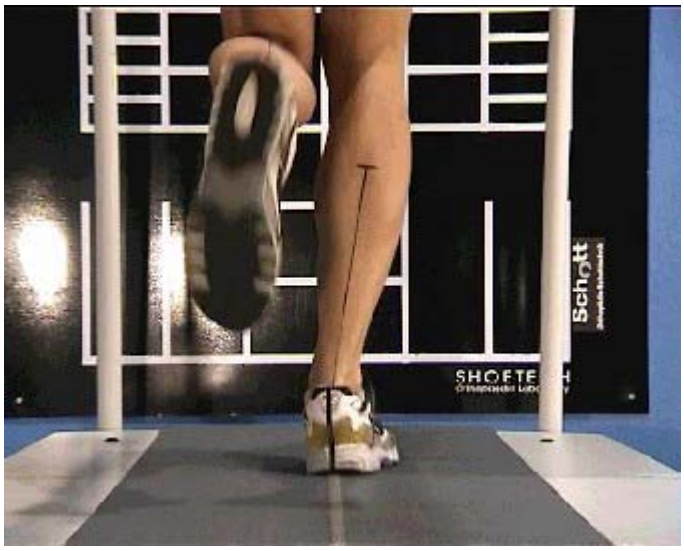
for the metatarsal dome, which can be very disturbing to runners and could increase the tension on the plantar facie.

Picture B

shows a view from the top onto the orthotic with supportive elements in place. The supportive elements are highlighted. The elements are made of OVA, a PU based foam. The metatarsal dome is made of OVA Flex, a very soft material with Shore A 17. The medial longitudinal support is made of OVA fit, a slightly firmer material with Shore A 24. Blue on the left (medial) side of the picture is the medial longitudinal support with the circle indicating the hight point. Blue on the right side is the lateral cuboid support. The red line indicates the space for the plantar facia and the black colour shows the contours of the metatarsal dome. It need to be noted that those elements are kept at a lower profile in a sport orthotic compared to a non-sport orthotic. This is particular true for the metatarsal dome, which can be very disturbing to runners especially. The metatarsal dome could increase the tension on the plantar facie.

Picture C

Picture D



This is a video frame using a computerised system. The picture shows a runner and he is 30 years old, 76 kg and 180 cm tall. He runs typically 80 kilometres per week and participates in many

competitions. The shoe is an extra light competition shoe. Even so, the shoe has a medial reinforcement against over pronation; it is too soft for this runner. The over pronation is clearly visible. He does not wear an orthotic on this picture.

Picture E

The same runner with a new shoe and orthotics. You can see that there is no over pronation any more. The foot and shoe are in a good alignment.

Literature

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