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The Urban Runner with an Evolutionary Legacy: Suggestions Toward a Middle Ground

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Humans, at least in modern societies, ceased to be barefoot hunter-gatherers relatively recently (~10,000 years ago) in evolutionary history (Lieberman, 2012). Differences in foot morphology between those who have never worn shoes and those who are habitually shod have been described since 1905 (Hoffmann, 1905). The main developmental consequences of growing up shod compared to barefoot appear to be a reduction in arch height and a narrower foot. These developmental differences are thought to be responsible for higher peak pressure at the heel and metatarsals in shod populations and may explain the greater prevalence of metatarsal-phalangeal osteoarthritis compared to barefoot populations. By contrast, habitually barefoot populations demonstrate wider feet, a lower prevalence of flat feet and more equally distributed peak pressures toward the lateral foot and distal phalanges. This may explain the greater prevalence of osteoarthritis at the distal interphalangeal joints in barefoot populations.

The first mass market ‘cushioned’ running shoe was not manufactured until some 70 years after Hoffman’s initial warnings about the use of habitual footwear. An unsubstantiated narrative about the benefit of running shoes toward the aim of injury prevention entered the scientific literature in the 1980’s. The consequences of wearing cushioned running shoes appear to be linked to the consequences of habitual footwear use such as a propensity toward pronation (reduced arch height facilitated by navicular drop) and more concentrated peak pressures (facilitated by a rear-foot strike). These loading characteristics may contribute to shod runners higher risk of stress pathology.

The plantar surface of the foot is highly sensitised much in the same way the palmer surface is. Stimulation of the heel or plantar surface near the metatarsal-phalangeal joints, which are highly sensitive to pain, results in plantar and digit flexion. The result of this in a weight-bearing position is the redistribution of load toward the lateral edge of the foot and distal digits due a rising arch. In addition to a more even load distribution, a rising arch can subsequently yield in a way that a pronated arch cannot. By contrast, stimulation of the medial longitudinal arch results in dorsi-flexion of the digits and the ankle. The medial longitudinal arch is not stimulated when running barefoot but it is when shod. This sensory explanation may be one of the reasons that ~75% of shod runner's rear-foot strike.

During running, the plantar aponeurosis, plantar ligaments and spring ligament maintain integrity of the arch and provide a strain energy storing mechanism (~17J) that is reduced by cutting each structure in turn. These structures in conjunction with the Achilles tendon (~35J) make a significant contribution to the total (~100J) energy turnover during the stance phase of running generated by a 70kg man. Bio-tensegrity is the term used to describe how human tissue including organs, muscles repel sudden deformation through tensioning and stiffening elements present in tissue. Passive responses are influenced by strain history, foot position and muscle-tendon architecture and can change leg stiffness pior to any identifiable trace on EMG. Passive responses can alter leg stiffness within ~40 – 60 ms and likely overlap with reflexes occurring 50 – 100ms after landing which then overlap with EMG responses 70 – 188 ms after landing. Positioning the foot and leg in a position whereby muscular and connective tissue components have a mechanical advantage creates conditions for the absorption of ground contact.

The apparent greater number of muscle injuries and fewer number of passive tissue injuries in barefoot runners compared to shod runners suggests that muscles are required to perform greater work when running barefoot (Altman and Davis, 2016). During running, muscles are continuously operating via both feedforward (in anticipation) and feedback (in response) mechanisms. Passive (bio-tensegrity) and neural (reflex arc's) dynamics appear to be particularly dominant in the initial ground contact phase. This may be especially true around the foot and ankle joints which make contact with ground first and appear to have muscle-tendon architecture (short fibres and long tendons) designed for fast response. The proximal muscles (long fibred) may be seen to be more dominant in initiating action (feedforward) and in absorbing energy subsequent to feedback from passive and reflex responses. In many runners, acutely and at sub-maximal speeds, barefoot running or running on an irregular surface results in a reduction in stride length and increased plantar and knee flexion.

Proprioceptive training is recommended as an effective adjunct for the prevention and rehabilitation of musculoskeletal pathology in a range of sports. We suggest that a highly task specific form of proprioceptive training for runners would be to increase sensory input via the removal of shoes and to challenge it further by running on less predictable surfaces such as soft grass or sand. Subtle differences in ground deformation and subsequent foot placement will challenge the bio-tensegrity of foot structures and plantar cutaneous nerve receptors to respond with variations of tensioning and stiffening. These variations facilitate a consistent outcome i.e. running using different patterns of joint relations a concept known as dynamical systems.

Gait re-training may be viewed as a more sensible alternative particularly in an urban environment and it can address some of the kinematic changes needed to increase muscle work. The advantage of barefoot running is that the kinematic changes usually occur sub-consciously without coaching and that the passive and neural subsystems are stimulated directly by the absence of footwear. Whether grass or sand is used, we suggest that a surface that is not too hard i.e. concrete and not too soft i.e. soft sand is important. A pliable surface allows the runner to maintain cadence whilst running with a freedom not afforded by running barefoot on concrete. Conversely, a surface that is too soft makes the activity less like running and more like resistance exercise. The literature supports our view that barefoot running is well tolerated by most individuals when progressed in a careful manner.

Runners will no doubt be concerned about the exposure of the skin toward a roughened surface and the societal expectation to wear shoes in public. The skin has been shown to adapt to wear and to deform with pressure from objects to avoid perforation. The greater requirement for runners to look where they are going on such surfaces enhances the visual element of proprioceptive feedback and is usually sufficient to avoid perforation on surfaces such as playing fields which are well maintained. On surfaces regularly interrupted by sharp objects, a covering of the foot may be advised in the form of a minimalist shoe.

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