Computer simulation for internal-stability of foot longitudinal arch strengthened by plantar soft tissues and plantar static friction

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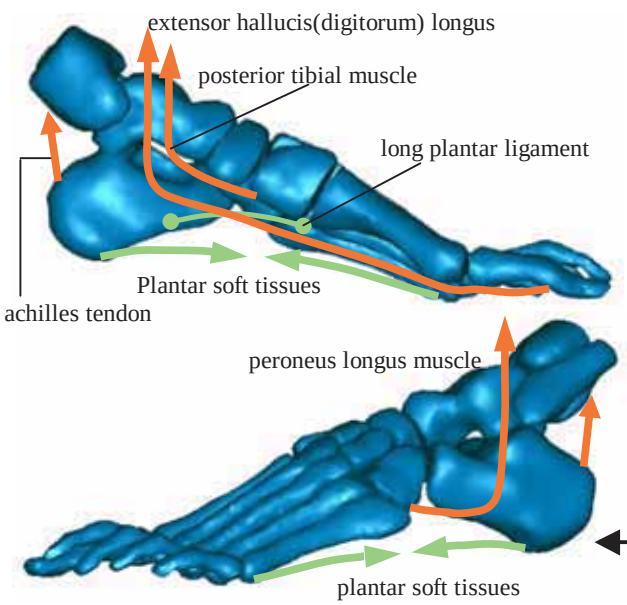
【**Abstract**】 ***Objective*:** To investigate anatomic structure and biomechanical mechanism for internal-stability of foot longitudinal arch, to offer quantitative academic base for normal arch internal-stability strengthened by plantar soft tissues and plantar static friction, and to calculate the stress distribution in plantar longitudinal arch changed by arch collapse. ***Methods*:** The method of reconstruction by CT images is adopted, which produces 3D model of foot arch in order to research its anatomic structure of medial and lateral longitudinal arch. The finite element method is also applied to establish biomechanical model of longitudinal arch of second ray of foot, which can analyze its stress distribution in standing phase. ***Results*:** A 3D computer model of longitudinal arch of normal foot and a finite element model of its second plantar longitudinal arch were created. When simulating naked foot standing with plantar static friction, Von Mises stress of second metatarsal bone and plantar aponeurosis were respectively 1.31MPa and 0.89MPa. When simulating naked foot standing with no plantar static friction, Von Mises stress of second metatarsal bone and plantar aponeurosis increased respectively to 2.35MPa and 1.22MPa. When simulating naked foot standing following surgical plantar aponeurosis release, Von Mises stress of second metatarsal bone and plantar aponeurosis were changed respectively to 3.21MPa and 0.02MPa. When simulating naked foot standing following arch collapse or flat foot standing, Von Mises stress of second metatarsal bone and plantar aponeurosis were changed respectively to 1.66MPa and 1.22MPa. ***Conclusion*:** Von Mises stress are concentrated mainly on second metatarsal bone and plantar aponeurosis when naked foot standing. Plantar soft tissues and plantar static friction can produce a marked effect to reduce degree of stress concentration in foot longitudinal arch, and can strengthened arch internal-stability. If foot arch collapses or flattens, degree of stress concentration of arch will aggravate over normal arch, and flat arch is disadvantageous to protect internal-stability of foot.

【Keywords】3D model of plantar longitudinal arch, plantar arch collapse, internal-stability, finite element method, biomechanics



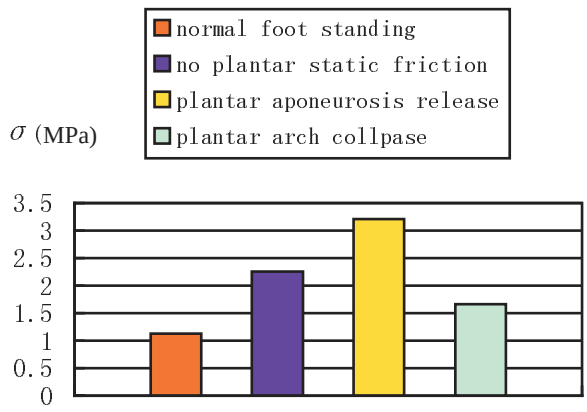


Fig.1 Von Mises stress peak values of 2nd metatarsal bone in several standing conditions

Fig.2 3D-computer model of longitudinal arch of normal foot

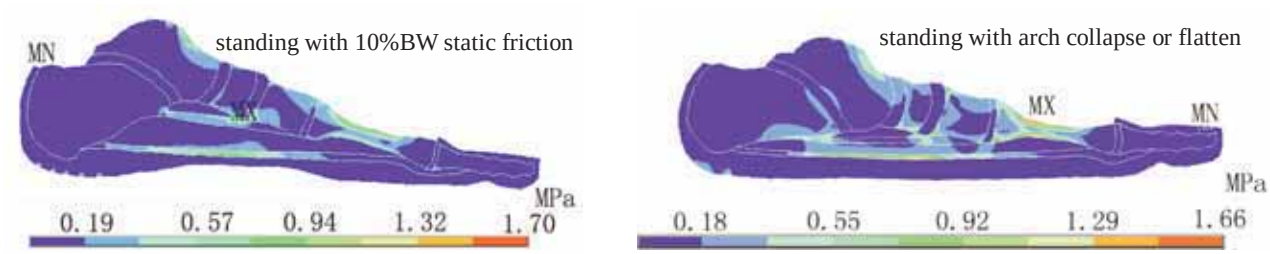


Fig.3 Von Mises Stress distribution in second plantar longitudinal arch under different standing condition

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