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Cortical representation of motor functions in individuals with rotationplasty

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The investigation of cortical reorganization in amputees relies on surrogate parameters such as motor imagery, phantom limb movement or sensory stimulation of adjacent areas. In contrast, the unique group of subjects with a rotationplasty allows for direct mapping of the cortical representation of the rotated foot which functions as a knee while the central and peripheral nervous systems remain intact. We used functional magnetic resonance imaging to study the leg's neural representation in the primary motor cortex. Ten subjects with rotationplasty and ten matched controls performed isolated flexion/extension movements of the knee, the ankle and the rotated foot in a block-design experiment. A somatotopic organization of the knee and the foot was evident. However, the arrangement diverged from Penfield and Rasmussen's homunculus as the representation of the foot was found superio-lateral to the representation of the knee in subjects with rotationplasty and in controls. We show that the cortical representation of the rotated foot is preserved as a foot instead of adopting a cortical representation as a functional knee in terms of activation intensity, extent and configuration. Moreover, the cortical representation of the rotated foot remains at the position of the foot in the primary motor cortex rather than shifting towards the knee representation. Analogously to findings in amputees, low phantom limb pain, frequent prothesis use, sensory feedback and a high level of motor control might prompt preserved cortical representation in subjects with rotationplasty.