Changes in muscle cross sectional area, muscle fibre pennation angle, maximal isometric muscle strength and specific torque in elderly and young men after two weeks of immobilisation

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Introduction
The debilitating effects of immobilisation on muscle strength and size in young individuals are well documented (Berg et al., 1991; LeBlanc et al., 1997). Moreover, sarcopenia has long been recognized as a major cause of muscle strength loss in old age, however, changes in muscle mass and architecture with immobilisation in the elderly has not previously been investigated. This is contrasted by the fact that the elderly population more often undergoes periods of immobilization and disuse not only due to joint pain but also due to a higher degree of co morbidity and hospitalisation (Manton et al., 1993). The purpose of the present study was therefore to compare the effect of a short period of unilateral immobilisation on muscle CSA, muscle strength and muscle fibre pennation angle in young and old healthy men.

Methods
Eight elderly men (EM, 61-73 yrs) and eleven young men (YM, 20-26 yrs) had a randomly selected lower limb casted from hip to angle (45 deg. knee joint flex) for two weeks. Muscle fibre pennation angle of the vastus lateralis muscle (VL) was measured by use of ultrasonography. The anatomical cross sectional area (ACSA) of the quadriceps muscle was obtained by use of axial MRI at 50% femur length. Maximal voluntary isometric strength (MVC) of the knee extensors was determined at a knee joint angle of 90°, and specific torque was measured as MVC/ACSA. Non-parametric tests were used for statistical analyses (significance level, p<0.05).

Results
Both EM and YM experienced a decrease in ACSA (EM: 64.50±5.1cm² to 61.5±4.1cm², YM: 71.7±10.9cm² to 65.9±8.7cm²), muscle fiber pennation angle (EM:12.80±1.70 to 12.52±1.70, YM:15.02±1.40 to 14.52±1.20), MVC (EM: 427±51N to 361±68 N, YM: 612±67 N to 488±59 N,) and MVC/ACSA (EM:6.62±0.9N/cm² to 5.87±1.1N/cm², YM: 8.5±1.7N/cm² to 7.4±1.7N/cm²) after 2 weeks of immobilisation. However, there was a significant higher reduction in muscle fiber pennation angle (EM:2.2%, YM:3.3%), ACSA (EM: 4.1%, YM: 8.0%) in YM compared to EM. Moreover there was a tendency towards a higher reduction in MVC (EM: 15.5%, YM: 20.3%, p=0.055) in YM compared to EM, but not in the decrease of specific torque (EM: 11.8%, YM: 13.8%). Furthermore, there was a correlation between the reduction in ACSA and the reduction in MVC for YM after immobilisation (r=0.77), but not in EM. No change was observed in the control leg in any of the groups.

Discussion
The present study is the first to investigate the effect of unilateral lower limb immobilisation on muscle mass and muscle architecture in healthy elderly men compared to healthy young men. Interestingly, it was shown that ACSA and muscle fiber pennation angle decreases more in YM compared to EM, but not in MVC and MVC/ACSA. These findings may indicate immobilisation affect younger persons more at the muscular level, whereas elderly individuals may be more affected at the neural level.

References