Interosseous membrane (IOM) extreme tautness in forearm neutral position, evident from in vitro anatomical observations, strongly suggests unwished effects on fingers and thumb long muscles, during repetitive tasks in vivo

Interosseous membrane (IOM) extreme tautness in forearm neutral position, evident from *in vitro* anatomical observations, strongly suggests unwished effects on fingers and thumb long muscles, during repetitive tasks *in vivo*

K.J. van Zwieten [a], P. Helder [b], P.L. Lippens [a], K.P. Schmidt [a], I.A. Zoubova [c], O.E. Piskùn [c], S.A. Varzin [c], A.V. Zinkovsky [c]

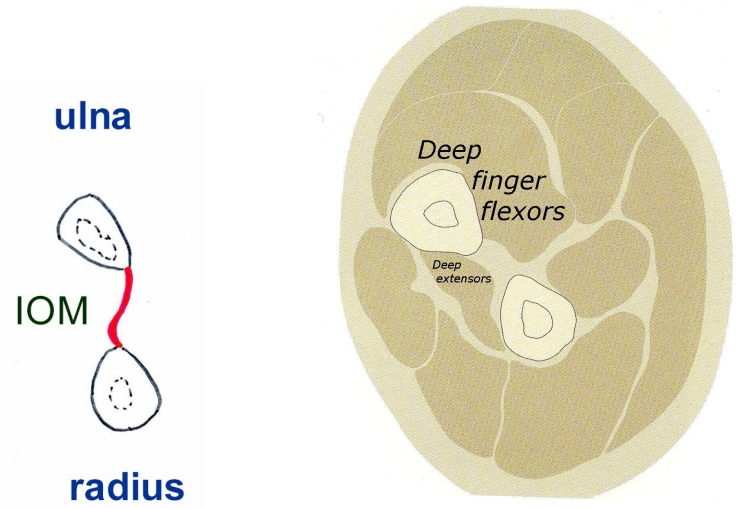
[a]*Functional Morphology, Anatomy, Universiteit Hasselt, BioMed, Diepenbeek, Belgium;* [b]*HandShoe Mouse, Hippus NV, Rotterdam, The Netherlands;* [c]*Department of Health Sciences and Biomechanics, St. Petersburg State Polytechnic University, IMOP, St. Petersburg, Russia*

Introduction, identifying the problem

Shifting the conventional, horizontal computer mouse over e.g. a mouse-mat includes crossed positions of the radius over the ulna in the forearm, which is also known as pronation. In modern man using the PC-mouse, prolonged pronation easily leads to undue tension in muscles and joints (1), thus eliciting certain forms of the much-dreaded repetitive strain injuries (RSI) (2). Traditional mice force the base of the palm to be horizontal to the work surface, which increases wrist and forearm pronation and elevates intracarpal tunnel pressure and the risk for injury (3).
With regard to the design of PC-mouse positions, various adjustments have been proposed to prevent injuries by using vertical or joystick-mice (4). Thanks to the necessary "handshake" or neutral position of the forearm, vertical mice in particular are assumed to leave thumb and fingers relatively free (5, 6) so as to prevent strain in forearm muscles and joints. Such solutions seem the more beneficial since they are considered as a possibility to use more frequently the long muscles of fingers (especially index) and thumb, whose origins are all situated in the forearm, thus preventing unwished overuse-effects of the smaller muscular units, that are well-documented (7, 8).
Anatomical *in vitro* studies however suggest negative effects of "neutral" forearm positions (9, 10). The convincing anatomical observations used to support this hypothesis are shortly repeated below.

Full supination of the forearm

Forearm interosseous membrane, bridging the distances between the interosseous borders of ulna and radius, is undulated and rather lax. Most thumb and fingers long muscles originate here (Fig. 1)



Figures 1a and 1b

Forearm transverse Ø: diagrams of the interosseous membrane (IOM) (after Csillag 1999, adapted)

Neutral position of the forearm

The ulna remaining unchanged in the frontal plane, the radius now lies in a sagittal plane, i.e. orthogonally perpendicular to the frontal plane. The radius' interosseous border forms a convex arch with respect to the ulna's interosseous border that still lies in frontal plane. As a consequence of the increased distances between them, the interosseous membrane appears to be taut (Figure 2).

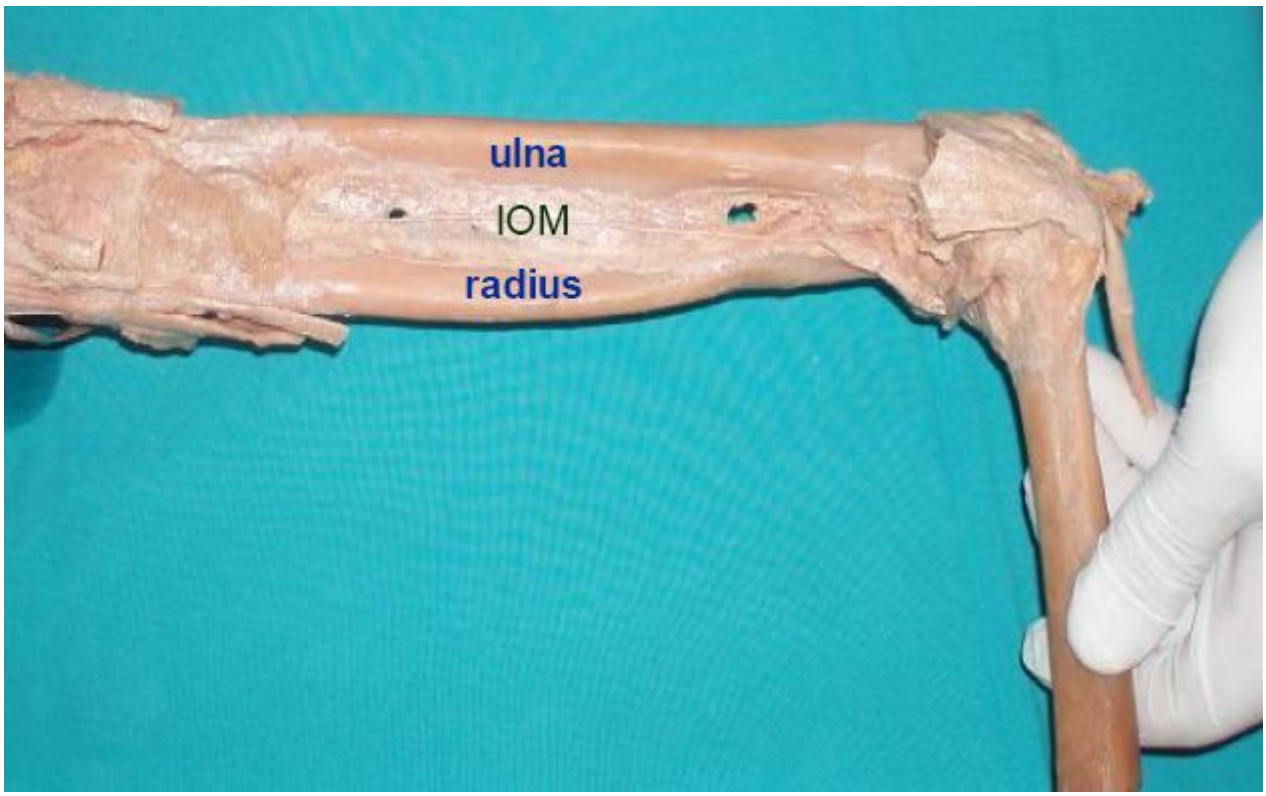


Figure 2

Anterior view of a left forearm anatomical wet specimen in neutral position *in vitro*. Elbow and wrist joints were preserved, as well as lower half of the bony humerus (right). With respect to the ulna (top), the radius (bottom) shows curvature of its bony interosseous border to be arched, causing the strong interosseous membrane (IOM) to be extremely taut in this forearm position here.

Pronation of the forearm

Anatomical evidence shows forearm interosseous membrane to become lax and undulated again, as the radius' and ulna's interosseous borders have re-approached each other, in this position (9, 10).
In pronation *in vivo,* the tilt of a lightly slanted PC mouse positions the wrist and the forearm at a natural angle causing minimal forearm muscular activities needed to handle such types of mice (12)

Discussion

In view of the molecular properties of skeletal muscle tissue, we like to stress the importance of the data presented above, based upon the observed maximal IOM tautness. As a skeletal muscle derives most of its force from bone periosteum, as well as from fascial sheaths and collagen membranes, forearm interosseous membrane and periosteum will be heavily relied upon by fingers and thumb deep long muscles arising here (13), in long and repetitive contractions at forearm neutral positions. Proprioception- and pain-registering organs located here too (13) may then lead to pain complaints.

A taut non-compliant interosseous membrane will require more of the elasticity of a normal muscle cell, causing subtle unwished molecular changes to occur during muscular contractions (14, 15, 16) Further, whereas a lax interosseous membrane will offer compliance in supination and pronation, regarding pumping up effects by contracting muscles within their compartments, a taut interosseous membrane at forearm neutral position might on the contrary evoke “compartment syndromes” (17). As was demonstrated, intramuscular biochemistry too is disturbed by compartment syndromes (18).

Conclusions

This short survey is concluded by stating that of all positions of the forearm, its so-called “neutral” position contains the greatest potential source of muscular and other damage during longstanding and repetitive movements of thumb and fingers. Most of this present conclusion is based on evident observations in preserved anatomical specimens of the forearm, supple enough to be compared to the situation in the living. Studies performed by means of modern imaging techniques moreover, applied to the forearms in otherwise normal subjects do clearly support these observations (19, 20). To avoid the abovementioned effects, as a consequence of PC mice in “handshake” of “joystick” positions, we strongly recommend pronated positions of the forearm, explicitly the somewhat tilted variances e.g. in using lightly slanted computer mice, by proof requiring least muscle activities (12)

Figures 3a and 3b

Lightly slanted mice like the ones shown here require less muscular activity (Chen & Leung 2007)

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