

# Anatomical variations of muscles in the human body and their relevance for clinical practice

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Georgiev GP. Anatomical variations of muscles in the human body and their relevance for clinical practice. *Int J Anat Var.* 2018;11(2): 48-49.

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Anatomical variations of the muscles are a broad group that refers to multiple types of variations, the clinical significance of which can range from incidental findings during physical examinations or imaging studies to presentation with pathological symptoms and conditions. Such variations include presence of additional or supernumerary muscles or absence of muscles (1-4), underdevelopment or hypoplasia of muscles (5), additional heads or bodies of the muscles (6-8), additional tendons (8-10), unusual origin or insertion of muscles with otherwise normal anatomical presentation (9,11), aberrant structures which represent remnants of muscles (12) and others. Although some of the studies have been conducted in the clinical setting (13,14), most of the literature data have been obtained through studies on human cadavers (1-12). Nevertheless, anatomical variations are relevant to all the clinical domains or specialties, as although mostly asymptomatic, they can present with various symptoms, may provoke pathological conditions or at the very least cause diagnostic difficulties during physical examination or interpretation of imaging studies (15-19).

The differential diagnosis of muscle variations is very broad and depends on factors such as age, gender, field of work, region in the body, etc. Most often, they do not lead to any pathological conditions. However, supernumerary muscles or additional heads of otherwise normal muscles may lead to blood vessel or nerve compression, presenting itself with pain, tickling sensation, claudication or other signs of impaired blood supply or nerve function (1,7,12-14). In particular, presence of muscular or fibro-muscular variations in the neck region may provoke compression of the brachial plexus and subclavian vessels in the thoracic outlet region or the so-called levator scapulae syndrome, which is characterized by pain radiated to the shoulder girdle and neck (2). Hypoplasia of a muscle may alter its usual contraction and simulate muscle rupture (5). On imaging studies, aberrant muscles or additional heads and/or tendons may simulate a soft tissue mass and thus complicate the differential diagnosis (3,4,9,14). Alternatively, such variant structures may play a key role in reconstructive surgery by providing grafting material or can be used to substitute the function of other muscles which have been damaged through trauma (3,7,18). Muscles of the forearm are particularly useful for such reconstructive operations - for instance, the tendon of extensor indicis muscle is very often utilised for such purposes because the extensor digitorum has a separate attachment to the index finger; thus the function of the finger would not be compromised by the surgical intervention (11). The palmaris longus is the muscle which is widely regarded as the 'ideal donor' in reconstructive and plastic surgery. The reason behind this is that the muscle has sufficient length and diameter and could be used successfully as harvest material with minimal donor site morbidity in various reconstruction interventions (7). Anatomical variations of muscles should also be considered in surgical planning as they may complicate the selected approach or even render it impossible to implement (4,7,8,10). Altogether, knowledge of anatomical variants of the muscles is key for the successful planning and implementation of diagnostic and treatment procedures (20-26).

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Received: March 12, 2018, Accepted: March 24, 2018, Published: April 06, 2018



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