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Terminologia Anatomica and its practical usage: pitfalls and how to avoid them

Running title: New Terminologia Anatomica and its practical usage

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ABSTRACT

In 2016, the Federative International Programme for Anatomical Terminology (FIPAT) tentatively approved the updated and extended version of anatomical terminology that replaced the previous version of Terminologia Anatomica (1998). This modern version has already appeared in new editions of leading anatomical atlases and textbooks, including Netter's Atlas of Human Anatomy, even though it was originally available only as a draft and the final version is different. We believe that updated and extended versions of anatomical terminology are important and they can be a powerful tool in communication between anatomists and other specialists around the world. In general, the new version uses more precise and adequate anatomical terms and many segments, including the part dealing with the nervous system, which is also known as the Terminologia Neuroanatomica, have been considerably improved. Nevertheless, some segments have not been extended or modernised, while other parts have been modified considerably, thereby posing a challenge to those who prefer the traditional version of Latin terminology because a number of official names for bones, muscles, organs and blood vessels have been changed. Whilst most of these changes seem to be inspired by a long anatomical tradition and thus cannot come as a surprise to anyone in the field, other modifications are characterised by terminological innovativeness. Selected new and unexpected changes that might cause confusion among those who prefer traditional anatomical terms and definitions are discussed here.

Key words: anatomical nomenclature, anatomical terminology, clinical anatomy, human anatomy, Nomina Anatomica, Terminologia Anatomica

INTRODUCTION

Many authors believe that extended and updated versions of anatomical terminology could be a powerful tool in communication between anatomists and other specialists in the future [2, 3, 8, 11-15, 19, 20, 23, 26, 27]. Therefore, the new version of anatomical terminology was adopted by the Federative International Programme for Anatomical Terminology (FIPAT) in 2016 in Germany [5]. Although medical students and anatomy teachers prefer traditional terms and definitions, whereas clinicians and older medical students adhere to the jargon of their instructors, thereby ignoring the official version of anatomical terminology [10], we believe that this situation does not mean that anatomists should not take care of their own language.

One example from real life can illustrate why the clinical jargon is so obscure and different from the official anatomical terminology. Before tonsillectomy, a surgeon explained to one of us the details of the procedure but when she heard that her patient is an anatomist she quipped: 'I should probably shift my terminology to yours so you can understand what I am saying'. This shows that clinicians ignore the official anatomical terminology largely because other problems attract their attention and they have no time for reflection on the language, and not because it does not merit any attention. Moreover, they are expected to use the very same language that their instructors and older colleagues use, just like in the case of lawyers, but they can use the official version of anatomical terminology if need be.

It is important to remember that the anatomical terminology is part of scientific terminology that deserves due consideration and can be updated and improved when necessary. It should be always simple, clear, precise, logical and coherent. Like other sets of scientific terms, the anatomical language is alive and changing, and consecutive versions of Terminologia Anatomica might reflect these changes, thereby providing a useful source of information over decades [9, 11, 13, 23, 26]. Although these recent changes [5] seem to be inspired by a long tradition and do not come as a surprise to anyone in the field, other modifications are characterised by innovativeness. Hence, there is a need to discuss selected new and unexpected changes that can cause confusion among those who prefer traditional names and definitions in anatomy.

BODY PARTS AND BONES HAVE DIFFERENT NAMES

According to the general rules of anatomical terminology that were established after the publication of the Basle Nomina Anatomica (BNA) in 1895, only one unique term should be

used for one structure [1]. Thus, different anatomical structures should have different names to avoid confusion. Unfortunately, names for a couple of bones did not differ from the names of pertinent body parts or regions [4], which was an infringement of the abovementioned rule. Namely, the Latin term *femur* was used to describe the part of the body between the hip and the knee joint as well as its only bone, even though it should be confined to the former as there are several well-established anatomical terms that refer to the part of the body and not to the skeletal support, e.g. *musculus quadratus femoris*, *musculus rectus femoris*, *arteria circumflexa femoris lateralis et medialis*, *nervus cutaneus femoris lateralis*, etc. Therefore, the thigh bone is now officially termed ***os femoris seu femur*** (femur, thigh bone in English) and its parts are currently termed accordingly *caput*, *collum*, *corpus* etc. + *ossis femoris* [5], which is a better option. Similarly, the only bone of the foot that articulates with the tibia and the fibula to form the ankle joint is now officially called ***os tali seu talus*** (talus, talar bone in English) as the Latin term *talus* (but not *tarsus*) should be reserved for ankle. Traditionally, *talus* was used for ankle and its bone, and multiple synonyms were used for the latter, including the Greek term *astragalus*. Other authors used longer or descriptive terms such as *quaternio s. quartio* (Andreas Vesalius), *choragus ossium pedis* (Arnaldus de Villa Nova) or *os talare* (Zacutus Lusitanus). Other bones have their own names and there is no need to change them. Therefore, the bones of the leg should be called the tibia and the fibula. The heel bone should be termed *calcaneus* in Latin and English, even though other authors used synonymous terms such as *calcaneum* (Laurentius) *os calcis* (Celsus). Surprisingly, there is a tendency to name several other bones using clumsy synonymous terms with the part 'os' such as *os humeri*, which is a terminological mistake as the term *ossa humeri* originally denoted three bones, i.e. the clavicle, the scapula and the humerus [2, 3].

A NUMBER OF IMPORTANT TERMS HAVE BEEN MODIFIED

A number of names for important structures have been either changed or added to the list of official anatomical terms. The unpaired bone that forms the central part of the base of the skull is officially termed ***os sphenoidaleum seu os sphenoidale*** (sphenoid bone, sphenoidal bone in English) [5], even though the shorter and traditional term for this bone is *os sphenoides* (as featured in excellent works by Caspar Wistar, Rauber-Kopsch and other authors). The part of this bone that lies in front of the chiasmatic sulcus (*sulcus chiasmaticus* in Latin) and connects the lesser wings is called ***jugum sphenoidaleum seu jugum sphenoidale***. The carotid sulcus that stretches from the foramen lacerum to the medial side of the anterior clinoid process, lying laterally on both sides of the sella turcica is officially termed ***sulcus***

carotidis seu sulcus caroticus in Latin, although the latter was always used and preferred since it appeared in the BNA [1].

Similarly, the unpaired and pneumatized bone that lies in the ethmoid notch of the frontal bone and is located in the superior part of the nasal cavity is officially termed *os ethmoideum seu os ethmoidale* (ethmoid bone, ethmoidal bone in English) [5]. The shorter and traditional name for this bone is *os ethmoides* (as featured in excellent works by Caspar Wistar, Rauber-Kopsch and other authors). The main and paired part of this bone that lies on each side of the perpendicular plate is called *labyrinthus ethmoideus seu ethmoidalis*, and its cells are called *cellulae ossis ethmoidei seu cellulae ethmoideae osseae* (but not *cellulae ethmoidales*). The bony ethmoidal infundibulum is termed *infundibulum ethmoideum osseum seu infundibulum ethmoidale osseum*.

The traditional term *tuber frontale* (frontal tuber in English) is currently synonymous to the official term *eminentia frontalis* (frontal eminence). Similarly, the term *tuber parietale* (parietal tuber in English) is synonymous to the official term *eminentia parietalis* (parietal eminence in English).

NUMEROUS NEW TERMS HAVE BEEN ADDED

Interestingly, the glenoid fossa (glenoid cavity) is officially termed *fossa glenoidea seu fossa glenoidalis seu cavitas glenoidea* (but not ‘*cavitas glenoidalis*’) in the final version of Terminologia Anatomica [5], which is an unexpended change since the official term from the previous version of terminology [4] was thus excluded from the list of official anatomical names and is not even a synonym for the preferred term. The glenoid process of the scapula within the lateral angle of the scapula is described as *processus glenoideus scapulae*. The acromial angle (*angulus acromii*) is recognised within the acromion, which harks back to the traditional descriptions of the scapula. A new but unofficially used for a long time term is spinoglenoid notch (*incisura spinoglenoidea seu incisura inferior scapulae* in Latin), which is clinically important as the suprascapular nerve passes through this notch after giving off its motor branches to the supraspinatus and a number of pathologies are associated with these structures, including the entrapment of the suprascapular nerve.

The roughly bony area between the outer and inner lips of the iliac crest that gives origin to the internal abdominal oblique muscle is termed *linea intermedia* (intermediate zone in English), although the term *zona intermedia* was proposed as a better option. The former was used by the BNA and its successors (entry 14.20 reads *linea intermedia*) [1] and virtually all textbooks and atlases ever since.

A number of new and important names have been added to the official list of anatomical terms, including *sulcus popliteus* (groove for popliteus muscle), i.e. the groove that is located just below the site of attachment of the fibular (clinically often termed ‘lateral’) femoral ligament to the lateral side of the lateral condyle of the femur where the tendon of the popliteus muscle arises. Another examples of new terms include *sutura sphenovomeris*, *sutura ethmoidolacrimalis*, *synchondrosis sphenothmoidea*, *fonticulus sphenoides et mastoideus* (BNA), *symphysis intervertebralis* (as *discus intervertebralis* is only a part of this junction), *tuberculum ligamenti transversi* (transverse ligament tubercle, traditionally termed the tubercle for the transverse ligament of the atlas), *tuberositas ligamenti coracoclavicularis* (BNA *tuberositas coracoidea*), i.e. *linea trapezoidea et tuberculum conoideum*, *skeleton thoracis* (for the previous terms such as *compages thoracis et cavea thoracis*), *malleolus posterior* (as this term is clinically useful), *labrum articulare*, *ligamentum thyreochoideum laterale*, *musculus pterygoideus proprius* as a variant structure that is occasionally present, *musculus triangularis*, *musculus quadratus*, *musculus multipennatus*, etc. The inconvenient term ‘os’ was replaced with the term *stoma seu ostium orale* (mouth in English). Also within *tunica muscularis intestini tenuis* two new terms have been added, i.e. *stratum helicoidale longi et brevis gradus* as the disposition of the fibres is not longitudinal or circular but helicoidal.

The new terminology concerning the circulatory system is probably the most surprising and we believe it can be very problematic, cf. [2]. Nonetheless, anatomists who work on the anatomical terminology always felt that the Valentine position of the heart in which this organ is traditionally described should be replaced with the anatomical position [21]. Other changes include the modification of the traditional term *aorta thoracica* (thoracic aorta) as it currently includes three parts, which breaks with the long tradition in anatomy as this part of the aorta was defined as the superior part of the descending aorta that terminates at the level of the aortic hiatus and its continuation was known as the abdominal aorta.

DIFFERENT TYPES OF DECLENSION IN GREEK AND LATIN TERMS

The new version of terminology uses either simplified or traditional (and usually more sophisticated) types of declension in Greek and Latin terms [5]. In general, the language of the BNA is preferred over modern versions of terminology but there are also new changes.

The term *gaster*, which is of Greek origin, is preferred over the Latin term *ventriculus* (stomach in English), although this preference is unstable over decades and earlier versions of terminology used the latter. Currently, some authors argue that the Latin term should be a

synonym [6], which seems judicious as the older anatomical textbooks and atlases use it and it is preferred in some clinical terms. Those parts of the stomach whose names derive from the Greek term *gaster* have *gastris* as the second part of the term, i.e. ***fornix gastris, fundus gastris, corpus gastris***, instead of *fornix gastricus, fundus gastricus* and *corpus gastricum*. Likewise, the anterior and posterior wall of the stomach can be described as ***paries anterior and posterior gastris***. Only the term ***canalis gastricus seu canalis gastris*** (gastric canal in English) uses the older type of declension. Unfortunately, the Latin term for the stomach, i.e. *ventriculus* along with its derivatives such as *cardia ventriculi, pylorus ventriculi, fundus ventriculi, fornix ventriculi, corpus ventriculare (ventriculi), curvatura ventriculi major et minor* etc. remain unofficial, although they are used by the majority of authors. It could be argued that the Greek term is preferred as Greek terms are generally preferred for the adjacent structures, e.g. ***hepar*** for the liver (not *jecur*), ***duodenum*** and ***splen*** (spleen in English). Also it is shorter, much more convenient and cannot cause confusion unlike the term *ventriculus* (ventricle, ventricular etc.). The fact that these Latin terms and their derivatives are not officially recognised as synonyms for the preferred terms is criticised by those authors who stress the importance of clinical practice [6].

Other new types of declension of Greek and Latin terms include the derivative *splenis* (e.g. *hilum splenis* instead of *hilum splenicum*) and the derivative *renis* (e.g. *hilum renis* instead of *hilum renale*). Thus, the shorter and more elegant types of declension (*gaster – gastris, splen – splenis, ren – renis*) are currently used in the most recent edition of the Terminologia Anatomica [5].

ELIMINATION OF THE APPOSITION IN LATIN TERMS

It has recently been noticed that more than 125 anatomical terms from the current version of Terminologia Anatomica can be simplified without loss of clarity by prohibiting use of more than one noun in nominative case in Latin terms [22]. This idea was tentatively approved by the FIPAT and numerous traditional and well-established anatomical terms were changed [5], e.g. the official and preferred name is currently **Masseter** instead of *musculus masseter*, **Pronator teres** instead of *musculus pronator teres*, **Flexor radialis carpi** instead of *musculus flexor carpi radialis*, **Palmaris longus** instead of *musculus palmaris longus*, **Flexor ulnaris carpi** instead of *musculus flexor carpi ulnaris*, **Flexor superficialis digitorum** instead of *musculus flexor digitorum superficialis*, **Flexor profundus digitorum** instead of *musculus flexor digitorum profundus*, **Flexor longus pollicis** instead of *musculus flexor pollicis longus*, **Pronator quadratus** instead of *musculus pronator quadratus*, **Extensor**

radialis longus carpi instead of *musculus extensor carpi radialis longus*, **Extensor radialis brevis carpi** instead of *musculus extensor carpi radialis brevis*, **Extensor digitorum** instead of *musculus extensor digitorum*, **Supinator** instead of *musculus supinator*, **Flexor longus hallucis** instead of *musculus flexor hallucis longus*, **Erector spinae** instead of *musculus erector spinae*, **Sphincter pylori** instead of *musculus sphincter pylori* (definitely not ‘pyloricus’), **Sphincter ductus biliaris** seu choledochi instead of *musculus sphincter ductus biliaris*, **Sphincter ampullae** instead of *musculus sphincter ampullae*, **Detrusor vesicae** instead of *musculus detrusor vesicae*, **Sphincter externus ani** and **Sphincter internus ani** instead of *musculus sphincter ani externus* and *internus*, respectively, etc. [5]. The second name within the pair is now a synonym but it was preferred in the previous versions of terminology [4].

In our opinion, this change is unfortunate as the Latin version of terminology has lost its coherence, e.g. the term ‘Sartorius’ is not preferred over the traditional term *musculus sartorius*, the term ‘Rectus femoris’ is not preferred over the term *musculus rectus femoris*, the terms ‘Vastus lateralis/intermedius/medialis’ are not preferred over *musculus vastus lateralis/intermedius/medialis*, and so forth. It could be argued that the new rule consists in omitting the term *musculus* only when the name refers to the action of the muscle (e.g. extensor, flexor, pronator, supinator, detrusor, erector, sphincter etc.) as other names, such as *musculus anconeus*, *musculus brachioradialis*, *musculus biceps brachii* etc., remain unchanged but it is not true since the term **Platysma** does not refer to the action of this muscle and it should be termed *musculus platysma* according to this rule. On balance, the English version of anatomical terminology should be preferred over the Latin version as it is more logical and coherent. Moreover, this change has other unfortunate consequences. The old, traditional and rather difficult names had to be changed to be even more difficult for students. For example, the well-established term *sulcus tendinis musculi flexoris hallucis longi* was changed to *sulcus tendinis flexoris longi hallucis calcanei seu sulcus tendinis flexoris hallucis longi calcanei* (groove for tendon of flexor longus hallucis of calcaneus or groove for tendon of flexor hallucis longus muscle of calcaneus in English). Also the order (sequence) of words in many anatomical terms had to be changed, e.g. *sphincter ani externus et internus* are now described as *sphincter externus et internus ani*. Although the new rule of elimination of the apposition in Latin names is in agreement with the traditional rule that anatomical terms should be as short and simple as possible [1], the modern tendency towards greater precision and coherence appears to be in conflict with this rule. Furthermore, a great number of terms cannot be simplified without loss of clarity, e.g. ‘Sternocleidomastoid’ refers to both muscle

and vein. Therefore, the very idea of simplification of terminology by prohibiting use of more than one noun in anatomical terms is defective and treacherous as it produces new inconsistencies. Please notice that the FIPAT wanted to change the ancient term *diaphragma* to *diaphragma respiratorium seu thoracoabdominale* in order to distinguish between the pelvic diaphragm and the respiratory (thoracic) diaphragm, even though there was no risk of confusion. As stated above, the traditional term *platysma* was first replaced with the term *musculus platysma* in the draft version of terminology but then the traditional term **Platysma** was reintroduced to replace the new term *musculus platysma*, which shows that some authors prefer terms with apposition. Thus, although this proposal of simplification and modernisation of anatomical terminology by eliminating appositions in Latin terms is not without some merit, it brings new problems and complications.

NEW TERMINOLOGIA ANATOMICA WARRANTS FURTHER REFINEMENT

Like earlier versions of *Nomina* (1955, 1961, 1966, 1977) and *Terminologia Anatomica* (1998, 2011), the modern version is not perfect and it can be criticised in the future by astute authors, which is a good practice in anatomy [7, 11, 13, 16-20, 26]. We are surprised that the FCAT describes [see endnote 66] the sigmoid sinus (*sinus sigmoideus*) as the terminal portion of the transverse sinus (*sinus transversus*) as such a definition is archaic. The sigmoid sinus is the continuation of the transverse sinus that descends in the groove for the sigmoid sinus to the jugular foramen where the terminal portion of this sinus is continuous with the superior bulb of the internal jugular vein (*bulbus superior venae jugularis*), whereas the terminal portion of the transverse sinus is continuous with the first portion of the sigmoid sinus. Similarly, the definition of *inion* as the most prominent point of the external occipital protuberance is misleading. *Inion* is located below the external occipital protuberance where the superior nuchal lines cross the midplane of the external surface of the occipital squama.

Noteworthy, the FCAT uses the term *ligamentum teres* for two different ligaments interchangeably [see endnotes 449 and 554], which makes these parts of the text extremely sloppy as the round ligament of the liver (*ligamentum teres hepatis*) is the vestige of the obliterated umbilical vein that connects the umbilicus of the anterior abdominal wall with the left branch of the portal vein, while the round ligament of the uterus (*ligamentum teres uteri*) is the remains of the lower part of the gubernaculum that passes over the pelvic inlet to reach the deep inguinal ring and then courses through the inguinal canal to end within the connective tissue that is associated with the labium majus. Surprisingly, the well-established

term *ligamentum teres hepatis* (the round ligament of the liver) cannot be found in the modern version of anatomical terminology.

Regrettably, not all inadequate anatomical names were modified as some of them were used for such a long time that they were accepted by the scientific community. Some authors assert that *ductus* and *canalis nasolacrimalis* should be termed the other way round, i.e. *ductus* and *canalis lacrimonasalis* and *sinus venosus sclerae* should be changed to *sinus aquosus sclerae* [16]. There are much more examples of incorrect, imprecise or inadequate anatomical terms that should be changed in the future, cf. [13, 16-21, 26]. These names include *nodus lymphaticus seu lymphoideus* that should be probably termed *nodus lymphaceus* in Latin (although this term is very uncommon and the first name should be preferred) as the synonymous term comes from the Greek word means ‘similar to lymph node’, and the preferred term means an ‘insane, frenzied’ node in Latin. Currently, the inconsistent term *nodi lymphoidei* is preferred over the term *nodi lymphatici*, which should be changed as these structured should be labelled as *lymphatici* [24].

CONCLUSIONS

On balance, the new version of anatomical terminology uses more logical, precise and coherent terms. The older, traditional and clinically important terms are generally preferred over new or awkward names. Nevertheless, several unexpected changes or modification have been endorsed by the FIPAT that are thought-provoking and can be described as highly innovative as they break with the long tradition in anatomy. This shows that the anatomical language is alive. We believe that the preference for the English version of terminology can enhance its development in the future.

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Table 1. Frequent mistakes and departures from the official anatomical terminology adopted by the FIPAT [4, 5] that can be found in textbooks and scientific papers.

Erroneous or obsolete term	Valid term
Adrenal gland	Suprarenal gland
Ampulla of vas deferens	Ampulla of ductus deferens
Genoid cavity	Glenoid fossa
Clavipectoral triangle	Deltopectoral triangle
Dorsal carpal ligament	Extensor retinaculum
Epiploic foramen	Omental foramen
Esophagoventricular	Esophagogastric (e.g. junction)
Highest nuchal line	Supreme nuchal line
Iliopubic ramus	Iliopubic eminence
Inferior nasal turbinate	Inferior nasal concha
Intermediate line (ilium)	Intermediate zone
Internal mammary artery	Internal thoracic artery
Introitus vaginae	Vaginal orifice
Lacertus fibrosus	Bicipital aponeurosis
Lienal (in compounds)	Splenic
Lower jaw	Mandible
Malar bone	Zygomatic bone
Malar/Anterior surface of zygoma	Lateral surface
Maxillary process of zygoma	[Antero-inferior/Maxillary border]; Zygomaticomaxillary suture
Middle nasal turbinate	Middle nasal concha
Os (for mouth)	Stoma
Peroneal	Fibular
Prechiasmatic groove	(Pre)chiasmatic sulcus
Procheilon ¹	[Superior labial tubercle]
Superior nasal turbinate (Supreme nasal turbinate)	Superior nasal concha (Supreme/Highest nasal concha)
Symphysis pubis	Pubic symphysis
Thoracic aorta ²	Descending thoracic aorta ²
Transverse carpal ligament	Flexor retinaculum
Upper jaw	Maxilla
Vas deferens	Ductus deferens
Vermilion ¹	[Intermediate part of upper/lower lip]

¹ In forensic anthropology, these terms are used instead of anatomical names that are longer and unofficial. Nonetheless, it can be argued that *vermilion* is less precise than traditional anatomical names as it refers to the intermediate part of both lips.

² Contrary to anatomical convention, the thoracic aorta is currently described as the first part of the aorta that has three portions: the ascending aorta, the aortic arch and the descending thoracic aorta.