



Minireview

Terminologia Anatomica after 17 years: Inconsistencies, mistakes and new proposals

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ABSTRACT

The article deals with our experience of Terminologia Anatomica (TA) in fields of education (of systemic and topographic anatomy) and clinical medicine (teaching of clinical anatomy and courses for young physicians in endoscopy). The anatomical nomenclature in Latin has been official for 120 years and its latest version for 17 years. Its main weak points should be discussed in public (or at least the discussion should be provoked), which is the reason for publishing the following findings and ensuing proposals. They are classified with seven groups: mistakes in TA, discrepancies in TA, multiplication of terms, synonyms in TA, identical terms for different structures, too long terms and missing terms in TA. The last group comprises missing terms in systemic anatomy, clinical anatomy, a paucity of terms in variant anatomy, in locomotion system and in topographic anatomy. Several attempts to draw attention to these have been made by the publication of inaccuracies in Nomina Anatomica and TA but this article summarizes and reviews current situation, emphasizing the weak points of the TA and brings several proposals and suggestions for further discussion.

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1. Introduction

Terminology serves as a unique tool of communication both within and outside any specific scientific field. To enable a clear and unconfused communication, a nomenclature is usually developed in the frame of the terminology. As anatomy can be considered the first exact medical field, its terminology is both very old and serves as a principal for other medical disciplines (theoretical and clinical). Its origin goes back to the ancient period, more than two thousand five hundred years ago, to the Greek and Latin languages. But the current anatomical nomenclature is much younger, dating back to 1895, when the Anatomische Gesellschaft (Society of German-speaking anatomists) issued the first Latin anatomical nomenclature at the Society meeting in Basel in Switzerland, hence termed the Basiliensia Nomina Anatomica (B. N. A., BNA). Although it was not accepted worldwide (mainly not in France and Great

Britain), it served as a basis and an impulse for further extensions and newer editions (His, 1895; Kachlik et al., 2008a).

Finally, the last revision of the Latin anatomical nomenclature was created by the Federative Committee on Anatomical Terminology (FCAT) and then approved by the International Federation of Associations of Anatomists (IFAA) as the only valid Latin official nomenclature of anatomy in 1997. It was issued a year later and named Terminologia Anatomica (TA) (FCAT, 1998). The anatomical nomenclature has been official for 120 years in Latin and in its latest version for 17 years.

The summarized amount of items listed in the Terminologia Anatomica is 7635. Some of them have one (*arteria fibularis*; *arteria peronea* or *valva atrioventricularis dextra*; *valva tricuspidalis*) or rarely two synonyms (*myelencephalon*; *medulla oblongata*; *bulbus*). In such instances, the first one was largely recommended by the FCAT. Comparison of the total amount of Latin items in the older nomenclatures – BNA (4311), INA (4329), PNA (4822), TA (7635) – shows a trend of extension and stabilization of the nomenclature going hand-in-hand with the research progress (Kachlik et al., 2008a).

The article deals with our experience of Terminologia Anatomica in fields of education (of systemic and topographic anatomy) and clinical medicine (teaching of clinical anatomy and courses

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for young physicians in endoscopy). The weakest point of the whole project was the path of accessibility. Although the book was issued together with a CD, its promotion was very poor, both by Thieme publisher and IFAA. Moreover, if the anatomical nomenclature (and its revision) should be spread to all scientists, the effort has to be maximal, based on free access to the database. This mistake was later corrected with the announcement of a new terminological organ – Federal International Programme on Anatomical Terminology (FIPAT) – in 2009 which is the successor of FCAT (later renamed to Federative International Committee on Anatomical Terminology in 2004 (FICAT)). The effort of FIPAT led to free access to the nomenclature at: <http://www.unifr.ch/ifaa>

The period from 1998 to the present has revealed several other weak points, which resulted in FIPAT's activity to redress the Terminologia Anatomica. Commissions dealing with certain topics were established and TA can be changed and completed by help of all morphologists who feel interest and would like to be involved, at <http://www.ifaa.net/index.php/fipat/change-fipat/fipat-discussion-forum>

The American Association of Clinical Anatomists has also contributed a bit to the Clinical Anatomical Terminology at <https://ilios.ttuhs.edu/AnatomicalTerminology/>. This website indicates several suggested additions or corrections.

However, some of the main weak points should be also discussed in public (or at least the discussion should be provoked), which is the reason for publishing the following findings and ensuing proposals. The proposals are not usually supported by citations while the authors consider them anatomically clear and well known, often stated in fundamental anatomical or clinical textbooks and atlases. They are classified as mistakes in TA, discrepancies in TA, multiplication of terms, synonyms in TA, identical terms for different structures, too long terms and missing terms in TA.

The official terms of the Terminologia Anatomica, used in this article, are written in Italics; the unofficial, old, obsolete or incorrect terms are in normal font and with quotation marks. The suggested changes and proposals for the new edition are written in bold italics.

We are dealing with 7 following groups of incorrect or inaccurate terms presented in TA.

2. Group 1—Mistakes in Terminologia Anatomica

Mistakes in the nomenclature can be classified as grammatical and semantic.

2.1. Mistakes in grammar

The proper and correct use of Latin grammar is a fundamental feature of the nomenclature. Several simplifications were introduced to enable the pronunciation for English-speaking users, as mentioned in our previous papers (Kachlik et al., 2008a; Kachlik et al., 2009). Some corrections of typographical and minor grammatical errors in TA have already been noted. A listing of such errors, and their remedies (83 in total), is accessible at IFAA webpage: <http://www.unifr.ch/ifaa/Public/EntryPage/TA98Corrections.html>

One substantial grammar mistake, obviously also an attempt to simplify (shorten) the terminology, was already introduced in PNA in 1955 and should be ameliorated: *facies articularis calcanea posterior, media et anterior* of talus. The term “*calcaneus*” is a substantivised adjective from the substantive “*calx*” (heel) (*os calcaneum* developed into *calcaneus* only). Then, the adjective derived from the substantive “*calcaneus*”, expressing the relationship to the heel bone, is “*calcanearis*” (similarly to “*talus*” and the derived

adjective “*talaris*”). The recommended form of the term is ***facies articularis calcanearis posterior, media et anterior***.

Another example is the Latin term “*psoas*” (derived from former Greek term “*psoa*”, genitive “*psoas*”), a nominative with genitive “*psoatis*”, already complained about by Hyrtl (1880) as inappropriate and causing linguistic difficulties. The term derived for the fascia investing *musculus iliopsoas*, in TA as *fascia iliopsoas*, should be either genitive (“*fascia iliopsoatis*”) or adjective (***fascia iliopsoatica***), which seems to be more consistent with other terms relating to muscle fascia.

The term “*systema conducente cordis*”, a synonym for *complexus stimulans cordis*, is not used correctly. The word “*conducens*” (genitive “*conducentis*”) is a regular participle of the verb “*conducere*”. The correct form of this cardiac structure is ***systema conducens cordis***.

The discrepancy in the position of words in terms of cerebral veins and arteries seems to be an unclear step back in the nomenclature. The PNA featured a similar term for both groups of vessels but TA has brought a different opinion: terms for cerebral arteries are generally arranged as follows—*arteria cerebri* completed with a positional adjective (*anterior, media, posterior*) but terms of cerebral veins are generally arranged in the opposite manner: *vena anterior cerebri, vena media superficialis cerebri, vena magna cerebri*, etc. This discrepancy should be corrected by returning to the former pattern used in PNA, i.e. first the non-concordant adjective “*cerebri*” completed with a concordant positional adjective: ***arteria cerebri media, vena cerebri magna***. Similarly, the terms of cerebellar vessels should be changed according to this general pattern. Such changes should follow the linguistic roots and rules of the Latin language.

Finally, a term of possessive genitive (unique in TA) in the term *sustentaculum tali* can be misleading implying to be a part of calcaneus. A simple change into ***sustentaculum talare*** could be helpful.

2.2. Mistakes in semantics

In TA, we can find some semantic (terminological) mistakes, which take their origin in incorrect use of the terms or in incorrect anatomical description. Following items can serve as examples of such mistakes:

- *synchondroses thoracis* are subdivided into *symphysis manubriosternalis et symphysis xiphosternalis*; the superordinate term for both symphyses should be ***symphyses thoracis***;
- *articulatio sacrococcygea* is in fact a *symphysis* due to the anatomical structure of this juncture between *os sacrum* and *os coccygis*, which is usually arranged as a juncture without a cavity, connected by means of fibrous cartilage, and thus should be called the ***symphysis sacrococcygea***;
- *synarthrosis manubriochondralis* is a *junctura* between the tip of first costal cartilage and the *incisura costalis prima sterni*. It is formed by a synovial joint with fibrocartilaginous articular surfaces on both chondral and sternal aspects, and therefore the term *synchondrosis* should be considered as inappropriate and replaced with a newly created term describing this unusual type of synarthrosis.

3. Group 2—Discrepancies in Terminologia Anatomica

Some terms which are used more times in the nomenclature, usually the specifying adjectives or substantives in genitive, differ in their linguistic form when used for different parts of the human body. We can classify these discrepancies into several groups (see examples in Table 1):

Table 1
Examples of discrepancies in Terminologia Anatomica.

Pudendus in chapter Systema nervosum and Systema cardiovasculare	Pudendalis in chapter Musculi
Oesophageus in chapter Musculi, Systema digestorium and Systema nervosum; oesophagei in chapter Systema nervosum	Oesophagealis in chapter Musculi; oesophageales in chapter Systema cardiovasculare
Peronealis in chapter Anatomia generalis and Ossa	Peroneus in chapter Musculi and Systema nervosum
Pharyngeus in chapter Ossa; Systema digestorium; Systema respiratorium; Systema cardiovasculare; Systema lymphoideum; Systema nervosum and Organa sensuum	Pharyngealis in chapter Systema digestorium; pharyngeales in chapter Systema digestorium, Systema cardiovasculare and Systema lymphoideum
Interspinalis in chapter Anatomia generalis, Juncturae and Musculi	Interspinosus in chapter Ossa
Pelvicus in chapter Anatomia generalis; Ossa; Musculi; Systema urinarium; Systemata genitalia and Systema nervosum	Pelvinus in chapter Cavitas abdominis
Gluteus in chapter Ossa, Musculi, Systema cardiovasculare, Systema lymphoideum and Systema nervosum	Endopelvinus in chapter Musculi
Cavitas nasalis ossea in chapter Ossa	Glutealis in chapter Anatomia generalis
Cavitas tympani	Cavitas nasi in chapter Systema respiratorium
Trigonum femorale in chapter Musculi	Membrana tympanica
Hilum renale ; hilum splenicum	Trigonum femoris in chapter Anatomia generalis
Canalis carpi	Hilum pulmonis ; hilum ovarii
Regio antebrachialis	Canalis femoralis
Regio brachialis	Regio antebrachii anterior et posterior
Kyphosis thoracica et sacralis , lordosis lumbalis	Regio brachii anterior et posterior
	Lordosis cervicis (colli)

3.1. Adjective discrepancy: See Table 1

Only one version should be selected: **pudendus**, **oesophageus** (in case of peroneus/peronealis see below), **pharyngeus**, **interspinalis**, **pelvicus (endopelvicus)**.

On the other hand, the terms *palatinus/palatinalis* are applied in a discriminating way: the adjective *palatinalis* is reserved for teeth and one of the directions describing them, *palatinus* for all other structures related to the palate; the terms *spinalis/spinosus* are arranged in a similar way: the adjective *spinosus* is restricted only to the *foramen spinosum ossis sphenoidalis* and related structures, *spinalis* to the spinal cord and other *spinae* of the body.

3.2. Discrepancy in concordant and non-concordant attribute in the same term

Cavitas *nasalis/nasi*; cavitas *tympani/membrana tympanica*; *trigonum femoris/femorale*; regio *antebrachialis/antebrachii*; regio *brachialis/brachii*.

The last two cases point to another discrepancy in denominating the region of limbs: regions of the upper limb are termed with adjectives (*regio deltoidea*, *brachialis*, *cubitalis*, *antebrachialis*, *carpalis*) with the above mentioned discrepancies but those of the lower limb feature more non-concordant attributes (*regio femoris*, *genus*, *cruris*—but *regio talocruralis*). The simple solution is to select only one version: **concordant attribute** in all cases.

3.3. Discrepancy in concordant and non-concordant attribute in similar terms:

Terms identifying similarly arranged structures—e.g. *hilum renale/hilum pulmonis*; *canalis carpi/canalis femoralis*. The simple solution is again to select only one version: non-concordant attribute in case of *hilum* and concordant attribute in case of *canalis*.

Very peculiar is the case of stomach—all parts of the stomach are termed with adjective (concordant attribute) – *fundus gastricus*, *fornix gastricus*, *corpus pyloricum*, *antrum pyloricum*, *canalis pyloricus* – unlike the other organs (e.g. pancreas, gallbladder, uterus). The simple solution is again to select only one version: **non-concordant attributes** (*fundus gastrici*, etc.). The same situation appears in terms describing the curvatures of vertebral column—*kyphosis thoracica* et *sacralis* and *lordosis lumbalis* but *lordosis cervicis (lordosis colli)*. The simple solution is again to select only one version: **concordant attributes** (*lordosis cervicalis*).

3.4. Discrepancy in using synonyms in an attributing position

Cervicalis/colli—this is the most striking example of inconsistency. Just follow the terms related to the neck (*collum*; *cervix*) and similar structures of various organs of the body in TA. Only a few examples are stated to illustrate this incomprehensiveness. All necks of bones are termed *collum*, but necks of organs are both the *collum* (3) and *cervix* (4). The general term for cervical regions is unique but the subordinate ones feature three synonyms (*regio cervicalis anterior/trigonum cervicale anterius/trigonum colli anterius*). The branch of *nervus facialis* is preferably *ramus colli* as well as the transverse cervical nerve (*nervus transversus colli/nervus transversus cervicalis*), but all other nervous structures (both, peripheral and central) are exclusively cervical. If both terms are used, their position (the more recommended one) is not coherent, e.g. *pars cervicalis oesophagei/pars colli oesophagei* but *ramus colli nervi facialis/ramus cervicalis nervi facialis*.

The solution is not as simple as in previous examples but one possible way is following: the term *collum* should be used for the bones only, the term *cervix* for all other structures (neck of body, neck of organs and related structures) with no possibility to use the other synonym.

3.5. Terminological inconsistencies

Some similar or neighboring structures are termed inconsistently. Two examples are stated to illustrate it. The classification of the chapter *Organa sensuum* should be arranged in a unified manner. As the smell and taste organs are termed *organum olfactorium (organum olfactus)* and *organum gustatorium (organum gustus)*, respectively, the visual and auditory organ should be termed similarly as *organum visuale (organum visus)*—now “*oculus et structurae pertinentes*” and *organum statoacusticum (organum auditus et aequilibratus)*—now “*auris*”, retaining their subdivision into the eye and accessory organs, and external, middle and internal ear, respectively.

The description of the visual organ is used inconsistently within the chapter *Organa sensuum*. The headline runs as “*oculus et structurae pertinentes*” (A15.2.00.001) but further it is subdivided into “*bulbus oculi*” and “*structurae oculi accessoriae*”. This discrepancy should be corrected in the denomination of the whole subchapter—either **organum visuale (organum visus)** or **oculus et structurae oculi accessoriae**.

3.6. Anatomical discrepancies

There are several examples to present: arteries supplying the intercostal spaces are termed the *arteriae intercostales posteriores* (being branches from the *aorta thoracica* and *arteria intercostalis suprema*) but the *rami intercostales anteriores* (being branches from the *arteria thoracica interna*). Although the posterior ones are larger, the terms should be consistent and both groups denominated as **arteriae**.

But one of the principal problems of anatomy and its precise terminology are the fasciae as already stated by Wendell-Smith (1997), Schleip et al. (2012), Kumka and Bonar (2012), Guidera et al. (2014) and Stecco et al. (2013). From the morphological point of view, we lack a detailed and exact definition of fascia as a unit. Different fibrous structures, e.g. organ covers, muscle fasciae, layers of body walls, connective tissue spaces between organs or other structures are denominated as fasciae but their histological structure, function and behavior under pathological conditions significantly differ.

But even in the existing terms of principal fasciae there are significant discrepancies. For example, let us talk about the fascia covering the inner wall of the body cavity, original *coeloma*, lined with *mesothelium* and later separated and divided into *cavitas thoracis et abdominopelvica*. Their muscular, fibrous and bony walls are covered with fasciae, termed as *fascia endothoracica* (*fascia thoracis parietalis*), *fascia abdominis parietalis* (*fascia endoabdominalis*) and *fascia pelvis parietalis* (*fascia endopelvina*). The terms should be consistent in the sense of preference in all three cavities. The simple solution is to prefer the term **fascia parietalis** in all three cases.

Further, other regions of the body need a particular and deep review of the connective tissue structures, predominantly the neck and pelvis. The connective tissue in the vicinity of pharynx is often defined and termed in different ways as well as *fascia pelvis visceralis*, its “pillars” and fasciae around and behind rectum (Wendell-Smith, 2000a).

4. Group 3—Repetition of terms

Several terms are stated repetitively in the Terminologia Anatomica.

4.1. Shortened terms

Some terms seem similar throughout the TA, e.g. *ramus anterior*, *facies medialis*, *margo interosseus* but they are subordinated under larger structures to which they belong and they can be stated in full extent if needed (in case of possible confusion), e.g. *margo interosseus radii*, *margo interosseus ulnae*, *margo interosseus tibiae* et *margo interosseus fibulae*.

4.2. Relation to different structures within one chapter

Some terms can be, due to their morphological relation, stated more than once. A representative example can be the *vena lumbalis ascendens* (A12.3.07.011), subordinated to the *vena azygos*. But this vein is usually connected with the origins of *venae lumbales* and caudally also drains into the *vena iliaca communis*. This latter relationship comes to clinical relevance in case of the anterior surgical approach to the lower lumbar vertebrae. This is the reason to repeat it in TA again as a tributary (subordinated term) of the *vena iliaca communis* (but with the same Identification number).

4.3. Relation to different structures through chapters

The reason to repeat an identical term is to attach it logically to the related structure(s) and chapter(s), either under the same or

under a different Identification number. Two examples are stated to illustrate this correct localization: the *musculi perinei* in the chapters *Musculi* and *Systemata genitalia* but in both cases under the same Identification number (A04.5.05.001); and the *sinus maxillaris* in the chapters *Ossa* and *Systema respiratorium*, but under different Identification numbers, showing the difference between the bony structure (A02.1.12.023) and the body structure lined with mucosa (A06.1.03.002).

5. Group 4—Synonyms in Terminologia Anatomica

Many terms in TA are stated as synonyms, usually two, exceptionally three, e.g. *nodus lymphoideus/nodus lymphaticus/lymphonodus* or *myelencephalon/medulla oblongata/bulbus*. This approach must be viewed from both sides. It can reflect local and linguistic differences and enable the survival of various deep-rooted terms but on the other hand, it can maintain surviving confusions and worsen searching, especially when using electronic searching tools. The last revision of TA was influenced by a dominant position of the English language. The issues are of two types: First, several Latin terms underwent orthographic and grammatical changes (simplifications), e.g. the diphthong -ae- has remained in the *haema*, *caecum*, *taenia*, *locus caeruleus* (which was incorrectly stated as “locus coeruleus” in PNA and may be intentionally kept in the English nomenclature, since it is a commonly used term, even though spelled incorrectly) but successively simplified to the sound -e- in the *gluteus* and in preposition pre- (*prevertebralis*). Position of three vowels in direct contact has remained in the *hyoideus* but was simplified in the *thyroideus* and *choroideus*. These changes seem to ease the pronunciation but the selected approach was not comprehensive.

Second, evidently again due to the dominant position of English language as a communication tool in the current scientific world, some terms are now preferred without a reasonable linguistic or scientific background, e.g. the *splen/lien* are used as synonyms although the term *splen* (now ranked as the first choice) was not commonly used (but it is very similar to the English word “spleen”); the *nodus lymphoideus/nodus lymphaticus/lymphonodus* are used as synonyms although the term *lymphoid* from the linguistic point of view means only “similar to lymph” (“eidos” is a Greek term for form) and thus the term **lymphatic** should be preferred. This example also refers to the ambiguity of using three synonyms, a practise which should be abandoned (Krpmotić-Nemanić and Vinter, 2003a).

Other synonymic terms, not based on the influence of English, can be easily solved and replaced with only one unique official term, such as *spina mentalis superior et inferior/spina geni superior et inferior*; *spatium lateropharyngeum/spatium pharyngeum laterale/spatium parapharyngeum* or *processus costiformis/processus costalis*. The proposed only terms are **spina mentalis superior et inferior**, **spatium parapharyngeum**, because the Greek term *geneion* is not used as a substantive (just as an adjective—*musculus genioglossus et geniohyoideus*); the indication of position “latero-” is not used elsewhere in TA unlike “para-” which is applied several times. In case of real necessity of having two/three synonyms, in mentioned examples their order should be changed so that the preferred terms are the above in bold recommended ones. In case of the lateral paired process of the lumbar vertebrae, formerly termed the “processus costarius” and erroneously very often as the “transverse process” in English literature, a newly introduced term *processus costiformis* (preferred to the synonym *processus costalis*) is misleading because the process is a rudimentary rib (and not a process in a shape of a rib) that is why the very simple term **processus costalis** should be applied as the only choice.

Last but not least is the term *fascia pelvis/fascia pelvica* which offers some synonyms, but similar terms, as the *fascia abdominis*,

fascia dorsi (non-concordant attribute) and the *fascia cervicalis*, *fascia thoracica* (concordant attribute) are incoherently stated, concerning both the linguistic view and the absence of other synonyms. A simple solution is to select only one consistent way of forming the adjectives to the general term fascia.

6. Group 5—Identical terms for different structures

Many terms stated in Terminologia Anatomica describe different structures (e.g. *ramus anterior*, *ramus posterior*) but they are subordinated to other terms and no confusion appears. But the term *plexus pharyngeus* is used both for the venous plexus and nervous plexus of pharynx giving no possibility to distinguish between these two anatomical structures—the terms must be specified as follows: ***plexus venosus pharyngeus*** for the venous plexus and ***plexus pharyngeus*** for the nervous one.

7. Group 6—Excessively long terms

If some terms seems to be too long for practical use and no possible confusion occurs if they are changed or shortened, it would be suitable to perform such replacement, e.g. the term *vena portae hepatis* should be shortened to *vena portae* as it is worldwide used in this form and there is no danger in confusion with any other vein.

8. Group 7—Missing terms in Terminologia Anatomica

Although the last valid official anatomical nomenclature is the best and most extended out of all the nomenclatures ever issued, the last weak point is the largest one, dealing with missing terms of important anatomical structures. The best processed chapter is without a doubt the *Systema nervosum*. The scientific research in this field has been the largest and quickest of the whole system of the human body, which can be proved also by the extension of the terms within the chapter. In PNA (1955), the chapter contained 333 items but in TA (1998) it included 1947 items (e.g. hypothalamus contains 43 items itself). To compare with some other chapters, the *Systema skeletale (Ossa)* contained 847 items in PNA and 993 in TA and the *Organa sensuum* contained 429 items in PNA and 517 in TA (Woerdeman, 1957; FCAT, 1998). The weaker aspects of TA are missing terms of clinical anatomy, a low number of terms of variant anatomy and a low number of terms of locomotion system and of topographic anatomy.

8.1. Missing terms of systemic anatomy

Systemic anatomy is relatively precisely processed but from both didactic and clinical point of view, for example segments (parts) of larger vessels, nerves and canals should be denominated, such as already done in case of organs (oesophagus, trachea, duodenum, uterine tube, ductus deferens), vessels (*arteria carotis interna*, *arteria vertebralis*), nerves (*nervus opticus*). But such classification should be extended to other structures (*ductus choledochus*, *arteria subclavia*, *arteria axillaris*, *vena cava inferior*) or existing classifications can be reconsidered due to clinical reasons and usefulness (*arteria carotis interna*, *arteriae cerebri*), as proposed below on the example of *arteria carotis interna*:

- *arteria carotis interna* should be redivided from four to seven segments—*pars cervicalis (segmentum C1)* in the neck, *pars petrosa (segmentum C2)* within *canalis caroticus*, *pars lacera (segmentum C3)* within *synchondrosis sphenopetrosa* in *foramen lacerum*, *pars cavernosa (segmentum C4)* within *sinus cavernosus*, *pars clinioidea (segmentum C5)* within *dura mater cranialis* next to the *processus clinioideus anterior et medius*, *pars ophthalmica*

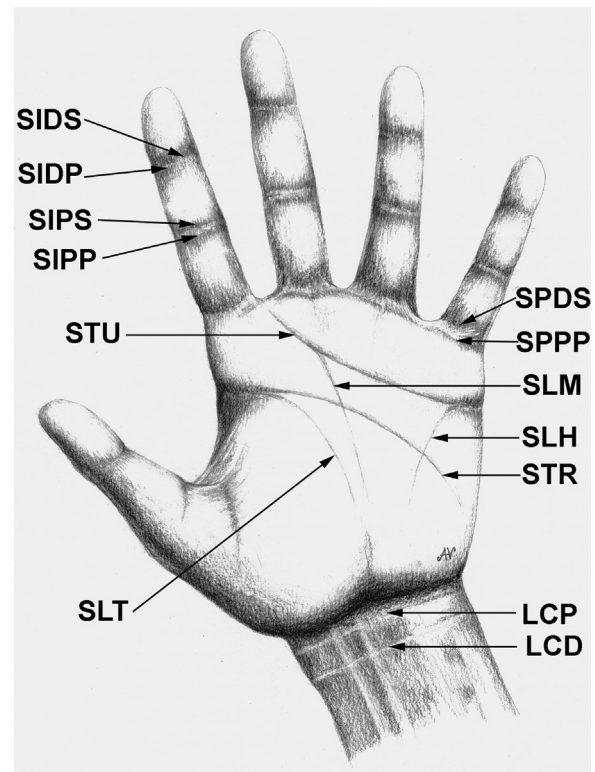


Fig. 1. Skin creases of palm. LCP+LCD—*linea carpalis palmaris proximalis et distalis*; SIDP+SIDP—*sulcus interphalangeus distalis primus et secundus*; SIPP+SIPS—*sulcus interphalangeus proximalis primus et secundus*; SLH—*sulcus longitudinalis hypothenaris*; SLM—*sulcus longitudinalis medianus*; SLT—*sulcus longitudinalis thenaris*; SPDP+SPDS—*sulcus palmaris digitalis primus et secundus*; STR—*sulcus transversus radialis*; STU—*sulcus transversus ulnaris*.

(**segmentum C6**) extending from *dura mater cranialis* exit to the origin of the *arteria communicans posterior* and ***pars communicans (segmentum C7)*** extending from the origin of the *arteria communicans posterior* to the final bifurcation of the *arteria carotis interna* into the *arteria cerebri anterior et media*.

Several well-known and well-described parts of the human body also lack their official terms in TA, such as:

- ***recessus triangularis ventriculi tertii*** (obsolete term “vulva cerebri”) is a ventral projection of third brain ventricle bounded by paired *pars libera columnae fornicis* laterally and by unpaired *commissura anterior* basally
- ***foramen diaphragmatis sellae*** (of Pacchioni) is an opening in the center of *diaphragma sellae*, through which the *infundibulum hypophysis* passes (do not confuse with “foramen ovale” (of Pacchioni) which is an obsolete term for *incisura tentorii*)
- ***venulae aquosae*** are fine vessels (25–30) collecting the *humor aquosus* from the *sinus venosus sclerae* (of Schlemm and Lauth) into *venae episclerales*
- skin creases of palm (see Fig. 1)
 - ***linea carpalis palmaris proximalis et distalis*** are two close lines at the border of a wrist and forearm
 - ***sulcus longitudinalis thenaris*** is a line encircling the thenar
 - ***sulcus longitudinalis hypothenaris*** is a line encircling the hypothenar
 - ***sulcus longitudinalis medianus*** is a line between the two previous lines
 - ***sulcus transversus ulnaris*** is the more distal transverse line starting at the ulnar side of the hand and terminating in between the middle and index fingers

- o **sulcus transversus radialis** is the more proximal transverse line starting at the end of *sulcus longitudinalis thenaris* and running parallel to the previous line toward the hypothenar
- o **sulcus palmaris digitalis primus et secundus** are two very close lines at the *articulatio metacarpophalangea*
- o **sulcus interphalangeus proximalis primus et secundus** are two very close lines at the *articulatio interphalangea proximalis*
- o **sulcus interphalangeus distalis primus et secundus** are two very close lines at the *articulatio interphalangea distalis*
- o **sulcus interphalangeus pollicis primus et secundus** are two very close lines at the *articulatio interphalangea pollicis*

8.2. Missing terms of clinical anatomy

Clinical (applied) anatomy is from the educational point of view the most important part of the anatomical science. The terms actively used in clinical medicine are those which should be insisted upon during education. But some clinically used terms are surprisingly not part of TA. This unevenness in the anatomical nomenclature reflects underwhelming communication between the theoretical science and practical (clinical) medicine. Fortunately, deputies of one very active branch of medicine, phlebology, performed a decisive act. In 2001, at the 14th World Congress of the International Union of Phlebology (and under the auspices of IFAA and FICAT), a consensus document was approved to complete the anatomical nomenclature of superficial and deep venous systems of the lower limb. Some insufficient terms have been changed and sixteen new terms have been added, in relation to their clinical relevance and topography (Caggiati et al., 2002; Kachlik et al., 2010a,b). Three years later, at the 21st World Congress of the International Union of Angiology, a second consensus document was approved to complete the anatomical nomenclature of the pelvic venous system and terms used in the everyday clinical practice; the insufficient terms have been changed and six new ones were added (Caggiati et al., 2005; Kachlik et al., 2010c; Thiagarajah et al., 2011; Kachlik et al., 2012). But not every term meets all the requirements of the current anatomical nomenclature. There are two points to be argued. First, the term *extensio cranialis venae saphenae parvae*, which replaced the former term “vena femoropoplitea” is inaccurate due to the selected adjective *cranialis* which is used to determine directions in the whole body except limbs. That is why the term should be changed to more precise ***extensio proximalis venae saphenae parvae***. Second, the recommended eponyms as preferred terms (Giacomini’s vein, Cockett’s perforators and Santorini’s plexus) do not match with the rule already accepted in PNA in 1955 and strictly followed in all next revisions not to use eponyms as official terms in the anatomical nomenclature (Woerdeman, 1957; Caggiati et al., 2005). Although the Terminologia Anatomica (1998) contains a list of eponyms (362 items) at the index chapter, it serves only as a mere hint for users to find its corresponding proper Latin terms (FCAT, 1998). To be consistent with this rule, all the preferred eponyms should be listed only in the index (or special appendix) and each structure should bear first its Latin non-eponymic term. This state is not kept in case of “vena Giacomini” which completely lacks its non-eponymic term.

On the other hand, all the other branches of medicine have not been so extensively active and many clinical terms used everyday should be incorporated in TA, e.g. terms of joint movements (*inversio/eversio*, *circumductio*, *elevatio/depressio*, *protractio/retractio*), parts of *cusps valvae mitralis/tricuspidalis* (*apex*, *margo*, *basis*), *ponticuli* of coronary arteries, etc.

A possible confusion can appear when using the term “perforator”. In clinical medicine, it is used to denominate two different structures: *vena perforans*, connecting the superficial and deep venous system of limb and piercing the fascia (important in venous reflux and treatment of varices of lower limbs); and arterial

perforator supplying an angiosome, used in reconstructive surgery as a pedicle for various types of flaps. Moreover, there are other vessels in the human body, *arteria perforans prima, secunda et tertia* in thigh, *ramus perforans arteriae fibularis* in leg, etc. The nomenclature of venous perforators was specified and codified in 2004 (Caggiati et al., 2005) but the terminology of arterial perforators is from the anatomical point of view unsorted and unprocessed at all.

Several examples of proposed terms for incorporation:

- ***prominentia arteriae carotidis*** and ***prominentia nervi optici*** (optic tubercle of Killian) are two convex structures inside *sinus sphenoidalis* on its lateral wall, elevated by *arteria carotis interna* and *nervus opticus*, respectively;
- ***foramen ovale superius*** (called foramen of Weitbrecht in clinical medicine) is a thinned area of the articular capsule anterior side of *articulatio humeri*, between *ligamentum glenohumerale superius et medium*, where the articular cavity invaginates into and communicates with *bursa musculi subscapularis*. It is a locus minoris resistentiae in a dislocation of shoulder. Similar is the ***foramen ovale inferius*** between *ligamentum glenohumerale medium et inferius*, being cul-de-sac;
- ***trigonum pharyngooesophageum superius*** (of Killian) is a weakened triangular spot in the posterior wall of pharynx, bounded cranially by *pars thyropharyngea musculi constrictoris pharyngis inferioris* and caudally by its *pars cricopharyngea*;
- ***trigonum pharyngooesophageum inferius*** (of Laimer) is a weakened triangular spot in the posterior wall of pharynx, bounded cranially by *pars cricopharyngea musculi constrictoris pharyngis inferioris* and caudally by upper oblique fibers of longitudinal muscle layer of oesophagus. It is a place where pharyngo-oesophageal diverticle (of Zenker) can occur;
- ***ligamentum appendiculoovaricum*** (of Clado) is an inconstant peritoneal fold in the female, extending from the *appendix vermiformis* (in case of its pelvic or subcaecal position) across *linea terminalis* to the ovary and containing lymphatic channels which can cause a spread of infection;
- ***ampulla urethrae*** is an enlarged part of *pars spongiosa urethrae masculinae* right below the *diaphragma urogenitale*. Its wall is very thin and can be perforated during catheterization;
- ***cavitas vaginalis testis*** (obsolete terms “cavum serosum scroti” or “cavum vaginale”) is a narrow slit between two layers (*lamina parietalis et visceralis*) of *tunica vaginalis testis*, a remnant of *processus vaginalis peritonei*, an evagination of peritoneal cavity located dorsally to the descending scrotum, which later becomes obliterated and loses all previous connections with the peritoneal cavity;
- *crus sinistrum fasciculi atrioventricularis* (left crus of Tawara) bifurcates into ***crus anteriosinistrum*** and ***crus posteriosinistrum***, which may suffer from blockades;
- ***rami retroperitoneales anteriores*** are minute direct branches from the *aorta abdominalis*, *arteria testicularis/ovarica*, *arteria iliaca communis*, *arteria renalis* and *arteria renalis accessoria*, supplying the adjacent lymph nodes, ureter, peritoneum, loose connective tissue around the *aorta abdominalis* and *vena cava inferior*, autonomic nervous plexuses, ganglia and finally, the wall of both large vessels in a form of *vasa vasorum*. These arteries are accompanied by corresponding veins, draining into the anterior aspect of *vena cava inferior* and its tributaries, termed the ***venae retroperitoneales anteriores*** (Turyna et al., 2013 and Turyna et al., 2014).

8.3. Low number of terms of variant anatomy

Variant anatomy is related to the anomalies and abnormalities of the human body structure, which differ from the norm determined arbitrary, following more than two thousand years of the

anatomical experience. The Terminologia Anatomica contains 149 terms of variant structures which are stated in the parentheses to distinguish them easily from constant ones. The selection in TA is relatively good but still some clinically relevant ones are missing, e.g. the *arteria lusoria* (*arteria subclavia dextra* branching as the last branch from the *arcus aortae*, left to the origin of the *arteria subclavia sinistra*), *arteria brachioradialis* (the most frequent variant of the upper limb arterial trunks) or *arteria brachioulnaris*. It would be worthwhile setting out criteria for selecting terms for variations for inclusion into TA.

Some other important variants proposed for incorporation:

- **cellulae infraorbitales** (of Haller) (clinically also termed maxilloethmoidal cells) are pneumatized *cellulae ethmoidales anteriores* projecting along the mediocaudal floor of the orbit and are present in approximately 20% of cases;
- **cellulae sphenothmoidales** (of Onodi and Grünwald) belong to the *cellulae ethmoidales posteriores* lying laterocranially to the *sinus sphenoidalis* and are present in approximately 10% of cases. As a result of its location, *nervus opticus*, and less commonly, *arteria carotis interna* are very closely related to the bone separating them;
- **ponticuli arteriarum coronariarum** are slips of myocardium skipping and covering the coronary arteries and their branches. Although they are not presented at constant sites they are reported in 42–78% of cases and stenosis often develops in arteries right behind the *ponticuli*;
- **ramus intermedius arteriae coronariae sinistrae** is a variable but thick and clinically relevant artery (bypass application), branching from the terminal bifurcation of the *arteria coronaria sinistra* (trifurcation in that case), supplying the anterior surface of left ventricle, being present in 15–25% of cases;
- **extensio cervicalis thymi** is a part of thymus which, during the development, remained in the *regio cervicalis anterior*, but not as a separate part (*ectopia thymi*, *textus thymicus accessorius*), but as an extension of usually positioned thymus. It is present in approximately 50% of children.

8.4. Low number of terms of locomotion system

The locomotion system (chapters *Systema skeletale*, *Systema articulare*, *Systema musculare*) belongs to the parts of the human body which were described quite well a hundred years ago. The basic research ceased in the last century but the orthopedic approaches need more detailed information which unfortunately remained restricted to the clinical textbooks only and the terms have not yet reached the anatomical nomenclature—e.g. ligaments of the wrist (*ligamentum radiotriquetrum et ulnotriquetrum*, *ligamentum radiocapitatum et capitatotriquetrum*). Another striking example is a missing term for facets of composed articular surfaces, which are separated with a crest and situated in somewhat different planes, usually gripping an acute angle—e.g. *facies articularis carpalis (radii)* is composed of two facets for *os scaphoideum et lunatum*, separated with a slight crest; or *facies articularis patellae* is composed of two facets for two facets of *facies patellaris (femoris)*. The appropriate term does not exist in Latin but a diminutive of the term *facies*—**faciecula** can be one of possible solutions and **crista articularis** can be a simple and corresponding term for the crests between the facets.

A separate group features terms of ossification centers and transient bones during bone ossification both prenatally and postnatally. The best example can be the ossification parts of *os sphenoidale*: **presphenoid** (unpaired and paired center) and **basisphenoid** (two paired centers) are ossification centers of *corpus ossis sphenoidalis*, **alisphenoid** and **orbitosphenoid** are ossification centers of *alae majores* and *alae minores*, respectively.

Lamina medialis processus pterygoidei and *conchae sphenoidales* have separate innominate ossification centers.

Some proposals have already been published: for example there is a missing term for the distal end of radius. **Crinis radii**, was proposed by van Riet et al. (2002), meaning originally “tail of a comet” or “rays of the sun” in Latin and being in relation to the word “radius”. It can be a new appropriate term for it as agreed by Wendell-Smith (2003). The other example are the term **artiulatio femoropatellaris**, a part of knee joint, and the terms **linea condylopatellaris medialis et lateralis**, separating *facies patellaris* from condylar surfaces of femur (Krmptić-Nemanić and Vinter, 2003a).

Some other important structures proposed for incorporation:

- **tuberculum vastoadductorium** (former “tuberculum innominatum”) is a projecting distal end of *trochanter major femoris*, serving for origin of *musculus vastus medialis* and for insertion of *musculus gluteus medius*
- **plica synovialis articulationis zygapophysialis** (incorrectly termed meniscoid) is an inconstant synovial fold of *articulationes zygapophysiales*, sometimes filled with adipose, less frequently fibrous tissue. It fills the free space of the articular cavity to adjust the incongruencies of the articular surfaces and produces the synovial fluid as well. It can be caught between the articular surfaces and cause spinal restriction and painful conditions.
- terms of additional movements (in opposite directions) should be added, concerning movements of the scapula and mandible (**elevatio/depressio**, **protractio/retractio**), lateral movements of the mandible (**lateropulsio**) and complex movements of the foot (**inversio/eversio**)

8.5. Low number of terms of topographic anatomy

Topographic anatomy is the most complex and most clinically relevant part of the anatomical science. It serves to understand the spatial relationships of various structures in specific parts of the body. Many of the spaces, triangles and canals, taught at medical schools and used in clinical medicine, possess their Latin and English terms, for example:

- **arcus tendineus musculi supinatorii** (of Frohse) is a fibrous arch (present in 2/3 of cases), strengthening the entry of the *canalis supinatorius* and being a possible structure to cause entrapment of *ramus profundus nervi radialis*
- **septum styloideum** (“fascia stylopharyngea” of Zuckerkandl and Testut) is a triangular fibrous plate stretching from *basis cranii interna* and *processus styloideus* along the muscles originating from the process mediocaudally to the pharyngeal wall and dividing the upper part of *spatium parapharyngeum* into **spatium prestyloideum** (continuous ventrally with *fossa infratemporalis*) and **spatium retrostyloideum**
- **trigonum omotrapii** together with the trigonum omoclaviculare forms *regio cervicalis lateralis* and is bounded ventrally by *musculus sternocleidomastoideus*, dorsally by *musculus trapezius* and caudally by venter inferior *musculi omohyoidei*
- **canalis pronatorius** between the heads of *musculus pronator teres* and between the heads of *musculus flexor digitorum superficialis* containing *nervus medianus*
- **canalis supinatorius** between two layers of *musculus supinator* containing *ramus profundus nervi radialis*
- **canalis malleolaris** under *retinaculum musculorum flexorum pedis* containing three tendons of posterior group of leg muscles, *vasa tibialia posteriora* and *nervus tibialis*
- **sulcus tracheoesophagealis** is a groove between the adjacent sides of trachea and oesophagus, containing *nervus laryngeus*

recurrens and lymph nodes; their location is relevant during thyroidectomy and parathyroidectomy

- **recessus pubicus fossae ischioanalis** is a paired cul-de-sac stretching from the fossa ischioanalis ventrally between the cranial diaphragma pelvis and caudal membrana perinei to the symphysis pubica

9. Discussion and conclusion

Several articles have attempted to draw attention to problems of usage and application of anatomical terminology and nomenclature (Bolgov, 2012; Hirsch, 2011; Kachlik et al., 2009; Kagan and Kolesnikov, 2011; Manzanares-Céspedes, 2010; Martin et al., 2009; Pawlina and Drake, 2009; Vogl, 2009; Wendell-Smith, 2003). A clear and understandable nomenclature is necessary for non-problematic communication. The principal argument that the specialists in anatomy (and/or other medical fields) understand each other without difficulty and that minor nomenclature discrepancies do not cause critical confusion in communication, is misleading for two reasons. First, anatomists represent only a small group among medical scientists and physicians, and moreover, it is quite a heterogeneous group mainly from the language point of view. Different languages and different scientific schools prefer special terminological phrases and even the existing TA (unfortunately mandatory in Latin only) has not removed the majority of discrepancies. Second, anatomy is a basic language of medicine and has to be simple, clear and understandable for all people involved in medicine, not only scientists and physicians, but also paramedical staff, journalists, lawyers, translators, linguists, information specialists, etc. Each well-developed scientific branch takes pride in quality and unambiguous nomenclature.

Several small attempts to draw attention to the problem have resulted in publications on inaccuracies in NA and TA but unfortunately no author reviewed it as a whole (Ajayi et al., 2013; Bartoska et al., 2013; Benninger, 2013; Benninger and Delamarter, 2013; Cheynet et al., 2003; Davidge et al., 2010; Ercoli et al., 2005; Ferreira et al., 2011; Grodinsky and Holyoke, 1938; Guidera et al., 2012; Hromada and Voboril, 1968; Isik et al., 2014; Kachlik et al., 2008b, 2010a,b,c,d,e; Kodama et al., 1987; Krmpotić-Nemanić and Vinter, 2003b; Krmpotić-Nemanić et al., 2003; Lengelé and Scalliet, 2009; Lobo and Menezes, 2011; Loukas et al., 2007; Matusz, 2010, 2011; Mirilas and Skandalakis, 2002; O'Brien et al., 2013; Paraskevas, 2011; Pauza et al., 1997; Ribas, 2010; Rodríguez-Hernández et al., 2011; Rohrich et al., 2008; Saleh et al., 2012; Schurter and Letterman, 1976; Shokrollahi et al., 2014; Skandalakis et al., 2006; Starmühler, 2011; Tran-Dinh, 1987; Vavilov and Kosourov, 2004; Voboril, 1985; Vojniković et al., 2013; Wendell-Smith, 2000b; Ziyal et al., 2005).

This article emphasizes several weak points of the Terminologia Anatomica. It is intended to evoke broader, more open discussion in public and suggest some proposals. The effort of all nomenclature commissions from times of BNA to FIPAT should be appreciated and a tribute to them should be paid by further refinement, expansion and deepening of both Latin and English anatomical nomenclature.

Last but not least, it has to be emphasized that FIPAT is working hard on all aspects of the nomenclature amelioration (terminological, technical, informative). FIPAT has increased the accessibility to its online documents, as cited above, and is consequently fully opened to receive and consider any comments, suggestions and proposals, in good time, and from a wide range of groups, including clinical and scientific societies as well as individuals involved in contribution to better anatomical, histological and embryological nomenclatures.

We are persuaded that the final issue of FIPAT work will be a very detailed, precise and correct nomenclature suitable to and meeting

the needs of both the anatomists and clinicians throughout the world. The role of FIPAT is irreplaceable and the effort in removal of synonymy and in unification, systematization, and clarification of anatomical terminology must be seen and appreciated.

Declaration of interest

The authors declare that they have no financial interest.

One of the authors is a member of FIPAT Working group on Informatics.

Transparency document

The [Transparency document](#) associated with this article can be found in the online version.

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