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COMMENTARY

A review of anatomical terminology for the hip bone

Emily Deem[1] · Nicholas Passalacqua[2] · Diana Messer[2] · Paige Sanseverino[2] · Katie Zejdlik[2] · Alexandra Klales[3]

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Abstract
Anatomists have been attempting to standardize anatomical terminology of the human body and in doing so created the *Terminologia Anatomica* as a standard language of anatomy. Despite developments such as the *Terminologia Anatomica*, a lack of consistency of anatomical terminology is still seen across and within disciplines. This study explores the variation in terminology for the hip bone through a literature review. In total, ten terms used to describe the hip bone were searched in PubMed, JSTOR, and EBSCO databases: "coxal bone," "hip bone," "innominate bone," "*os coxa*," "*os coxae*," "*ossa coxa*," "*ossa coxae*," "*os innominatum*," "*os pelvicum*," and "pelvic bone." Results found that the terms "hip bone" and "pelvic bone" were the most commonly used terms, with the most frequently used discipline being medicine. However, we argue against the use of these terms in favor of "coxal bone" or "innominate bone." "Hip bone" should be avoided due to its colloquial nature, and "pelvic bone" is not specific enough to the structure of the hip. Latin terms are often incorrectly conjugated (e.g., "*os coxae*"); therefore, the English equivalent should be used when possible. Regardless, standardization of anatomical terminology should be adopted through consensus by practitioners, researchers, and stakeholders.

Keywords Anatomical terminology · Hip bone · Innominate · Coxal bone · Pelvis

Introduction

There is a long history of attempting to standardize anatomical terminology of the human body in anatomy and medicine (O'Rahilly 1989; Sakai 2007). The focus of these efforts has primarily been to create stronger and more consistent connections between clinical practitioners and anatomy educators who do not always use the same terms for the same structures (Kachlik et al. 2008; Kachlik et al. 2009; Kachlik 2013; Kachlik 2021; Whitmore 1999). Part of this discrepancy of terms originates from conflicting *anatomical terminology* (i.e., a system of terms used by a discipline), without regard for *anatomical nomenclature* (i.e., a cross-disciplinary standardized system of terms, set according to certain classification principles) (Kachlik et al. 2009; Kachlik 2021). Modern anatomical nomenclature has been established and continues to be revised by the Federative Committee on Anatomical Terminology (FCAT), a committee from the International Federation of Associations of Anatomists (IFAA).

Anatomical nomenclature is contained in the *Terminologia Anatomica* (FIPAT 2019), currently in its second edition; the first edition was published in 1998 after nine years of work (Whitmore 1999). The goal of the FCAT in its development of the *Terminologia Anatomica* was the creation of an internationally accepted language of anatomy, essentially a standardization of anatomical terminology for both clinicians and anatomists. The basis of the *Terminologia Anatomica* is Latin, with the equivalent English terms provided (Whitmore 1999). However, continued reliance on the Latin language as the basis for anatomical terminology rather than the English language (described as the present-day "lingua franca of science") has generated some criticism (as summarized in Neumann et al. 2020). The *Terminologia Anatomica* is divided into bodily systems (bones, joints, muscles, etc.) and when available provides Latin language terms, Latin language synonyms, UK and US English language terms,

✉ Nicholas Passalacqua
nvpassalacqua@wcu.edu

[1] Western Carolina University, 1 University Way, Cullowhee, NC 28723, USA

[2] Department of Anthropology and Sociology, Western Carolina University, 1 University Way, Cullowhee, NC 28723, USA

[3] Department of Sociology and Anthropology, Washburn University, Topeka, USA

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and English language synonyms, as well as other applicable synonyms/eponyms (FIPAT 2019).

Despite the publication and revision of the *Terminologia Anatomica,* there continues to be a lack of consistency in anatomical terminology both within and across disciplines (e.g., Galic et al. 2018; Caro et al. 2018; Kachlik et al. 2010; Lund et al. 2014), as well as between languages and nations (e.g., Gielecki et al. 2008). Because of these inconsistencies, this paper explores the various anatomical terms for the hip bone and their usage in manuscript publications and attempts to provide guidance for the standardization of terminology for the hip bone.

Materials and methods

Because the aim of this project is to examine the use of various terms over time and by discipline, we included as many terms as possible when performing literature reviews. We first started with the terms for the hip bone listed in the *Terminologia Anatomica.* The Latin language term used in the *Terminologia Anatomica* is "*os coxae"*; with both the UK and English language terms being "hip bone". Additionally, "coxal bone" is listed as the primary English language synonym, with the additional synonyms: "pelvic bone", "innominate bone", and "*os pelvicum*" (FIPAT 2019). Several other terms were included based on their observed usage by the authors in publications, although they were not listed in the *Terminologia Anatomica*. In total, ten terms used to describe the hip bone were searched: "coxal bone," "hip bone," "innominate bone," "*os coxa*," "*os coxae*," "*ossa coxa*," "*ossa coxae*," "*os innominatum*," "*os pelvicum*," and "pelvic bone." For all searches either "os" or "bone" was included as part of the search term to avoid inclusion of papers with similarly named structures such as "innominate artery" (this is also consistent with naming conventions used in the *Terminologia Anatomica*).

Searches for scientific articles were conducted using the PubMed, JSTOR, and EBSCO databases. These databases were chosen for their accessibility and wide coverage of academic subjects. All journal articles, review articles, and conference proceedings available on these databases were examined from their earliest included publications through December 2020. Discipline of use was determined via the primary audience for the publication venue, examples provided in Table 1.

Initial search results were individually screened to ensure that the search terms were used to refer to the hip bone within the context of the article. Only articles which included references to the hip bones of humans, human ancestors (e.g., *Homo erectus*), and primates were included in the analysis (articles solely concerning non-human/non-primate animals were removed). If a manuscript included multiple terms for the hip bone (e.g., *os coxae* and *ossa coxa*), then it was included for both terms. Duplicated entries for single terms found across databases were removed. The remaining search results were included in the analyses corresponding to 6813 publications ranging in date from 1769 to 2020 with a mean publication date of 2005, a median publication date of 2012, and standard deviation in publication date of 22.5 years.

Descriptive statistics and plots were created to examine trends in term usage over time and between disciplines. Violin plots were generated in RStudio (version 4.0.4) to visually assess term usage trends.

Table 1 Examples of journals and their primary disciplinary audience

Primary Disciplinary audience	Journal
Anthropology	*The American Journal of Biological Anthropology*
Biology	*Nature Genetics*
Engineering	*Annals of Biomedical Engineering*
Forensic Sciences	*The Journal of Forensic Sciences*
Health Science	*Journal of Sports Sciences*
History	*Studies in the History of Art*
Human biology	*Age and Ageing*
Humanities	*Philosophical Quarterly*
Medicine	*Journal of the American Medical Association*
Science	*PloS one*
Zoology	*Journal of Zoology*

Results

Results demonstrate differences in terminology used to describe the hip bone both over time and between disciplines. Regarding temporal trends, the term "hip bone" ($n = 2965$) was the most frequently used term overall and the second-longest term in use (from 1802 to present), making it overall the most consistently used term. This was followed by "pelvic bone" as the next most frequently used term ($n = 2825$), with "innominate bone" ($n = 376$) as a distant third, "*os coxae*" ($n = 307$) fourth, and the other terms being much less frequently used (see Table 2 and Figs. 1 and 2).

Note that despite appearing in the *Terminologia Anatomica*, use of "*os pelvicum*" was not found in any of the databases. While it had the earliest and longest span of usage, the term "*os innominatum*" was used relatively infrequently, with its peak usage in the late 1800s. Additionally, use of the term "coxal bone" appears to have begun relatively recently (first used in 1967, but not used again until 1990) and quickly increased in usage.

Table 2 Term used by primary publication discipline

Bone term used	Anthropology	Biology	Engineering	Forensic Science	Health Science	History	Human biology	Humanities	Medicine	Science	Zoology	n
Hip bone	108	84	67	25	221	34	54	193	2012	167	0	2965
Pelvic bone	92	34	133	40	152	16	24	120	2102	109	3	2825
Innominate bone	58	9	6	10	51	1	9	27	191	13	1	376
os coxae	83	9	0	73	11	2	29	12	53	35	1	307
os coxa	24	0	1	45	0	0	8	7	12	15	0	111
os innominatum	22	2	0	0	0	2	1	11	38	6	0	82
coxal bone	20	6	5	17	6	0	1	0	34	3	0	92
ossa coxae	14	5	0	5	2	0	7	1	6	12	0	52
ossa coxa	1	0	0	0	0	0	1	0	1	0	0	3
os pelvicum	0	0	0	0	0	0	0	0	0	0	0	0

Regarding term usage by discipline, the main disciplinary audience was medicine, followed by science, and health sciences (Table 3). In regard to forensic science specifically (which includes forensic anthropology papers published in the *Journal of Forensic Sciences* for example), the term "*os coxae*" was the most frequently used, followed by "*os coxa*", and then "pelvic bone". Additionally, forensic science had the greatest relative usage of the term "coxal bone".

Discussion

This project examined the usage of various terms for the hip bone over time, and by discipline through the primary audience of various publications. Language is dynamic and varied; observing differences in language use over time and by different types of users is expected. However, despite the *Terminologia Anatomica* and its attempt to standardize anatomical nomenclature, a great deal of variation continues to exist in the use of terms for the hip bone both within and across disciplines. This variation not only includes anatomy and medicine, the primary audiences for the *Terminologia Anatomica*, but to all other disciplines as well, including forensic anthropology. Based on the literature searches performed here, of the ten terms examined in this paper, seven of them were used as recently as 2020, which was the most recent year included in this literature review. These results were consistent with Google Books N-grams of these same ten terms. Google Books N-grams are freely available graphs which display the use of words and phrases over time from books in Google's library, which includes scholarly and non-scholarly works (see https://books.google.com/ngrams/info for more information). Because Google Books N-grams find all usages of a word, they cannot be used to only examine usage for just the hip bone in particular contexts, and thus should be considered with caution.

Turmezei (2012) found that most anatomical terms in use today have an origin of Classical Latin or Classical Greek (~86% of terms); all the terms examined here appear to have Latin language roots. In regard to *Os innominatum*/innominate bone, the word "innominate" (plural "innominates") is English and comes from the Latin "*in*" meaning "not" and "*nominatus*" meaning "named". *Innominatum* represents the neuter (i.e., genderless) nominative version of the term, and of course "os innominatum" means "unnamed bone"). This theoretically represents the unique shape of the adult hip bone and how it did not resemble any other familiar objects which it could be named after. This "descriptive" approach to anatomical names was common (e.g., Tekiner et al. 2015; Walker 2002) and explains why the "brachiocephalic artery" is also sometimes referred to as the "innominate artery" (O'Conner & Kellerman 2015).

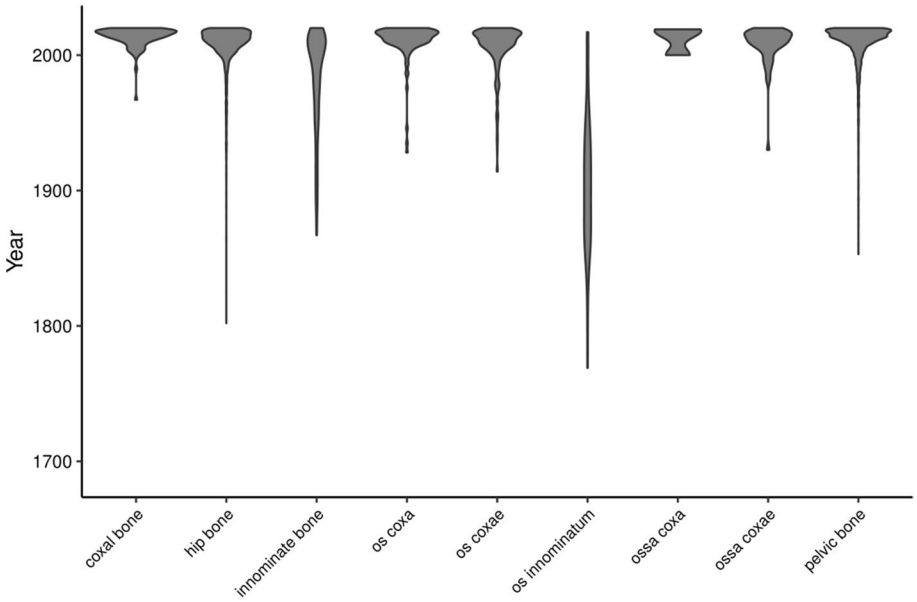

Fig. 1 Violin plot of all terms used over time, from 1700 to 2020. Note: ossa coxa and os pelvicum omitted due to lack of usage

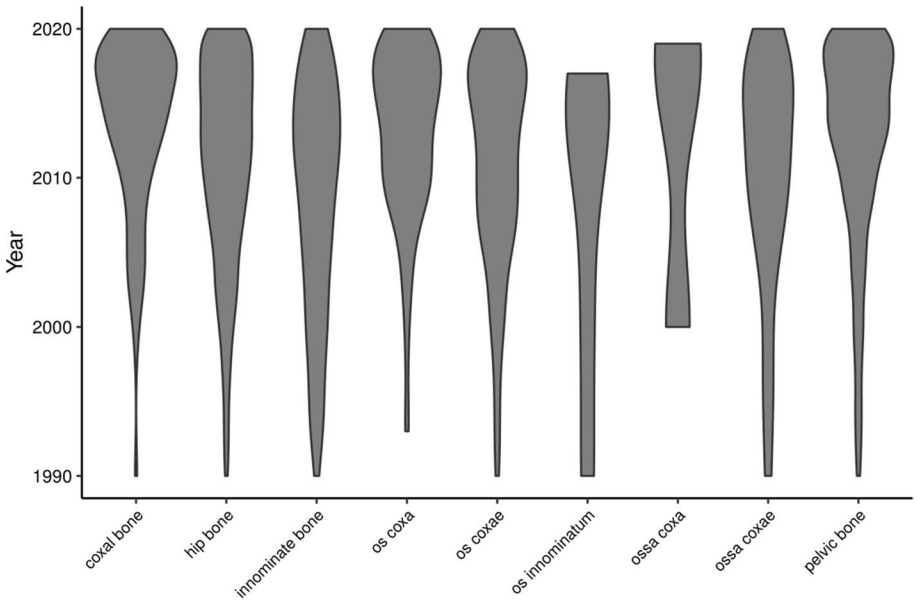

Fig. 2 Violin plot of terms used over time, truncated from 1990 to 2020 to focus on recent usage. Note: ossa coxa and os pelvicum omitted due to lack of usage

The term "coxal bone" (plural "coxal bones") is English and comes from the Latin "*os*" meaning "bone" and "*coxa*" meaning "hip". Saladin (1999) clarifies that "*os coxa*" translates to "bone hip" while "*os coxae*" translates to "bone of the hip" and that there are frequent misunderstandings in the pluralization of "*os coxae;*" the correct plural being "*ossa coxae*" which translates to "bones of the hip".

The term "pelvic bone" (plural "pelvic bones") is English and comes from the Latin "*os*" meaning "bone" and "*pelvicum*" meaning "basin" (Walker 2002). Like *innominatum*, *pelvicum* is a descriptive name for an anatomic structure.

In this literature review, the most frequently used terms were "hip bone" and "pelvic bone", dwarfing all other terms for the hip bone. We argue that both of these terms are potentially problematic in that "hip bone" is colloquial and typically colloquialisms (such as "shin bone") are not used in professional contexts, while "pelvic bone" is a misnomer

in that the pelvis is an anatomical structure composed of the paired hip bones and the sacrum; thus referring to a single bone as the pelvic bone, could lead to confusion. The next most frequently used term was "innominate" followed by "*os coxae*".

When synonyms are available for an anatomical structure, there is guidance for which term is most appropriate; which is to follow the *Terminologia Anatomica* (Kachlik et al. 2009). Additionally, multiple general style guides exist for facilitating the consistent use of language in writing (e.g., The Chicago Manual of Style) and while there are variations in these style guides, they are consistent in that foreign language terms be avoided when an English language equivalent is available. As such, we recommend the use of consistent terminology which avoids: colloquialisms (e.g., hip bone), terms that could be confusing (e.g., pelvic bone), and terms in foreign languages when an English language equivalent is available (e.g., *os coxae*). All present-day terms used for bones in the English language derive from non-English language origins. Essentially all bones in the skeleton have English language equivalents as their primary used term. The use of these exceptions in English-speaking publications should be discontinued as they are inconsistent with English grammar rules and are, thus, often used/conjugated incorrectly (i.e., incorrect use of *os coxae* as plural of *os coxa*). More broadly, we recommend all terms using "*os*" be replaced with their English equivalents (e.g., "*os pubis*" be replaced with "pubic bone").

When considering the most appropriate English language term for the hip bone, we argue that there are two options for consideration: "coxal bone" and "innominate bone." Both terms are formal English language equivalents of their Latin language counterparts, and both presently see widespread usage. We argue that despite its descriptive origin as "nameless", "innominate bone" is the most appropriate term for the hip bone, as it has the longest history of use (deriving from "*os innominatum*"). However, "coxal bone" could also be considered acceptable, as it has a more appropriate derivation for its name (deriving from "*os coxae*"), it and has been rapidly increasing popularity in the last 20 years or so (which may be related to the publication of the *Terminologia Anatomica*).

Regardless, standardization of terminology is necessary. While the *Terminologia Anatomica* is a great resource, it is not perfect, which reflects its constant state of revision. Additionally, the *Terminologia Anatomica* is meant as a resource for anatomists, and while inter-disciplinary standardization would be ideal, at present there appears to be little crossover between the anatomical and other disciplinary domains in this regard. To move towards a standardization of terms for the hip bone (and any other terms needing standardization), in the English language, we argue only through consensus by the communities of practice themselves

Table 3 Use of terms over time

Bone term used	Mean year of use	Median year of use	SD	First usage	Most recent usage	n
Hip bone	2007	2011	17.0	1802	2020	2965
Pelvic bone	2009	2013	16.1	1853	2020	2825
Innominate bone	1984	2000	36.6	1867	2020	376
os coxae	2006	2011	17.5	1914	2020	307
os coxa	2010	2014	14.4	1928	2020	111
os innominatum	1905	1901	49.0	1769	2017	82
coxal bone	2013	2015	7.4	1967	2020	92
ossa coxae	2008	2011	14.2	1930	2020	52
ossa coxa	2012	2017	10.4	2000	2019	3
os pelvicum	N/A	N/A	N/A	N/A	N/A	0

(anatomists, biologists, physicians, etc.) can standardization be achieved. As such, we suggest the following courses of action:

- Editors of journals as well as Textbook publishers adhere to style general style guides, which discourage the use of non-English language terms when English language equivalents exist.
- Professional organizations could host workshops on the importance of standardization of terminology, its importance in education and practice, and offer mechanisms for discussion and collaboration for creating and maintaining terminological lexicons.
- Professionals (practitioners, educators, and stakeholders) first work within their own disciplines, likely as part of working groups in professional organizations, to generate publicly available standardized lexicons. These lexicons (similar to the *Terminologia Anatomica*) could further guide language usage in publications, and be compared to other disciplines with inter-disciplinary working groups created as needed for further collaboration and standardization. An intra- and inter-disciplinary model for this is available from the Organization of Scientific Area Committees for the Forensic Sciences (OSAC) at: https://www.nist.gov/organization-scientific-area-committees-forensic-science/osac-lexicon.
- Professionals could work with existing Standards Development Organizations (SDOs, e.g., American Academy of Forensic Sciences Standards Board [ASB]) to publish standardized terminology lexicons, making them more formalized.

Conclusions

Variation in the terminology used to describe the bony pelvis exists both within and between disciplines, as well as over time. Both anatomy (e.g., the *Terminologia Anatomica*) and forensic anthropology (e.g., the ASB) are currently attempting to standardize various aspects of their disciplinary practices. The usage of consistent terminology is the most basic and crucial form of standardization as it provides a common set to terms to facilitate education and practice. Here, we found a great deal of variation in the usage of terms referring to the hip bone, and that based on language, history, and professionalism, we suggest either "innominate bone" or "coxal bone" become the preferred English terms used for the hip bone.

Data availability Data available upon request from the corresponding author.

Declarations

Conflict of interest The authors declare that they have no conflict of interest.

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