A83 One Hundred Years Since Martin's Lehrbuch: Measurement Confusion and DCP 2.0

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After attending this presentation, attendees will appreciate that there have been many versions of measurement definitions published and neither the primary nor secondary definitions are always ideal, due to poor descriptions, inaccurate or incomplete translations, or definitions for measurements that can at times be impossible to take correctly.

This presentation will impact the forensic science community by serving as a reminder that metric standards are necessary but have been corrupted through various means and a new approach to standards must be taken for consistency.

Measurement standards and definitions are difficult to write clearly, explicitly, and unambiguously, but are necessary in order to use metric methods of forensic analysis. At the beginning of the 20th century, there were a number of different cranial measurement standards of varying quality, largely in French and German. International standards for cranial and postcranial measurements were established in Monaco in 1906 and in Geneva in 1912. In 1914, Rudolf Martin published his *Lehrbuch der Anthropologie* and established measurement standards that have persisted in one form or another to the present. His definitions have remained unchanged in newer editions posthumously published and include comments on subsequent measurement definitions, such as those from Howells.[1,2] The interpretations of Martin's definitions have dominated most anthropological metric standards since.

However, Martin's definitions have never been translated fully into English; they are at times extremely opaque, such as his definition for the landmark ectoconchion. In some cases, his definitions are somewhat contradictory, referring to the most inferior and most superior points initially, then specifying techniques to obtain a maximum measurement, such as in the maximum length of the femur. In 1973, W.W. Howells modified and clarified craniometric landmarks and measurements from Martin and others. One often-overlooked anthropologist, Aurel von Török was far ahead of his time. In 1890, his *Grundzuege einer Systematischen Kraniometrie* (*Essentials of a Systematic Craniometry*) defined more than 100 landmarks and listed more than 5,000 measurements on the cranium. He also advocated using a "universal craniometer" that would calculate all standard measurements, all interlandmark distances, and all possible angles, which modern digitizers and computers finally can do.

Most knowledge of Martin's definitions is indirect, from the *Standards* of Buikstra and Ubelaker (BUS) or University of Tennessee's (UT) *Data Collection Procedures* (DCP1).[3,4] BUS was supposedly based on translations of Martin in DCP1 and a few secondary sources; however, many of the definitions leave out specific information on techniques, meaning a "maximum" measurement may not be the actual maximum measurement. Some subsequent publications cite the definitions in BUS and find a maximum length of a femur that is smaller than the bicondylar length, which is impossible if the full Martin definition is used. Other information in BUS is simply incorrect, such as the locations of dacryon and ectoconchion: their figure 41 actually illustrates maxillofrontale and frontomalare anterior. These and other errors are propagated in other osteology references works, some of which cite BUS. The DCP1 is largely a translation of Martin with secondary sources cited, but the DCP1 procedure for maximum long bone lengths, taken by moving the bone up and down, left and right, apparently comes from Hrdlicka's *Anthropometry*, which was not cited.[5] Hrdlicka was likely influenced, directly or indirectly, by studying anthropometric technique in France under Manouvrier in 1896, to whom his book was dedicated, but Manouvrier's definitions are not as explicit as Hrdlicka's. Whatever the source for Hrdlicka's standards, they seem to be consistent with his stated goal of providing "simple, practical, well-tested instructions." Finding maximum measurements in such a fashion should be more consistent among measurers than basing measurements on the most superior and inferior points.

Measurement standards must also evolve as technology and equipment changes. For more than 100 years, the standard instruments included sliding and spreading calipers. With the advent of 3D digitizers and scanners, and geometric morphometric methods, the Howell's measurement definitions which use landmarks defined independently of the measurement taken, are geometrically better than Martin's, whose landmark locations sometimes depend on the measurement being taken.

Examples from Martin to BUS to DCP1 remind the forensic science community that measurement definitions need to be clarified, improved, and, if necessary, changed, especially in light of the *Daubert* decision and the 2009 National Academy of Sciences Report, *Strengthening Forensic Science in the United States: A Path Forward*.[6] Because definitions can always be improved and augmented, and the nature of publication has changed, versioning is necessary. Electronic standards can easily be versioned, and can include textual descriptions, methodological comments, illustrations, images, and even video instruction. All are necessary to establish consistent and reliable standards. These forms of information and instruction will be integral parts of *Data Collection Procedures for Forensic Skeletal Material 2.0*, which will provide "simple, practical, well-tested instructions" based on empirical data.

References:

1. Martin R, Knussmann R. *Anthropologie: handbuch der vergleichenden biologie des menschen*. Stuttgart: Fischer, 1988.
2. Howells WW. Cranial variation in man. Cambridge, MA: Peabody Museum of Archaeology and Ethnology, 1973.
3. Buikstra JE, Ubelaker DH. Standards for data collection from human skeletal remains. Fayetteville, AR: Arkansas Archaeological Survey, 1994.
4. Moore-Jansen PM, Ousley SD, Jantz RL. *Data collection procedures for forensic skeletal material*. Third edition. Knoxville: University of Tennessee, 1994.
5. Hrdlicka A. Anthropometry. Philadelphia: Wistar Institute of Anatomy and Biology, 1920.
6. Committee on Identifying the Needs of the Forensic Science Community, National Research Council of the National Academies. *Strengthening Forensic Science in the United States: A Path Forward*. Washington, DC: The National Academies Press, 2009.

Craniometrics, Measurement Standards, Osteometry