Teaching Tips

The Vitruvian Man Exercise: Preparing Exercise Professionals to Detect Segmental Deviations

Lon Kilgore, Ph.D.
Department of Sport, Health and Exercise
School of Science
University of the West of Scotland
Hamilton Campus
Hamilton ML3 OJB
UK
lon@lonkilgore.com

Background

Historically, the teaching and coaching of exercise has included an element of interpretive anatomy with three distinct applications. The most recognized and obvious is the selection of exercises based on anatomical structures in which adaptation is desired, be it cardiovascular, pulmonary, skeletal, neural, or muscular. Failure to understand structure weakens an exercise professional's ability to induce appropriate adaptations, or in other words, improve fitness.

A second application of anatomical knowledge is the use of anthropometric data in the identification of individuals with physical dimensions associated with success in sport (Bourgois 2000, Claessens 1998, Grimston 1986, Kansal 1980, Pipes 1977). It has become rather common to see sport coaches select potential athletes for a sport or a specific position within a sport based upon physical dimensions. Most frequently this occurs in developmental, school-age, and high school sport, where the coach is initially presented with no other means of selection or information other than stature – a simplistic application of anthropometric measurement.

A third, less understood, but important application, is an aptitude in visual evaluation of an individual's unique anatomical structure in order to place the trainee in a position that [1] is correct for producing efficient movement through a task appropriate range of motion and [2] provides a foundation for safety. Development of this third application is an area of weakness in virtually all university courses related to anatomy. Traditional anatomy courses do not address the concept that mastery of anatomy is essential for developing competency in the analysis of human movement. Anatomy and physiology courses designed for a wide range of allied health professionals similarly do not present information within this topic area, as it is not central to all of the allied health professions utilizing such courses. Even "functional" anatomy courses created specifically for exercise professional preparatory programs rarely provide for student competency in this important ability.

There are a growing number of exercise professionals and academics who believe that there exists an anatomical orientation of the body that creates efficient movement unique to individuals and individual exercises. For example, it has been demonstrated that a vertical alignment of the navicular bone, bar of the barbell, and scapular spine will produce a linear bar path in the deadlift exercise (Kilgore 2009). Deviations from this alignment induce curvilinear, inefficient motion. Given the variation in the length of body segments encountered across human populations, the composite of the joint angles contributing to this alignment produces a different appearance between individuals (Fig. 1). It has also been suggested that body segmental variations alter ambulatory exercise performance. And in fact there is data demonstrating that segmental differences alter gait and velocity transitions (Monteiro 2010).

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Fig. 1. At the start of the deadlift the navicular bone, the bar, and the most medial and inferior aspect of the scapular spine are aligned in order to produce a straight bar path during ascent. A simple variation in arm length effectively changes the constituent joint angles required to create that alignment and changes the appearance of the exercise position even though each is correct (reprinted from Kilgore, 2010).

There exists a dearth of modern literature relevant to this topic, and this combination of curricular and literary omission affects millions of average gym-goers each year. Their trainers or coaches have never been provided any guidance on how to adapt exercise positions for individual variations in body dimensions among other exclusions (Stacey 2010). As such, it is quite common to see the one-size-fits-all approaches to teaching exercise positions printed in a majority of the authoritative professional literature (National Strength & Conditioning Association 2008) adopted by practitioners. This is a limitation affecting both the exercise professional's competency and the quality of teaching and coaching received by the trainee.

So a curricular content inclusion question arises: how does one approach presenting students with a means to detect anatomical variations and how to accommodate them? The first step is to facilitate determination of whether someone has longer than normal legs, shorter than normal arms, longer than normal trunk, etc. For this to occur, one must have a reference standard.

Is there a reference standard that can be used in this application? A review of the scientific and exercise professional literature does not provide a direct answer – unless we consider the works of Leonardo da Vinci. One of the easiest methods of determining if an individual deviates from "normal" anthropometry is to use the historical concept of normal human dimensions created by da Vinci (circa 1487). Virtually everyone is familiar with the "Vitruvian Man", da Vinci's map of human proportions, center of mass, and center of gravity (Fig. 2). While exercise professionals may not be familiar with the utility of the illustration, it is a convention used in art instructional units around the world as a method towards creating proportional representations of the human body. In application within the exercise arena, one can simply use an individual's head length, as did da Vinci, as a basis for body segmental analysis. Using the Vitruvian map, field practitioners can visually, and rapidly, determine if a body segment is different from da Vinci's prototypical human male.

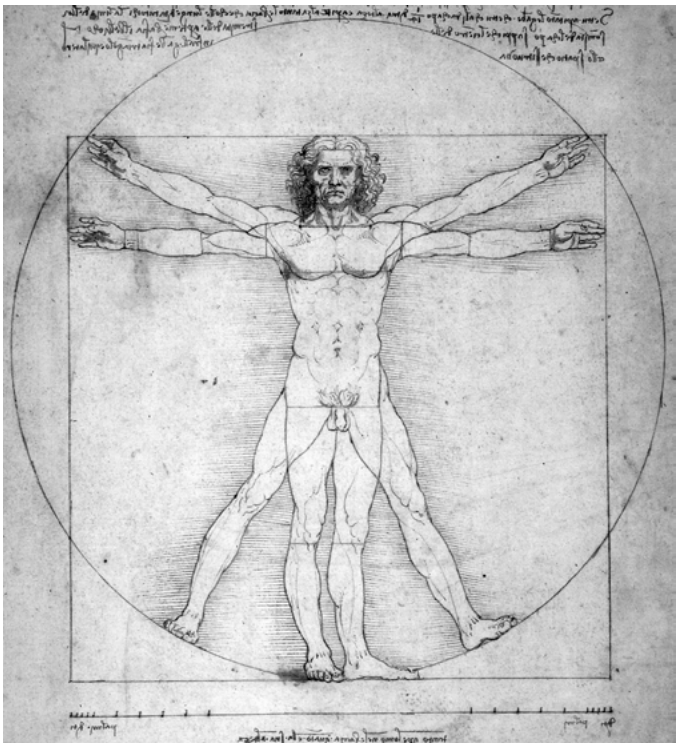

Fig. 2. da Vinci's Virtuvian Man (Uoumo Vitruviano). From the collection of the Gallerie dell'Accademia, Venice, Italy.

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The Exercise

A hands-on laboratory exercise using da Vinci's work as a basis was developed to help students grasp both the technique and utility of visual anthropometric assessment.

Step 1 of the learning process is to create an understanding of the Vitruvian model. The students are provided with a page-sized copy of the da Vinci's illustration (Fig. 2) along with a set of observations regarding segmental dimensions derived from his notes and illustration.

> From the top of the head to the bottom of the chin is one-eighth of a man's height.
>
> A man's height is four cubits, which conveniently is eight heads in overall length.
>
> The length of the outspread arms (wing span or reach) is equal to his height, or eight head lengths.
>
> The width of the shoulders is a quarter of a man's height, or two head lengths.
>
> The distance from the elbow to the armpit is one-eighth of a man's height, or one head length.
>
> The distance from the elbow to the tip of the hand is a quarter of a man's height, or two head lengths.
>
> The torso, from sternal notch to the level of the hip joint, is two and a half head lengths.
>
> The upper leg is two and a quarter head lengths.
>
> The lower leg to the ground is two head lengths.
>
> This widest point of the hips is one and a half head lengths.

Step 2 is the identification and palpation of the anatomical sites and features associated with each segment described. Each segment is discussed with respect to appropriate anatomical landmarks that bound the ends of each segmental measure. Three aids are provided each student pair to go along with the discussion: [1] the Vitruvian Man worksheet (Fig. 3), [2] a life size articulated skeleton, and [3] a laboratory partner. By having all students physically locate each structure on the illustration, skeleton, and on a fellow student during the presentation, they become familiar with the anatomical terrain and become prepared to perform the upcoming measurements accurately.

Step 3 is the creation of a subject-specific measurement device. Each student pair is provided two one-foot-long lengths of nylon cord. On this cord a set of marks is made. One represents the height of the head from the most inferior point of the chin to the highest and most superior point on the skull. Another mark is made at midpoint of the cord. The two resulting halves are bisected again to produce a measurement cord with increments of 0.25 head lengths.

Step 4 is measurement of the Vitruvian segments on the student partner using the customized cord. The identical measures are taken again in centimeters with a standard measuring tape. This step reinforces familiarity with topographical anatomy, develops a sense of measurement accuracy, and begins to develop a visual sense of segmental dimensions and orientation. Each measurement is recorded on a data reporting form created on a large whiteboard. This form has spaces for the data from each student in the class. Once the complete data set is on the whiteboard, the students copy the data set.

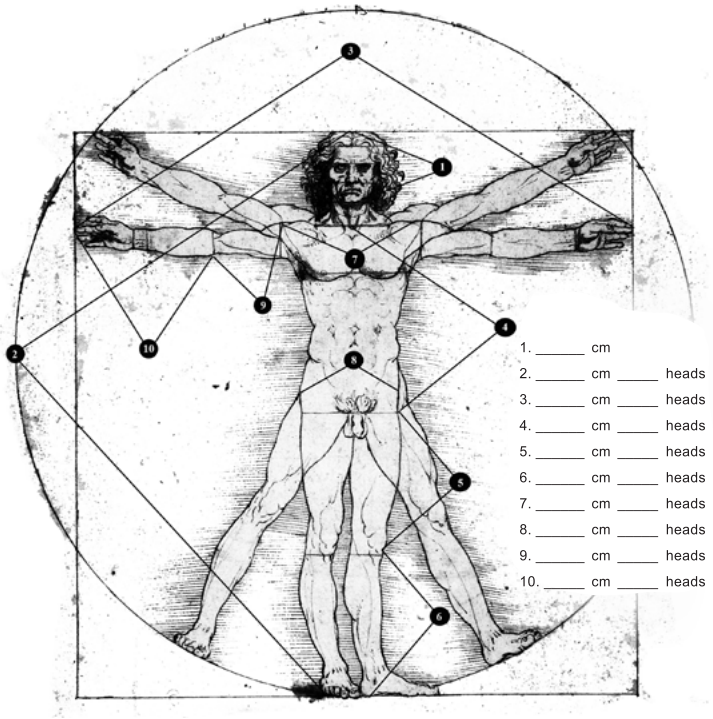

Fig. 3 Student guide to measurements and individual data recording sheet.

Step 5 involves simple statistical evaluation of the data using Microsoft Excel. Students are instructed briefly how to calculate means and standard deviations for each segmental measure for the entire class. This is assigned as out-of-class work in the form of a laboratory report. Five specific questions are included on the student's report form:

> Does the data from the class conform precisely to da Vinci's model of human dimensions? If not, describe the variance. If they are similar (within one standard deviation of the class mean) can the model still be used as a guide?

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Are there gender differences in the data? If so specify which dimensions display the greatest disparity.

Were any two subjects alike? What does this tell you about the value of being able to recognize segmental variation in your future trainees?

Step 6 takes place the following class period where the data, as analyzed by faculty, is compared to student reports and the directed questions are discussed.

Generally, what the students find is that the modern human does not conform precisely to the Vitruvian template, rather they see variation among the body segment lengths. However, they do find their results to be within one standard deviation of da Vinci's proposed segmental relationships. As such the template can still be cautiously applied.

Student feedback from this exercise has been exceptionally positive, with many reporting "Aha!" type moments when the connection between the presented information, the activity, and professional practice was realized. This laboratory, presented very early in the course schedule, has improved student participation in both lecture discussions and laboratory activities in subsequent portions of the course. Making a tangible connection between familiar art, learning, and professional practice has made the study of anatomy appealing to students who often look upon the study of anatomy as, at best, a necessary evil.

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