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ScienceDirect
Gait & Posture 27 (2008) 702–705
GAIT POSTURE
www.elsevier.com/locate/gaitpost

Technical note

# Shoulder motion description: The ISB and Globe methods are identical

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Received 21 March 2007; received in revised form 25 June 2007; accepted 3 July 2007

**Abstract**

*Background:* Three-dimensional shoulder position may be described by rotation sequences such as the proposed ISB standard. Alternative techniques to describe position (the Globe method) seek to simplify this description by eliminating rotation sequences and substituting unambiguous measurements.
*Methods:* Both methods (ISB and Globe) were applied to an analysis of shoulder positions, and an overall comparison was performed.
*Findings:* The ISB and Globe methods are numerically identical and interchangeable.
*Interpretation:* While all analytic methods are mathematically equivalent, investigators have sought simpler and more easily-applied ways of describing shoulder position that would be accurate, easily understood by clinicians, and unambiguous. This study demonstrates that the ISB rotation sequence and Globe descriptive method are numerically the same.


*Keywords:* Upper limb; Motion analysis; Shoulder

## 1. Introduction

The description of shoulder motion involves complexities that are unique to the joint. The dual nature of the anatomic structures involved in movement of the shoulder complex (scapulo-thoracic and gleno-humeral joints) has proven difficult to quantify [5], except by cumbersome methods (palpation, ultrasound, or MRI [2,4]). Even if the shoulder complex is simplified to movement of the humerus relative to the thorax, different rotation sequences and philosophies make comparison of upper extremity motion studies challenging.

The Cardanic method of three sequential angles about the individual axes of a moving Cartesian coordinate system imbedded in the distal segment has been widely used in human gait analysis, and has found application in upper extremity investigations [7]. However, difficulties applying this method in regions of 90° shoulder abduction have led to consideration of other techniques. An et al. described a sequence of three rotations that rotates the humerus to a plane of elevation, through an angle of elevation, and to a new rotational humeral position [1]. The first and third rotations are about the longitudinal axis of the humerus, and the second rotation is about the forward-directed humeral axis. This sequence was used to describe isolated humeral motion with respect to the scapula, and it is not always intuitive because the entire upper extremity must first rotate to the plane of elevation, and then must be rotated "back" to its final position after elevation of the humerus. Using different axis definitions, the International Society of Biomechanics (ISB) [8] proposed a similar standard for description of shoulder kinematics. The zero point of the plane of elevation is lateral (frontal plane) and the 90° plane of elevation is forward (sagittal plane); these definitions may confuse clinicians.

The ISB method is a sequence decomposition from a base starting position to the actual limb position. While engineers

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doi:10.1016/j.gaitpost.2007.07.003

understand this, clinicians without engineering expertise may not understand why the position cannot simply be ‘‘measured’’ without the necessity of strict sequences. Pearl et al. [6] attempted to solve this problem practically by *defining* the plane of elevation (the longitude of a Globe), but not actually *rotating* the arm to this position. The angle of elevation of the humerus is measured in that plane. Finally, humeral rotation is *described* by the angle of the 90° flexed forearm with the line of latitude at the elbow. Thus, Pearl substituted a definition, measurement, and description set for a sequence of three rotations. This is an important difference from the ISB method, as it is easier for clinicians to understand, and it mimics practical measurement methods commonly employed by physicians, therapists, etc. While an ordered set of numbers is used to describe position in the Pearl method, the measurement of angles in Pearl's approach is actually sequence-independent. A similar system is described by Doorenbusch et al. [3] These methods are designated the Globe method in this paper.

Selection of a specific method for reporting results is often determined by the ease of description of motion in a specific region of interest. The Cardanic sequence is best suited to activities directly forward of or behind the shoulder, and the other methods (ISB and Globe methods) are suited to movement at the side, particularly when the arm is abducted (such as throwing). Despite similarities, the ISB

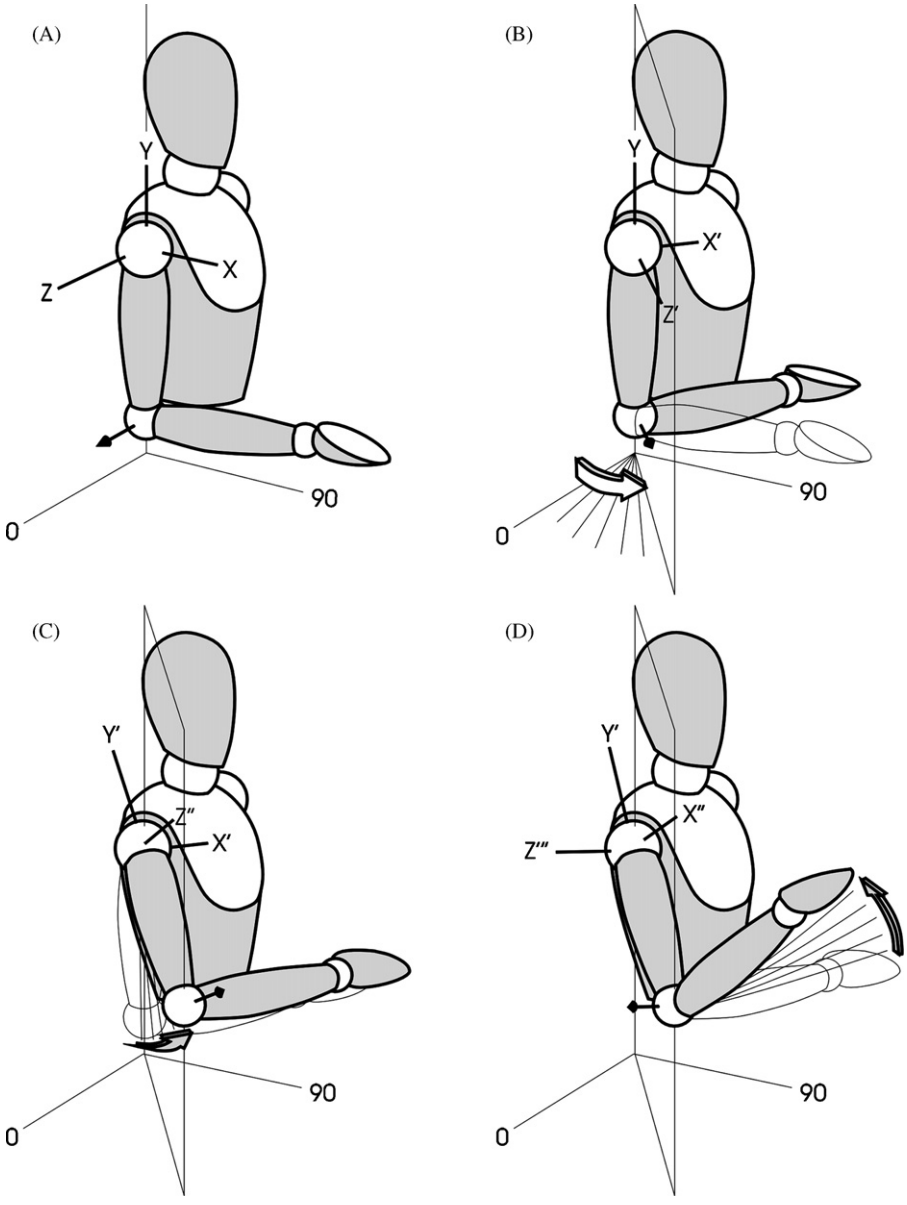


Fig. 1. ISB method applied to an articulated model position. (A) Initial position, with vector pointing laterally (humeral *Z*-axis) at 0° on the *XZ* plane. (B) The humerus is first rotated about its *Y*-axis until the humeral *Z*′-axis points to the plane of elevation. Note that the forearm (elbow 90° flexed) and *X*-axis are horizontal at this point. (C) The humerus is elevated about its *X*′-axis. Note that the forearm and *X*-axis remain horizontal, parallel to the *XZ* plane. (D) The humerus is externally rotated about its *Y*′-axis by to the final position. The *Y*′-axis is normal to the plane containing the rotating forearm.