Lecture 14

Joint I - Joints and Their Classification

Plan of the Lecture

1. Joints and Their Classification
    a. Bony Joints
    b. Fibrous Joints
        i. Sutures
        ii. Gomphoses
        iii. Syndesmoses
    c. Cartilaginous Joints
        i. Synchondroses
        ii. Symphyses
    d. Synovial Joints
        i. General Anatomy
        ii. Joints and Lever Systems
        iii. Mechanical Advantage
        iv. Types of Levers
        v. Range of Motion
        vi. Axes of Rotation
        vii. Classes of Synovial Joints
        viii. Movements of Synovial Joints
            1. Flexion and Extension, Abduction and Adduction
            2. Elevation and Depression, Protraction and Retraction
            3. Circumduction, Rotation, Supination and Pronation
            4. Special Movements of the Head and Trunk, the Mandible, the Hand and Digits, the Foot

LEARNING OUTCOMES

1. explain what joints are, how they are named, and what functions they serve;
2. name and describe the four major categories of joints;
3. describe the three types of fibrous joints and give an example of each;
4. distinguish between the three types of sutures;
5. describe the two types of cartilaginous joints and give an example of each;
6. explain, with examples, why some joints change categories as a person ages.
7. identify the anatomical components of a typical synovial joint;
8. classify any given joint action as a first-, second-, or third class lever;
9. explain how mechanical advantage relates to the power and speed of joint movement;
10. discuss the factors that determine a joint's range of motion;
11. describe the primary axes of rotation that a bone can have and relate this to a joint's degrees of freedom;
12. name and describe six classes of synovial joints;

13. use the correct standard terminology for various joint movements.

Any point where two bones meet is called a joint (articulation), whether or not the bones are mobile at that interface. The science of joint structure, function, and dysfunction is called arthrology.1 The study of musculoskeletal movement is kinesiology. This is a branch of biomechanics, which deals with a broad variety of movements and mechanical processes in the body, including the physics of blood circulation, respiration, and hearing. The name of a joint is typically derived from the names of the bones involved. For example, the atlanto–occipital joint is where the atlas meets the occipital condyles; the glenohumeral joint is where the glenoid cavity of the scapula meets the humerus; and the radioulnar joint is where the radius meets the ulna. Joints can be classified according to the manner in which the adjacent bones are bound to each other, with corresponding differences in how freely the bones can move. Authorities differ in their classification schemes, but one common view places the joints in four major categories: bony, fibrous, cartilaginous, and synovial joints. This section will describe the first three of these and the subclasses of each. The remainder of the chapter will then be concerned primarily with synovial joints.

The most familiar type of joint is the synovial joint, also called a diarthrosis. Ask most people to point out any joint in the body, and they are likely to point to a synovial joint such as an elbow, knee, or knuckle. Many synovial joints, like these examples, are freely mobile. Others, such as the joints between the wrist and ankle bones and between the articular processes of the vertebrae, have more limited mobility. Synovial joints are the most structurally complex type of joint and are the type most likely to develop uncomfortable and crippling dysfunctions. They are the most important joints for such professionals as physical and occupational therapists, athletic coaches, nurses, and fitness trainers to understand well. Their mobility makes the synovial joints especially important to the quality of life. Reflect, for example, on the performance extremes of a young athlete, the decline in flexibility that comes with age, and the crippling effect of rheumatoid arthritis. The rest of this chapter is concerned with synovial joints. Many bones, especially the long bones, act as levers to enhance the speed or power of limb movements. A lever is any elongated, rigid object that rotates around a fixed point called the fulcrum. Rotation occurs when an effort applied to one point on the lever overcomes a resistance (load) at some other point. The portion of a lever from the fulcrum to the point of effort is called the effort arm, and the part from the fulcrum to the point of resistance is called the resistance arm. In skeletal anatomy, the fulcrum is a joint; the effort is applied by a muscle; and the resistance can be an object against which the body is working (as in weight lifting), the weight of the limb itself, or the tension in an opposing muscle. In solid geometry, we recognize three mutually perpendicular axes, x, y, and z. In anatomy, these correspond to the transverse, frontal, and sagittal planes of the

body. Just as we can describe any point in space by its x, y, and z coordinates, we can describe any joint movement by reference to the transverse, frontal, or sagittal anatomical planes. There are six fundamental types of synovial joints, distinguished by the shapes of their articular surfaces and their degrees of freedom. We will begin by looking at these six types in simple terms, but then see that this is an imperfect classification for reasons discussed at the end. All six types can be found in the upper limb. They are listed here in descending order of mobility: one multiaxial type (ball-and-socket), three biaxial types (condylar, saddle, and plane), and two monaxial types (hinge and pivot). Kinesiology, physical therapy, and other medical and scientific fields have a specific vocabulary for the movements of synovial joints. This section introduces the terms for joint movements, many of which are presented in pairs or groups with opposite or contrasting meanings. All directional terms used here refer to a person in standard anatomical position. When one is standing in anatomical position, each joint is said to be in its zero position. Joint movements can be described as deviating from the zero position or returning to it.

Check yourself! The questions for self-control

1. What is the difference between arthrology and kinesiology?
1. Distinguish between a synostosis, synarthrosis, and amphiarthrosis.
2. Define suture, gomphosis, and syndesmosis, and explain what these three joints have in common.
3. Name the three types of sutures and describe how they differ.
4. Name two synchondroses and two symphyses.
5. Give some examples of joints that become synostoses with age.
6. Describe the roles of articular cartilage and synovial fluid in joint mobility.
7. Give an anatomical example of each class of levers and explain why each example belongs in that class.
8. Give an example of each of the six classes of synovial joints and state how many axes of rotation each example has.
9. Suppose you reach overhead and screw a lightbulb into a ceiling fixture. Name each joint that would be involved and the joint actions that would occur.
10. Where are the effort, fulcrum, and resistance in the act of dorsiflexion? What class of lever does the foot act as during dorsiflexion? Would you expect it to have a mechanical advantage greater or less than 1.0? Why?

Recommended readings:

1. Kenneth S Saladin - Anatomy & Physiology. The Unity of Form and Function (2016, McGraw-Hill Education)
2. Barbara Gylys - Medical Terminology Systems (2012, F.A. Davis Company)
3. Richard L. Drake A. Wayne Vogl, Adam W. M. Mitchell - Gray's Atlas of Anatomy, Second Edition (2015, Churchill Livingstone Elsevier)