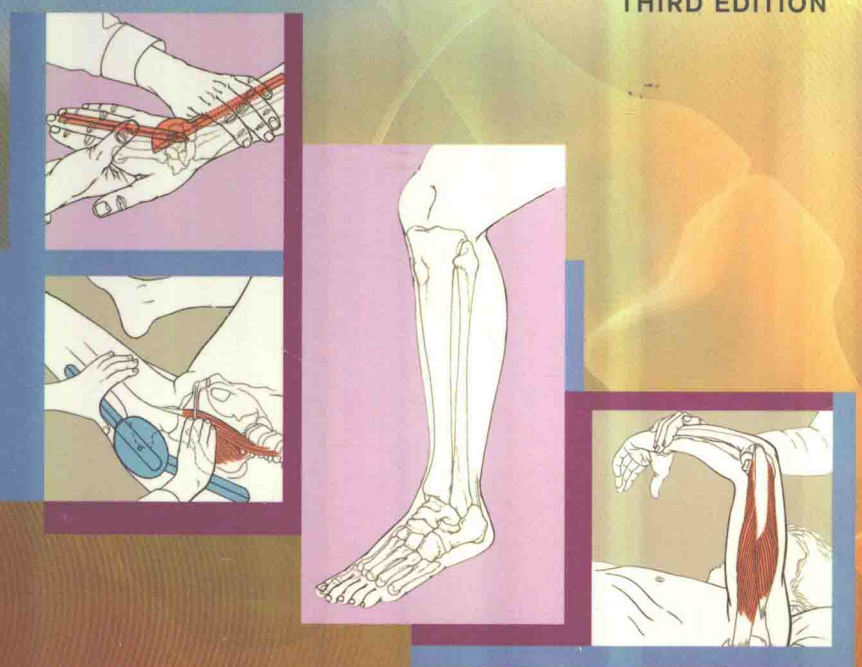
Musculoskeletal Assessment

Joint Motion and Muscle Testing

Hazel M. Clarkson

THIRD EDITION



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MUSCULOSKELETAL ASSESSMENT

Joint Motion and Muscle Testing

Third Edition

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Dedicated to my parents,
Dr. and Mrs. Graham and
June Clarkson,
who have so generously given so
much of themselves for so many in
such a quiet way

Preface

I am delighted to introduce the third edition of *Musculoskeletal Assessment: Joint Motion and Muscle Testing*. This edition continues the quest to convey new information, methodology, experience, and wisdom to students and professionals alike. New approaches that facilitate learning elevate the existing status of this title as an important educational tool and clinical resource. The third edition is updated to include the latest research findings and assessment techniques.

New to This Edition

Some of the more significant additions to the third edition include the following.

Practical testing forms for the assessment and measurement of joint range of motion (ROM), muscle length, and assessment of muscle strength are found on this book's companion website at http://thepoint.lww.com/Clarkson3e. These forms list the criteria for each assessment and measurement technique in a chart/checklist format. Judging from my teaching experience, these forms will be an invaluable tool for students to become proficient in the clinical assessment and measurement techniques, allow for evaluation of student proficiency, and serve as a handy review. **Practice Makes Perfect** icons appear next to clinical assessment and measurement techniques throughout the textbook to cross-reference the corresponding online practical testing forms. (For information on other ancillary materials available with this text, see section on "Additional Resources" in this preface.)

Further noteworthy additions to the third edition include more in-depth reviews of articulations, arthrokinematics, the SFTR method, and illustration of normal and reverse scapulohumeral rhythm resulting from restricted glenohumeral joint ROM. Normal ranges of motion are now emphasized in red font in the text. New techniques are described and illustrated to measure active range of motion (AROM) of the temporomandibular joint (TMJ) using the ruler and calipers, and the spine using the tape measure, standard inclinometers, the Cervical Range-of-Motion Instrument (CROM), and the universal goniometer. For the assessment and measurement of muscle length, muscle origins and insertions are included with each procedure. A more concise description of grading muscle strength is presented. A new chart of patient positioning for the assessment and measurement of joint ROM, muscle length, and muscle strength is added as Appendix C.

Many new photographs and illustrations augment the written text. Of special note are unique illustrations of the measurement of joint passive range of motion (PROM) showing the universal goniometer and therapist's hand positions in relation to the deep anatomy, and those of the noncontractile normal limiting factors (NLF) that limit movement. Illustrations of the deep bony anatomy that accompany the photographs of surface anatomy are also new.

Need for This Textbook

Assessment of joint ROM and muscle strength are important clinical skills in the practice of physical and occupational therapy. These evaluations form two component parts of the physical assessment of a patient with a musculoskeletal disorder. This book has evolved in response to a need for a comprehensive textbook that contains the principles and methodology of joint ROM and manual muscle strength evaluation in one volume. The content is written on the assumption that the student possesses prerequisite knowledge of the anatomy of the musculoskeletal system.

Organizational Philosophy and Use of Visual Material

Section I: Principles and Methods (Chapters 1 and 2)

Chapter 1 of this volume focuses on the principles and methodology of evaluation. The overview of the principles and methods provided here contains knowledge prerequisite for the remaining chapters.

Chapter 2 (Chapter 9 in the previous edition) of this volume illustrates how specific assessment methods are

utilized and adapted to serve as treatment methods. Using description and illustration, the principles and methodology of joint ROM, muscle length, and manual muscle strength evaluation are shown to be the same as those used for selected treatment techniques. The content of this chapter relates directly to the principles and methodology presented in Chapter 1. This unique presentation blends the topics of assessment and treatment to facilitate learning and application of these skills as practiced clinically.

Section II: Regional Evaluation Techniques (Chapters 3 through 9)

Chapters 3 through 9 focus on the specific methodology of ROM and muscle strength evaluation of the extremities, head, neck, and trunk. Each of these chapters is devoted to a specific joint complex, and all are organized in an identical format.

Articulations and Movements

Each chapter begins with a review of the articulations, shapes of the articular surfaces, joint movements, and axes of movement pertaining to the specific joint complex. A summary of joint structure, movements, and NLF to joint movements are presented in tabular form. This table provides reference information pertinent to assessment, measurement, and interpretation of findings. Line drawings accompany the table to enable the reader to visualize the noncontractile NLF that normally limit joint motion.

Surface Anatomy

Through illustration and description, the pertinent landmarks for the assessment of joint ROM and muscle strength are identified. Muscles are excluded from this description, as precise points of palpation are presented in the description of each muscle test later in the chapter.

Range of Motion Assessment and Measurement

Following the surface anatomy is the methodology for assessing and measuring each movement at the particular joint complex. In some chapters, AROM scans used to guide the need for subsequent assessment procedures are described and illustrated.

A consistent method of assessing and measuring joint ROM is essential for accurate assessment of a patient's present status, progress, and effectiveness of the treatment program. Learning is promoted through consistency in documentation and illustration of methods.

The assessments of ROM are described under the main headings of joint movements. In *Chapters 3 through 8*, the description of the assessment and measurement of the ROM normally begins with a reminder to assess the AROM and identifies the substitute movements to be avoided, when applicable. For a select few peripheral joint movements, the measurement of the AROM is also described and illustrated.

For the joints of the extremities, description and illustration of the assessment of PROM that includes determination of the end feel is followed by description and illustration of the measurement of PROM using the universal goniometer and in some cases the OB "Myrin" goniometer.

Chapter 9 (Chapter 2 in the previous edition) covers the assessment and measurement of AROM for the TMJ and spine. This chapter is extensively revised to describe and illustrate many new measurement techniques using the ruler and calipers to measure AROM of the TMJ, and the tape measure, standard inclinometers, CROM, and universal goniometer to measure spinal AROM.

Muscle Length Assessment and Measurement

Following the assessment and measurement of joint ROM, assessment and measurement of muscle length is described and illustrated under the main headings of the muscle(s) being assessed.

Muscle Strength Assessment

The next section of the chapter focuses on manual muscle strength assessment. The section begins with a review of the relevant anatomy of the region, including muscle actions, attachments, and nerve supply.

In each chapter, the muscle strength tests are described under the main headings of joint movements. The prime mover(s) and accessory muscle(s) are identified. Through illustration and description, the against gravity tests are presented, followed by the gravity eliminated tests. The sequence is consistent for each movement.

For each muscle strength test, the first against gravity photograph illustrates the start position and stabilization. The next photograph illustrates the patient's position at the end of the ROM and the best point for muscle palpation. The resistance test follows with a photograph of the therapist applying manual resistance. An illustration of the muscle being tested and the location of the therapist's hand relative to deep anatomical structures when applying resistance accompanies the resistance photograph. The illustration also provides a visual review of muscle attachments and direction of muscle fibers to assist the student in visualizing the deep structures.

The first gravity eliminated test photograph illustrates the start position and stabilization. A second photograph illustrates the end position for the gravity eliminated test and the best point for palpation of the muscle(s) being assessed.

Normally, the assessment or measurement procedures for joint ROM and muscle strength first give the optimal start position that could be used to perform the procedures based on the position that offers the best stabilization. In some instances, there may be more than one position that could be used to assess or measure the joint ROM or assess the muscle strength. These positions are termed alternate positions and are documented if they are common in clinical practice or if the preferred start position is impractical or contraindicated for some patients.

Functional Application

The final section of each chapter is devoted to the functional application of assessment. The specific function of

the joint complex is described. The functional ROM at the joint is documented. Emphasis is placed on those ranges required for performance of daily activities. The function of the muscles is described according to biomechanical principles and daily activities. Assessments of joint ROM and muscle strength are not performed in isolation of function. Through knowledge of the ROM and muscle function required in daily activities, the therapist can elicit meaningful information from the assessments. The therapist correlates the assessment findings with the patient's ability to perform daily activities and, in conjunction with other physical assessment measures, determines an appropriate treatment plan to restore or maintain function.

Section III: Appendices

Appendices A and B present sample recording forms for ROM Assessment and Measurement, and Manual Muscle Strength Assessment, respectively. A new chart of patient positioning for the assessment and measurement of joint ROM, muscle length, and muscle strength has been added as Appendix C. Appendix D describes joint positions and motions of the lower limb throughout the gait cycle.

Additional Resources

Musculoskeletal Assessment: Joint Motion and Muscle Testing, Third Edition, includes additional resources for both students and instructors that are available on the book's companion website at http://thepoint.lww.com/Clarkson3e.

Students

Students who have purchased *Musculoskeletal Assessment: Joint Motion and Muscle Testing*, Third Edition, have access to the following additional resources:

- **Practical testing forms** (mentioned earlier in this preface) for the assessment and measurement of joint ROM, muscle length, and assessment of muscle strength; these forms list the criteria for each assessment and measurement technique in a chart/checklist format.
- **Video clips** illustrating assessment techniques

Instructors

Approved adopting instructors will be given access to the following additional resources:

- An image bank containing all the images and tables in the book
- A WebCT and Blackboard Ready Cartridge

In addition, purchasers of the text can access the searchable Full Text Online by going to the *Musculoskeletal Assessment: Joint Motion and Muscle Testing*, Third Edition, website at http://thePoint.lww.com/Clarkson3e. See the inside front cover of this text for more details, including the passcode you will need to gain access to the website.

A Final Note

It is my hope this textbook continues to serve as a valuable resource in the classroom, laboratory, and clinical environments to promote a high level of standardization and proficiency in the clinical evaluation of joint ROM and muscle strength.

Hazel M. Clarkson

Acknowledgments

The development and success of each new edition of *Musculoskeletal Assessment: Joint Motion and Muscle Testing* has come about because of the efforts of many people. I want to again thank all who worked with me to produce the first and second editions of this textbook. These editions served as the beginning to the third edition. I am now pleased to be able to thank those who assisted me with the production of the third edition.

I am most grateful for the unconditional support and encouragement I received from my family once again, as "we" took on yet another edition! A great many thanks to my husband Hans Longerich, parents Graham and June Clarkson, and brother Ronald Clarkson, who have given unselfishly of their time and expertise to edit the text, assist to manage photography sessions, serve as models for photographs and illustrations, and for always being there. It was always a great support for me to know you were there to help whenever needed.

I thank my clinical and academic colleagues who provided helpful reviews of my work and so generously shared their experience and expertise. A special thanks to Bob Haennel, Chairman, Department of Physical Therapy, Faculty of Rehabilitation Medicine, University of Alberta, for his support.

A special thanks to my good friend and colleague, Liza Chan, for giving so generously her time and expertise to assist with literature searches and the organization of research materials. Jess Chan, thank you for your assistance with collecting reference materials.

To my photographer for this edition, Thomas Turner, thank you for producing such high quality photographs. It was a pleasure to work with you. Ron Clarkson, my model, thanks for serving in this role again. I thank you for your thoughtfulness as you went above and beyond your modeling role.

To my artist, Kim Battista; it was a pleasure to work with you to create the new line art for this third edition.

Last but not least, I wish to extend my thanks to the entire Lippincott Williams & Wilkins team, and in particular to Meredith Brittain for having been such a dedicated team leader—thanks for your helpful suggestions and patience throughout the process.

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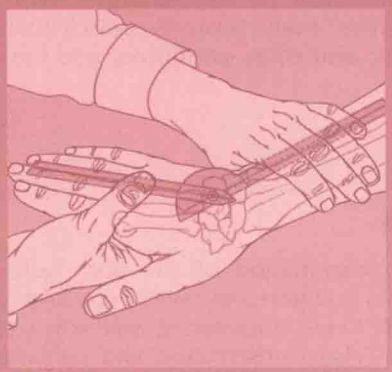
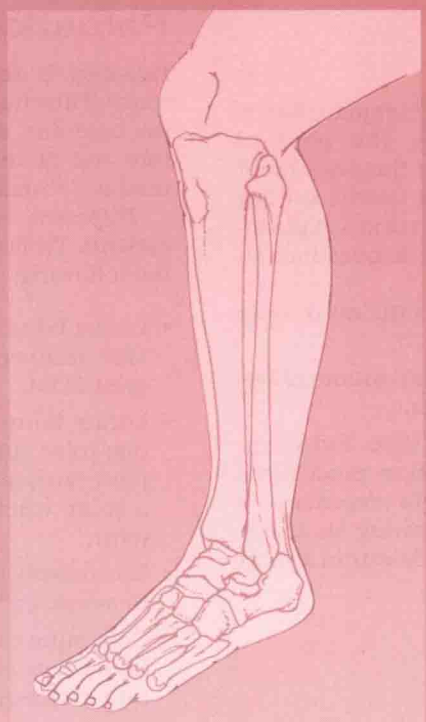
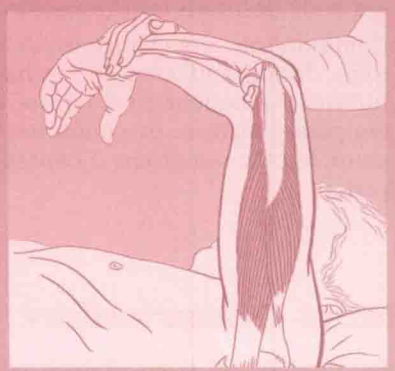
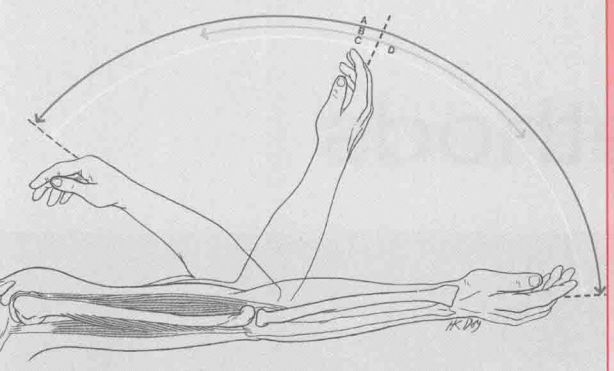
Principles and Methods









Chapter 1

Principles and Methods

A fundamental requisite to the study of evaluation of joint range of motion (ROM) and muscle strength is the knowledge of evaluation principles and methodology. This chapter discusses the factors pertinent to the evaluation of ROM and strength. A firm foundation in the principles, methods, and associated terminology presented in this chapter is necessary knowledge for the specific techniques presented in subsequent chapters.

Communication

When conducting a physical assessment, explain to the patient the rationale for performing the physical assessment and the component parts of the assessment process as these are carried out. Speak slowly, use lay terms, provide concise and easily understood explanations, and encourage the patient to ask questions at any time.

It is essential the patient understands the need to do the following:

1. Expose specific regions of the body and assume different body positions for the examination.
2. Communicate any change in his/her signs and symptoms during and after the examination procedures. Inform the patient that he/she might experience a temporary increase in symptoms following an assessment, but the symptoms should subside within a short period.

Visual Observation

Visual observation is an integral part of assessment of joint ROM and muscle strength. The body part being assessed should be adequately exposed for visual inspection. Throughout the initial assessment of the patient, the therapist gathers visual information that contributes to formulating an appropriate assessment plan and determining the patient's problems. Information gained from visual observation includes such factors as facial expression, symmetrical or compensatory motion in functional activities, body posture, muscle contours, body proportions, and color, condition, and creases of the skin.

Palpation

Palpation is the examination of the body surface by touch. Palpation is performed to assess bony and soft tissue contours, soft tissue consistency, and skin temperature and texture. Visual observation and palpation are used to "visualize" the deep anatomy.[1]

Palpation is an essential skill to assess and treat patients. Proficiency at palpation is necessary to perform the following:

- Locate bony landmarks needed to align a goniometer, tape measure, or inclinometer correctly when assessing joint ROM.
- Locate bony segments that make up a joint so that one joint surface can be stabilized and the opposing joint surface can be moved to isolate movement at a joint when assessing joint ROM or mobilizing a joint.
- Locate bony landmarks that are used as reference points to assess limb or trunk circumference.
- Determine the presence or absence of muscle contraction when assessing strength or conducting reeducation exercises.
- Identify bony or soft tissue irregularities.
- Localize structures that require direct treatment.

Proficiency at palpation is gained through practice and experience. Practice palpation on as many subjects as possible to become familiar with individual variations in human anatomy.

Palpation Technique

- Ensure the patient is made comfortable and kept warm, and the body or body part is well supported to relax the muscles. This allows palpation of deep or inert (noncontractile) structures such as ligaments and bursae.
- Visually observe the area to be palpated and note any deformity or abnormality.
- Palpate with the pads of the index and middle fingers. Keep fingernails short.
- Place fingers in direct contact with the skin. Palpation should not be attempted through clothing.
- Use a sensitive but firm touch to instill a feeling of security. Prodding is uncomfortable and may elicit tension in the muscles that can make it difficult to palpate deep structures.
- Instruct the patient to contract a muscle isometrically against resistance and then relax the muscle to palpate muscle(s) and tendon(s). Palpate the muscle or tendon during contraction and relaxation.
- Place the tips of the index and middle fingers across the long axis of the tendon and gently roll forward and backward across the tendon to palpate a tendon.

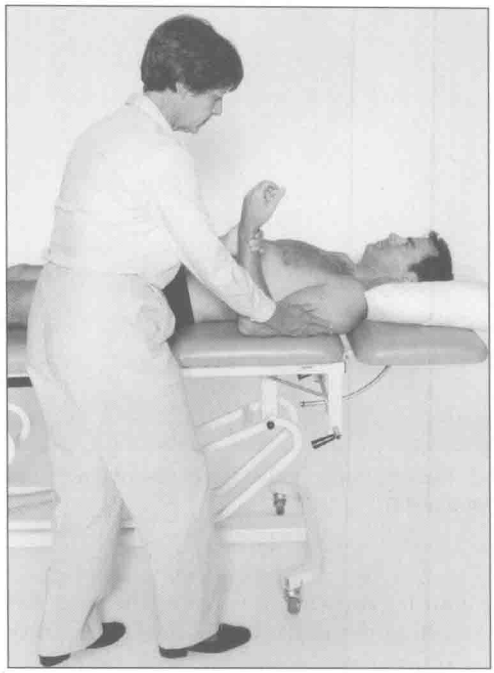


Figure 1-1 Therapist's stance when performing movements parallel to the side of the plinth.

Therapist Posture

Apply biomechanical principles of posture and lifting when performing assessment techniques. Therapist posture and support of the patient's limb are described.

Posture

Stand with your head and trunk upright, feet shoulder width apart, and knees slightly flexed. With one foot ahead of the other, the stance is in the line of the direction of movement. *Maintain a broad base of support* to attain balance and allow effective weight-shifting from one leg to the other. When performing movements that are:

- Parallel to the side of the plinth, stand beside the plinth with the leg furthest from the plinth ahead of the other leg (Fig. 1-1).
- Perpendicular to the side of the plinth, face the plinth with one foot slightly in front of the other (Fig. 1-2).
- Diagonal movements, adopt a stance that is in line with the diagonal movement with one foot slightly ahead of the other.

Protect your lumbar spine by assuming a neutral lordotic posture (the exact posture varying based on comfort and practicality) and avoiding extreme spinal flexion or extension.[2] Gain additional protection by the following:

- Keeping as close to the patient as possible.
- Avoiding spinal rotation by moving the feet to turn.

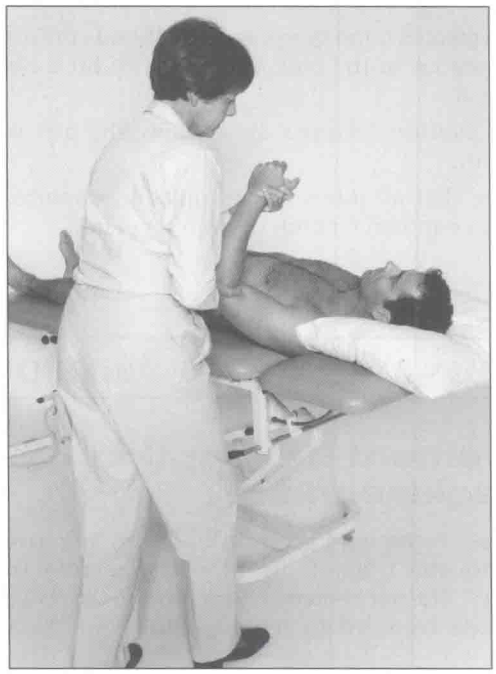


Figure 1-2 Therapist's stance when performing movements perpendicular to the side of the plinth.

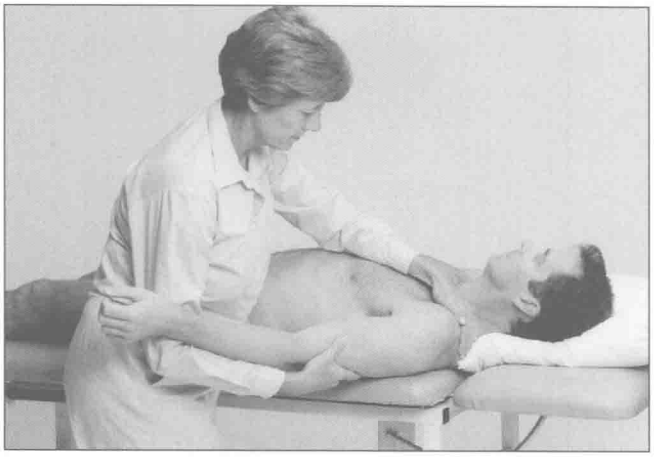


Figure 1-3 The limb supported at the center of gravity using a relaxed hand grasp.

- Using your leg muscles to perform the work by flexing and extending the joints of the lower extremity.

Adjust the height of the plinth to assume a neutral lordotic posture, keep close to the patient, and avoid fatigue.

Supporting the Patient's Limb

To move a limb or limb segment easily, perform the following:

- Support the part at the level of its center of gravity, located approximately at the junction of the upper and middle third of the segment (Fig. 1-3)[3].
- Use a relaxed hand grasp, with the hand conforming to the contour of the part, to support or lift a body part (Fig. 1-3)[3].
- Give additional support by cradling the part with the forearm.
- Ensure that all joints are adequately supported when lifting or moving a limb or limb segment.

JOINT RANGE OF MOTION

Movement Description: Osteokinematics

Kinematics is the term given to the study of movement.[4] *Osteokinematics* is the study of the movement of the bone in space.[4] The movement of the bone is assessed, measured, and recorded to represent the joint ROM. *Joint ROM* is the amount of movement that occurs at a joint to produce movement of a bone in space. To perform *active range of motion (AROM),* the patient contracts muscle to voluntarily move the body part through the ROM without assistance. To perform *passive range of motion (PROM),* the therapist or another external force moves the body part through the ROM.

A sound knowledge of anatomy is required to assess the ROM at a joint. This includes knowledge of joint articulations, motions, and normal limiting factors. These topics are discussed separately.

Joint Articulations and Classification

An *anatomical joint* or *articulation* is formed when two bony articular surfaces, lined by hyaline cartilage, meet[5] and movement is allowed to occur at the junction. The movements that occur at a joint are partly determined by the shape of the articular surfaces. Anatomical articulations are classified as described and illustrated in Table 1-1 (Figs. 1-4 to 1-10).

In addition to classifying a joint according to the anatomical relationship of the articular surfaces, a joint may also be classified as a syndesmosis or a physiological or functional joint. A *syndesmosis* is a joint in which the opposing bone surfaces are relatively far apart and joined together by ligaments (Fig. 1-11).[7] Movement is possible around one axis. A *physiological*[5] or *functional*[8] joint consists of two surfaces, muscle and bone (scapulothoracic joint) or muscle, bursa, and bone (subdeltoid joint), moving one with respect to the other (Fig. 1-12).

Movements: Planes and Axes

Joint movements are more easily described and understood using a coordinate system (Fig. 1-13) that has its central point located just anterior to the second sacral vertebra, with the subject standing in the anatomical position. The *anatomical position* is illustrated in Figures 1-14 through 1-16. The "start" positions for assessing ranges of movement described in this text are understood to be the anatomical position of the joint, unless otherwise indicated.

The coordinate system consists of three imaginary cardinal planes and axes (Fig. 1-13). This same coordinate system can be transposed so that its central point is located at the center of any joint in the body. Movement in, or parallel to, the cardinal planes occurs around the axis that lies perpendicular to the plane of movement. Table 1-2 describes the planes and axes of the body. Many functional movements occur in diagonal planes located between the cardinal planes.

TABLE 1-1 Classification of Anatomical Articulations[6]

Ball-and-socket (spheroidal)

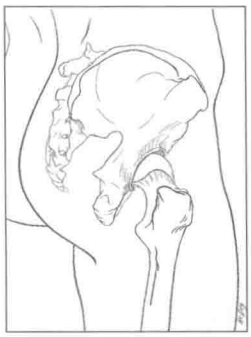


Figure 1-4 Ball-and-socket articulation (hip joint). A ball-shaped surface articulates with a cup-shaped surface; movement is possible around innumerable axes.

Hinge (ginglymus)

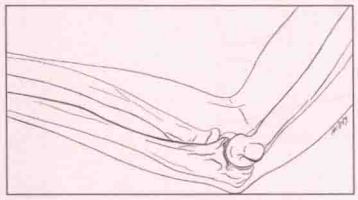


Figure 1-5 Hinge articulation (humeroulnar joint). Two articular surfaces that restrict movement largely to one axis; usually have strong collateral ligaments.

Plane

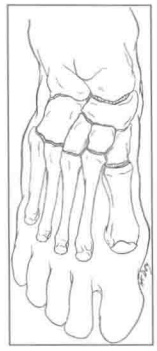


Figure 1-6 Plane articulation (intertarsal joints). This articulation is formed by the apposition of two relatively flat surfaces; gliding movements occur at these joints.

Ellipsoidal

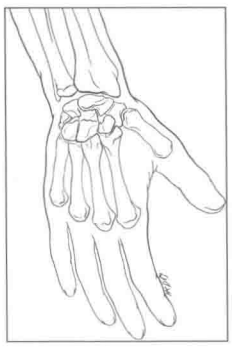


Figure 1-7 Ellipsoidal articulation (radiocarpal joint). This articulation is formed by an oval convex surface in apposition with an elliptical concave surface; movement is possible around two axes.

Saddle (sellar)

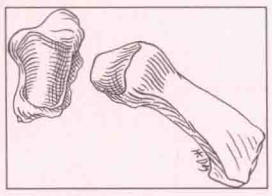


Figure 1-8 Saddle articulation (first carpometacarpal joint). Each joint surface has a convexity at right angles to a concave surface; movement is possible around two axes.

Bicondylar

Figure 1-9 Bicondylar articulations (femorotibial joint). Formed by one surface having two convex condyles, the corresponding surface having two concave reciprocal surfaces; most movement occurs around one axis; some degree of rotation is also possible around an axis set at 90° to the first.

Pivot (trochoid)

Figure 1-10 Pivot articulation (superior radioulnar joint). Formed by a central bony pivot surrounded by an osteoligamentous ring; movement is restricted to rotation.

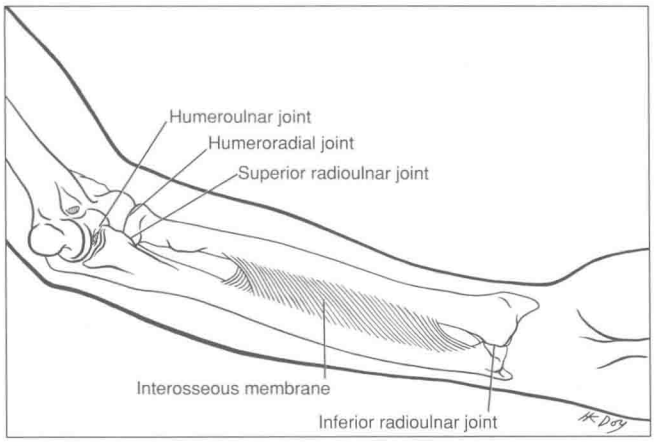


Figure 1-11 Radioulnar syndesmosis.

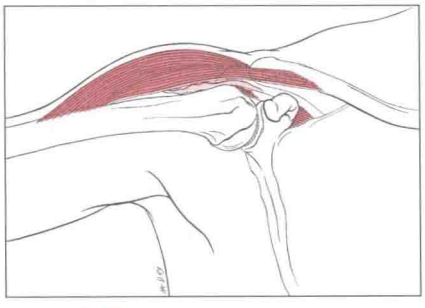


Figure 1-12 Physiological or functional joint (subdeltoid joint).

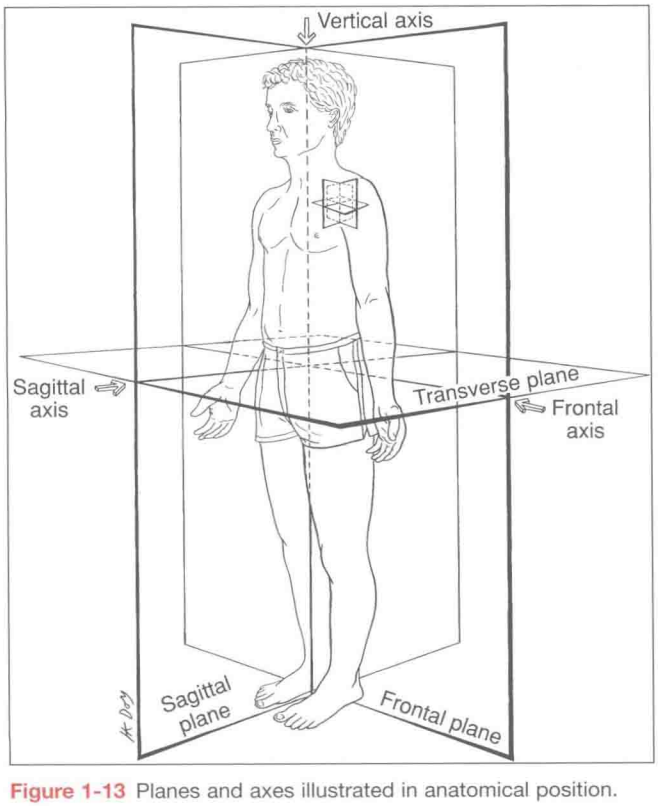


Figure 1-13 Planes and axes illustrated in anatomical position.

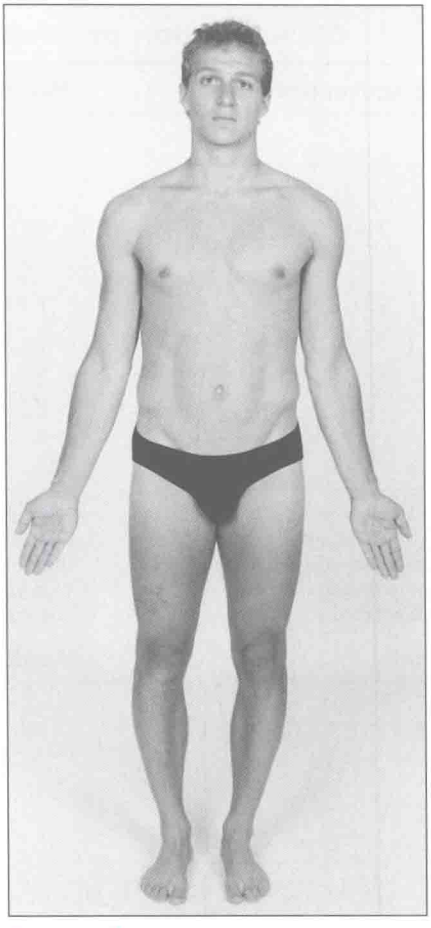


Figure 1-14 Anatomical position—anterior view. The individual is standing erect with the arms by the sides, toes, palms of the hand, and eyes facing forward and fingers extended.

Movement Terminology

Angular Movements

Angular motions refer to movements that produce an increase or a decrease in the angle between the adjacent bones and include flexion, extension, abduction, and adduction (Fig. 1-17).[6]

Flexion: bending of a part so the anterior surfaces come closer together. *Special considerations:* Flexion of the thumb—the thumb moves across the palm of the hand. Knee and toe flexion—the posterior or plantar surfaces of the body parts, respectively, come closer together. Ankle flexion—when the dorsal surface of the foot is brought closer to the anterior aspect of the leg, the movement is termed *dorsiflexion*. Lateral flexion of the neck and trunk—bending movements that occur in a lateral direction either to the right or left side.

Extension: the straightening of a part and movement is in the opposite direction to flexion movements. *Special*