Aging

The Health-Care Challenge

An Interdisciplinary Approach
to Assessment and Rehabilitative
Management of the Elderly

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Fourth Edition

An Interdisciplinary Approach
to Assessment and Rehabilitative
Management of the Elderly

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Previous editions of this book have been dedicated to parents, grandparents, and mentors. These people are long-lived role models and, sometimes, are even heroes.

This edition is dedicated to a different group of heroes: to the many people whose lives were cut short through accident, illness, or tragedy.

In particular, this book is dedicated to the memory of the thousands of innocent victims who lost their lives as a result of the horrific attack on the United States of America.

September 11, 2001 will be remembered.

Preface

The title of this book, *Aging: The Health-Care Challenge,* fourth edition, accurately sums up the contents of this comprehensive textbook for the rehabilitation professional: It was written to meet the needs of practitioners and students working in the field of geriatric rehabilitation. The first edition was the first text of its kind; now there are several textbooks on the topic, but this remains one of the few written for the entire allied health team.

Clinicians will appreciate this book because of the clinical emphasis in each chapter. Each author provides fundamental concepts, explanations, and case studies that pull the clinical chapters together. The students will appreciate the clear explanations of intervention techniques and examination tools. Background information is provided to help students develop a strong foundation for working with older patients and clients.

This book covers a wide variety of topics that are directly applicable to clinical practice, as well as to those that are peripheral. All topics covered have an important impact on the health-care management of the older person. The topics are divided into three sections describing internal variables, physical aspects, and external variables. Each chapter can stand by itself as a specific course unit or can be used as a specific study tool for the practicing clinician. Behavioral objectives for each area of clinical study provide the reader with a list of what follows in each chapter. All chapters describe normal and pathological changes as well as examination and intervention strategies commonly seen in geriatric rehabilitation practices. Each author is nationally recognized for his or her expertise and has provided a clear, concise chapter.

The fourth edition has been expanded to include more information on home care and new intervention concepts under managed care for institutionalized older persons. Case studies have also been included in each clinical chapter, as well as a new look at death, dying, and theories of aging. In this edition, each chapter has been completely revamped with the newest information available in the literature. For example, the musculoskeletal chapter provides specific norms for strength in older persons to use while performing dynamometry testing. This particular edition not only focuses on issues of the year 2002, but also focuses on anticipated issues that will arise in the years to come. In addition, the terminology used in this text reflects that of the most recently published *Guide to Physical Therapist Practice*.[1]

To get the most from the textbook, readers should have a basic understanding of rehabilitation and current rehabilitation procedures. Each chapter focuses on how these basic procedures can be modified for use with older persons. For clinicians currently practicing in rehabilitation, this book should be easy to understand and should expand their current knowledge base.

By the end of Part I, "Theories and Psychological Aspects of Aging", the reader will have a grasp of classical theories of aging and knowledge of the most recent theoretical developments. This section also includes a chapter on psychosocial changes and other nonorganic aging dysfunctions commonly encountered in rehabilitation settings.

Part II, "Physical Aspects of Aging", is a review of the body systems with which rehabilitation professionals work directly, including the musculoskeletal, cardiopulmonary, neuromuscular, and sensory systems. In addition, several chapters deal with important elements of life that are affected by the physical aspects of aging. Each author cites normal and pathological changes, as well as detailed intervention strategies for the practicing clinician and student.

Part III, "External Aspects of Aging: The Current Status", is an investigation of important issues in geriatric rehabilitation. The topics of health promotion, stress, nutrition, sexuality, dying, research, medications, home care, and the special considerations in a changing health-care environment are all discussed in terms of the older population. The contributors have covered the clinical implications of all these topics in detail and have provided comprehensive summaries of current programs and bibliographies.

When one enters the realm of geriatric rehabilitation, intervention strategies change. This book provides a strong foundation for clinical expertise in this area, as well as information for further study. The topic of geriatrics can confuse students because so much information must be extrapolated to meet the needs of the older person.

The editor has selected experts, not generalists, as contributors for this text, so that the reader has access to a high level of information. Specific intervention protocols encompassing current theories in various areas of rehabilitation are discussed in depth.

To be a good clinician in the geriatric field, it is important to know every aspect of geriatric intervention techniques. This book has taught me a great deal, and it is my hope that the reader will feel the same sense of challenge, excitement, and rewards to be gained from working with older people that are felt by its contributors.

C.B.L.

1. Guide to Physical Therapist Practice, ed 2. Phys Ther 81:9–744, 2001.

Acknowledgments

I would like to extend my deepest appreciation to those who helped make this book possible. The outstanding contributors, who have been patient and understanding and have come through so dependably on their timelines, made the task easier. I recognize that health care is much more difficult now than when the first edition of this book was published: To come up with completely new and innovative chapters when everyone has experienced this time crunch is commendable and deeply appreciated.

In addition, I would like to thank the new authors for providing such strong, exciting chapters. My thanks are also extended to Jean-Francois Vilain at F.A. Davis Company, for his support in producing this fourth edition. I really appreciate that he very much left me on my own for this edition, but was there for very gentle prodding. I would also like to acknowledge the staff at Physical Therapy Services of Washington, DC, Inc, including Taunya Everett and Sidney Jackson. Special thanks to Shari Kellems and Jean-Marie McAndrew for helping me contact authors, organize the manuscript, and for being supportive throughout this process. In addition, I would like to thank my wonderful children for understanding that their crazy mother gets up at 4:30 A.M. to write books. Thank you, Madison and Gerald, for being such sweet, wonderful children and for allowing me the time to meet the deadlines to publish professionally.

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Musculoskeletal Changes with Age: Clinical Implications

Carole B. Lewis, PT, GCS, MSG, MPA, PhD
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Behavioral Objectives

On completion of this chapter, the reader will be able to:

1. Define hypokinesis.
2. List three normal and pathologic causes for changes in strength, flexibility, posture, and gait.
3. Identify limitations a geriatric patient or client may have in a musculoskeletal rehabilitation program.
4. Suggest specific intervention modifications for musculoskeletal problems encountered by older patients and clients.
5. Describe how older patients and clients may differ from younger patients and clients in musculoskeletal parameters.
6. Design an examination and intervention protocol for a geriatric patient or client with a musculoskeletal disability or as a preventative measure.
7. Identify nutritional elements that play a significant role in muscle function.

There is a close similarity between the biologic changes of the musculoskeletal system attributed to the "process of aging" and those seen in the disuse phenomena. The coincidence of these two circumstances across a wide range of whole-body to subcellular changes suggests that perhaps those changes attributed to aging are correctable and ultimately preventable. Physical exercise as well as good nutrition has been found to hold promise for sustained health.[1]

Extremes of musculoskeletal functioning are clearly seen in aging. Chronological age has little usefulness in explaining individual differences. The stereotypical institutionalized elderly person is decrepit, frail, and confused. Yet there are those like Larry Lewis, who, at age 101, broke the world's record for athletes over 100 years of age by finishing the 100-yard dash in 17.8 seconds.[2] Variability is the key in dealing with the aging musculoskeletal system. Let us look at a more typical clinical scenario:

> Emily, a fragile-looking woman in her 80s, fractured her hip 1 week ago. She is sitting in your office for examination and intervention. Next to her is Rachel, a 20-year-old, athletic-looking woman. Rachel also has a week-old hip fracture. Their diagnoses are the same. Both have had this injury for the same period of time. Both are women waiting for you to provide them with the best rehabilitation program. However, they are very different.

If we were to look inside each of them, we would see different musculoskeletal pictures. Rachel is at the point in life when bone density in humans is the greatest, between ages 20 and 30 years.[3] After the age of 30, a gradual decrease in bone density occurs; this decrease is greater for women than for men. A general name for this decrease in bone mass is osteoporosis. Characteristic of osteoporosis is a decrease in total skeletal mass; however, the shape, morphology, and composition of the bone is normal. Emily is a candidate for osteoporosis simply because she is a woman older than 50 years. Other contributing factors to this general bone condition are hormonal, nutritional, and circulatory. After menopause, women lose large amounts of bone. This loss is linked to the decrease in hormonal levels, specifically a lack of estrogen.[4] The older person who has a history of poor nutrition will also be a prime candidate for osteoporosis. Low-calcium, high-phosphorus diets have been implicated as causative factors of osteoporosis.[2] In addition, fasting or dieting and high alcohol consumption also contribute to the increased resorption of bony tissue. Finally, decreased circulation as a result of bed rest has been shown to cause osteoporosis in even young and healthy populations.[5] Osteoporosis is usually asymptomatic. However, it can be a major cause of pain, fractures, and posture changes.[6]

Therefore, a closer look at Emily and Rachel reveals distinct biologic differences in their seemingly similar bone structure—age being the cause of orthopedic problems. The way Emily and Rachel appear and act reveals their outward differences. The differences are a result of biologic, functional, or pathologic causes, or a combination of these.

For example, Emily reaches slowly and with much effort for a magazine, but Rachel easily reaches across the table. Note the difference in their flexibility. Differences in strength become apparent when Rachel jumps from her chair to the upright posture in the parallel bars. Meanwhile, Emily methodically, cautiously, and with tremendous effort, pushes on her arms to stand upright in the parallel bars. You notice the variations in their standing postures. The two women begin their jaunt down the parallel bars for your examination. Rachel's steps are long and sure. Emily walks in a hesitating, scuffling manner. As the two pass in the adjacent parallel bars, they discuss the pain they are experiencing. Even in the area of pain, they have different outcomes and perceptions. Flexibility, strength, posture, gait, and pain are functional criteria for independence in daily living. Yet all of these criteria change considerably with age.

Biologic aging and disease influence the changes in flexibility, strength, posture, gait, and pain internally. In addition, functional changes in the lifestyle of the older person can also influence flexibility, strength, posture, gait, and pain. Emily demonstrated large differences in these criteria on simple observation. Exploring biologic, nutritional, functional, and pathologic causes in detail, along with modifications for examination and intervention, will provide us with the tools to design the best rehabilitation program for someone like Emily.

LOSS OF FLEXIBILITY

The first difference we noticed in our observation of Rachel and Emily was in flexibility. The change in flexibility as one ages can be the result of the change in collagen, dietary deficits, *hypokinesis* (decreased activity), the effects of arthritis, or a combination of these. The loss of flexibility compounds problems such as difficulty in walking, difficulty in accomplishing daily activities, pain, and ability to improve strength.

Collagen: A Biologic Cause

Collagen is defined as "the main supportive protein in skin, tendon, bone, cartilage, and connective tissue."[7] These fibers become irregular in shape owing to cross-linking, which increases as a person ages.[8] The fibers are less likely to be in a uniform parallel formation in the elderly than in young people. This closer meshing and decreased linear pull relationship in the collagen tissue is one reason for the decreased mobility in the body's tissues.[9] Poor nutrition may also contribute to collagen changes. For example, vitamin C has been found to be a vital component of normal collagen formation.[10,11] Fibrous elements of connective tissue, including collagen and elastin, undergo qualitative and quantitative changes in the process of biologic aging. There are changes in collagen turnover with age; less collagen is degraded and synthesized. A deficiency of vitamin C appears to interfere with normal tissue integrity and could therefore affect muscle functioning and collagen elasticity. Symptoms associated with vitamin-C deficiency include weakness, fatigue, and stiff aching joints and muscles.[12] Muscles, skin, and tendons are not as flexible and mobile in older people compared with younger people. In addition, the spine is less flexible because of collagen changes in the annulus and decreased water content of nucleus pulposa. These changes result in a decreased disk size and a more inflexible spine. Osteoporotic changes of the vertebral bones may cause wedge fractures of the vertebrae, further increasing collagen density and scarring, thus changing the biomechanics of the spine and contributing to decreased flexibility.

Time is an important treatment consideration in working with tightness caused by collagenous adhesions. Collagen in older persons is less mobile and slower to respond to stretch, but with time it does stretch. The older person can gain flexibility with some compensation for time, just as the younger person can.[13] An effective intervention modification is to provide slow, prolonged stretching activities, either individually or in group exercise classes. Table 7–1 illustrates a stretching protocol for contractures.[14]

Elderly people with flexibility decrements require longer rehabilitation programs than do young persons, and these are not always possible given insurance reimbursement restrictions. An older person with a frozen shoulder, for example, can usually gain full function range of motion (ROM) if given enough time to progress slowly through an exercise program. Insurance companies do not always recognize the need for this longer rehabilitation period and limit reimbursement for services. Therefore, the basic intervention strategy should emphasize home exercise from the beginning, thus limiting the need for lengthy clinical care.

Functional exercises and ways of measuring improvement should be the core of the home exercise program. An example of this is having the elderly person with shoulder limitations work on reaching objects in the cupboard. The method of evaluating improvement for this person is comparing heights of objects reached. Elderly persons can also perform daily tasks that encourage functional motion. For instance, in the case of shoulder limitations, if a person is able to reach for light switches or to dust cabinets, these activities can be given as exercises.

Table 7–1 Protocol for Stretching Contractures

Place the limb in the most lengthened position to be stretched.
Place hot pack on muscles to be stretched while in position 1 for 10 minutes.
Add weight (0.5% of patient's body weight) to distal part of limb in position 1 with heat still on for 5 minutes.
Remove heat and return part to neutral position for 1 minute.
Repeat steps 1–4 two more times.

Source: From Lewis, C, and Bottomley, J: Geriatric Physical Therapy: A Clinical Approach. Appleton & Lange, Norwalk, Conn., 1994, p 378, with permission.

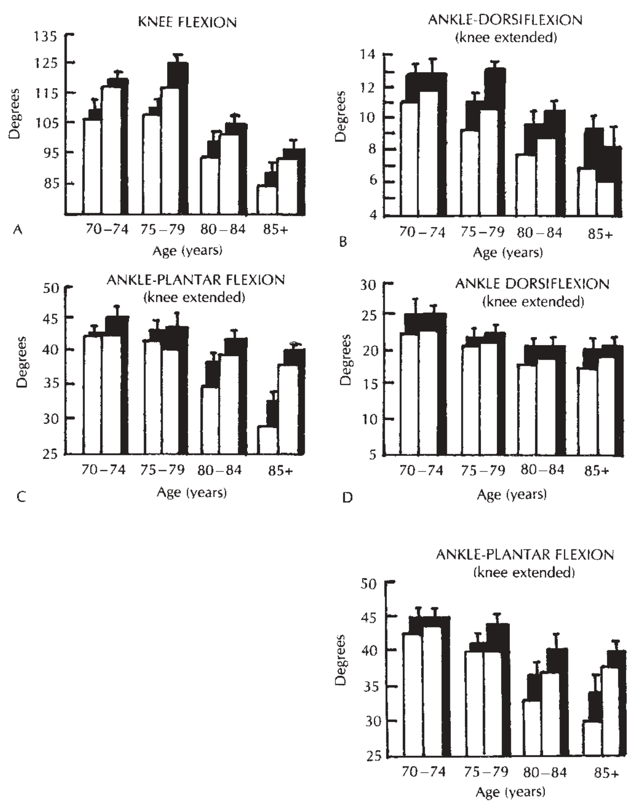
Hypokinesis: A Functional Cause

Hypokinesis, or decreased activity, can also cause an older individual to become less flexible. Elderly people generally sit for longer periods of time than do younger people. This increase in sitting time can cause an older person to have tightness in many of the body's flexor muscles. These flexor muscles, when put into a shortened position for long periods of time, may more easily develop the previously mentioned collagenous adhesions. The hip and knee flexor muscles are commonly tight in an older person. The rotators of the hip also may become tighter because of decreased use in functional activities.

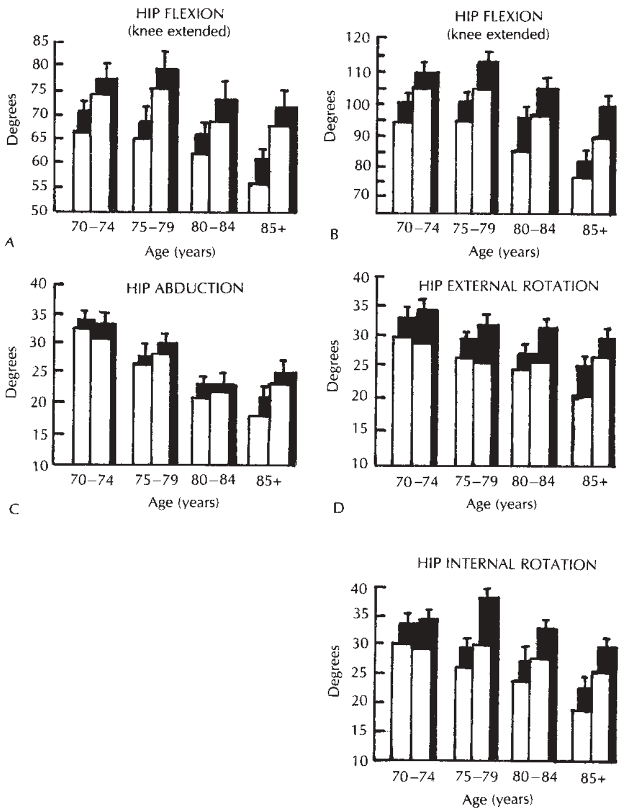
Many times older persons are thought to lose ROM in various joints, particularly the shoulders and hips. However, on closer examination, these joints reveal a very adequate functional ROM, raising the question of which joints are losing flexibility and need rehabilitation intervention. The answer is to consider functional independence in an older person and not to strive for "normal" ROM as one would for a younger patient or client. Figure 7–1 is a graphic representation of lower-extremity ROM for persons between 70 and 85 years of age.[15] Figure 7–2 shows, for several activities of daily living (ADLs),[16] the smallest ROM at which older respondents were able to perform without difficulty.

An assessment of the person's daily activities and how these relate to flexibility should be noted. Although an older person may appear independent and display muscular flexibility, there may be a tightness problem that is manifesting itself in another way. Tightness in the hip rotators may be reflected in an older person's gait pattern or hip stabilization. Therefore, when these problems are seen, a simple ROM test should be done. Gait difficulties and problems of daily inertia may relate directly to tight knee and hip flexors because of the strength needed to overcome the tightness.

Decreased flexibility occurs along any muscle that is put in its shortened state for a long period of time. The intervention for this is simply to break up the periods during which the muscles are in a shortened state. Older people need to be encouraged to stand up, walk around, lift their arms, rotate their hips, and turn and straighten their legs a minimum of three times per day.

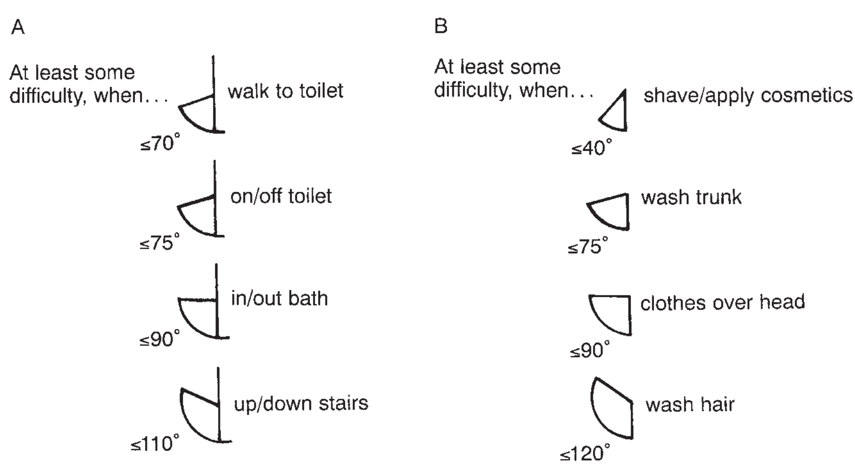


■ FIGURE 7–1. Lower extremity ROMs for persons ages 70 to 85 years. (From James and Parker,[15] with permission.) (*CONTINUED*)



■ FIGURE 7–1. (*CONTINUED*)

Decreased flexibility in an older person that is clearly a result of hypokinetics does not require intense rehabilitation measures. The rehabilitation professional should act as a consultant to activity programs that will help change a hypokinetic older person into a more active individual. Instruction to members of the health-care team and family about flexibility and exercise can be the starting point for daily programs encouraging increased movement. One excellent way to encourage increased motion for home clients is to instruct the person to stand, stretch, and shift weight at intervals such as during every television commercial.



■ FIGURE 7–2. Smallest ROMs for (*A*) shoulder abduction; (*B*) shoulder adduction at which a respondent had no difficulty performing specific ADL tasks. (From Young,[16] with permission.)

Finally, prevention of tightness through activity needs to be encouraged with older persons. Involvement in activities at frequent intervals in the day to maintain ROM, along with education about the deleterious effects of a sedentary lifestyle and poor nutrition on muscular flexibility, provides important tools for intervention in this area.

Arthritis: A Pathologic Cause

There are numerous forms of arthritis that can affect any age group. Osteoarthritis, rheumatoid arthritis, and polymyalgia rheumatica are discussed here because they can frequently cause limitations in elderly patients.

Osteoarthritis is an extremely common, noninflammatory, progressive disorder of movable joints, particularly weight-bearing joints, and is characterized pathologically by deterioration of articular cartilage and formation of new bone in the subchondral areas and at the margins of the joint.[17] The areas most involved in older persons that affect function are the knees, hips, and distal interphalangeal joints.

The limitations in motion observed with osteoarthritis may be caused by an acute synovitis due to minute fragments of articular cartilage that appear in the synovial fluid, or by the inability of joint surfaces to slide smoothly owing to deterioration of this particular cartilage. Muscle spasms secondary to pain can also cause limitations of motion. The physical presence of osteophytes that form at joint margins may cause limitations. These structures may also cause pain because they stretch the periosteum, which in turn limits motion. Weakness of muscles owing to disuse may also inhibit a joint's full motion.

The intervention modifications for limitation in motion caused by osteoarthritis are first to identify the source of limitation (that is, pain, weakness, or physical limitation). Pain and weakness can easily be identified with the administration of a pain questionnaire and a muscle test.

A physical limitation caused by osteophytes can be identified by feeling the bony end at the point of limitation and looking at x-ray films.

The appropriate intervention modifications for what has been previously described are proper individualized exercise instruction and programming. Exercise is extremely important and should be carefully taught. Frequent exercise, rather than large numbers of repetitions, is important to teach to an older person. An average program of instruction should include taking the limited joint through the ROM 2 to 3 times a session, 3 times a day.

Analyzing the cause of flexibility changes as a person ages and then using effective intervention planning can improve a situation that may be interfering with an older person's independent functioning. Carefully searching for the biologic, pathologic, metabolic, or functional cause may reveal that a simple intervention can give someone like Emily more independence.

LOSS OF STRENGTH

Of course, joint ROM is a factor in independence, but strength is also necessary to perform motion.

Biologic Causes

The obvious decrease in muscular hypertrophy and change in muscular function that occur in elderly persons are a result of complex interactions among a variety of factors. There is a reduction in strength with advanced age due to a decrease in the number and size of muscle fibers.[18] The number of muscle motor units also declines with age, influencing functional patterns by decreasing coordination and speed of muscle contraction. The ability of the cardiovascular system to deliver raw materials to the working muscles is reduced, and subsequent alterations in the chemical composition of the muscle fibers occur.[2]

The cardiovascular system loses some of its efficiency with age.[2] As a consequence, important elements such as various proteins are not delivered to the muscle tissues in the same quantity as they are with younger persons. Glycoproteins are small molecules that produce an osmotic force important in maintaining the fluid content of tissues. The reduction of this molecule (as in aging) results in an increased difficulty for the tissues to retain their normal fluid content.[19] This results directly in muscle hypertrophy differences in older persons.

In a study of younger and older men in a strength-training program of the quadriceps muscle, it was found after 2 months that both groups had increased in strength to the same level. The interesting point is that the older group increased in girth by only 1 to 2 percent, whereas the younger group increased by 12 percent.[20]

The clinical implications of this concept are twofold. First, rehabilitation specialists need to be aware that an older person does have the potential to increase significantly in strength as a result of treatment interventions. Second, in elderly persons, increasing girth muscle measurement is not a good indicator of improved muscle strength. Assessment of an individual's ability to carry out functional activities without muscle fatigue or evaluation of workload achieved in an exercise program (that is, measuring increase in weight per exercise) is a better indicator of an older person's performance.

Chemically, the greatest change with age is a decrease in efficiency of the muscle cells' selectively permeable membrane.[20] Certain chemicals—particularly potassium, magnesium, and phosphate ions—are in high concentration in the sarcoplasm, but other materials—such as sodium, chloride, and bicarbonate ions—are largely prevented from entering the cell under resting conditions. A characteristic feature of senescent muscle is a shift from this normal pattern. The concentration of potassium is particularly reduced. Lack of potassium ions in aging muscles reduces the maximum force of contraction that the muscle is capable of generating. Tiredness and lethargy in elderly persons may result from reduction of potassium ion content in the tissue. The clinical implication is that you will need to check for potassium deficiencies if a person complains of excessive tiredness or lethargy. Attempting exercises with someone who has potassium depletion will only fatigue him or her more. Therefore, it is imperative to check the tired person's electrolytes before beginning exercises.

The nutritional status of the muscle is rarely considered in exercise or activity prescriptions. Little is known about the nutritional needs of aging muscle.

Aging causes distortions and deteriorations in the integrative homeostatic mechanisms that stimulate and sustain a human being.[21,22] In considering the effects of nutrition on functional activity capabilities, it is important to remember that aging may change nutrient intake, increase the need for specific nutrients, and interfere with absorption, storage, and utilization of specific nutrients.

No concrete information identifies nutritional factors as influencing selective erosion of muscle tissue with aging. Several elements, however, have been shown to promote overall health and homeostasis of muscle tissue.

Nutritionally, vitamin C is of interest; in vitro studies with frog muscle have shown that vitamin C enhances contraction and delays the onset of fatigue.[23] Subsequent studies using human muscle tissue revealed the same result.[24] Vitamin C appears to be important in maintaining the physiologic health of muscle tissue while clearly not functioning independently. It is considered an important energizer and assists the body to tolerate both heat and cold; this ability to tolerate changing temperatures declines with age and results in poor tolerance to physical demands.[25]

Zinc, a nutritional element often found to be deficient in the aged population, functions in muscle homeostasis for needed growth and normal muscle's longevity.[26] High concentrations of zinc have been found in muscles following physical exertion,[26,27] and recent research suggests its importance in enhancing muscle function and strength of muscle contraction.[28,29]

Although this chapter does not allow intensive study of the effects of nutrition on muscle function, these examples clearly support the need for proper nutritional consideration in exercise and activity prescriptions for aged patients and clients.

Functional Causes

Numerous studies show a decline in strength as a person ages, especially after age 60. Some studies have shown a loss of up to 40 percent of maximum force by age 65, whereas others indicate losses of up to 18 to 20 percent.[30]

The areas most likely to show a decrease in muscle strength are the active antigravity muscles, such as the quadriceps, hip extensors, ankle dorsiflexors, latissimus dorsi, and triceps.[31] These muscles are used frequently in daily activity; however, they are used to a much greater extent when a person is engaged in vigorous work or athletic activities. An older person may no longer engage in these strenuous activities and therefore may have comparatively less maximum strength in these muscles.

Strength norms are difficult to obtain for older persons because they are written in terms that are not as functional as ROM norms. A good screening tool that is more functional for lower-extremity strength and balance is the one-legged standing balance test, developed by Richard Bohannon.[32] Bohannon found that people older than 70 are able to stand for 14.2 seconds on one leg with their eyes open and 4.3 seconds with their eyes closed. This 14.2-second norm will give therapists a general idea as to whether an elderly patient or client has strength and balance deficits or not.[32,33]

Another good screening tool for lower-extremity strength is the time needed to stand up 10 times from a standard chair without armrests. Csuka and McCarty[34] have reported the norms listed in Table 7–2. Although both of these tests may be too advanced for a very frail patient or client, standing on one leg or rising from a chair without armrests may be considered when using functional strength measures.

Handheld dynamometry testing is becoming a clinical "must" in evaluating an older person's strength losses and gains. Normative values for muscle actions in older persons with which therapists most commonly work are found in Table 7–3.[35]

An effective approach to examining the functional limitations caused by a decrease in strength is to evaluate the person in a situation that closely resembles the difficult functional activity. The muscles involved can then be strengthened in a close resemblance of the functional activity. Specificity of exercise for functionally strength-training an older person is extremely important because, in many older persons, tolerance for activity is decreased. It is imperative not to waste an older person's ability to improve in strength with meaningless exercises.

To improve strength, the clinician must first evaluate the strength an older person already has. One of the most effective ways to do this is by calculating a 1 Repetition Maximum (1 RM), followed by constructing a strength training program according to the Oddvar Holten Diagram. This is done with the following example:

Calculation of 1 Repetition Maximum

1. Select the corresponding percentage on the graph with the number of repetitions completed.

TABLE 7–2 TIME NEEDED TO STAND UP 10 TIMES FROM AN 18-INCH CHAIR SEAT

Age (Years)	Women (Sec)	Men (Sec)
65	18.4	17.6
70	19.3	18.5
75	20.1	19.5
80	20.9	20.5
85	21.8	21.5

Source: From Csuka and McCarty,[34] with permission.

TABLE 7–3 REFERENCE VALUES FOR FORCE OBTAINED WITH HANDHELD DYNAMOMETERS AS REPORTED BY MUSCLE ACTION, DECADE, GENDER, AND SIDE

Decade	Gender	Side		Force	
SHOULDER FLEXION					
50–59	M	N(23)	57.3	D(25)	60.2
	F	N(25)	33.6	D(25)	36.3
60–69	M	N(25)	50.0	D(26)	52.1
	F	N(29)	31.6	D(29)	33.2
70–79	M	N(25)	46.8	D(26)	48.9
	F	N(25)	27.1	D(25)	27.4
SHOULDER EXTENSION					
50–59	M	N(25)	68.0	D(25)	72.1
	F	N(24)	38.9	D(25)	40.6
60–69	M	N(26)	60.8	D(26)	63.0
	F	N(29)	33.0	D(29)	34.4
70–79	M	N(26)	56.5	D(26)	59.2
	F	N(25)	31.3	D(25)	32.9
SHOULDER ABDUCTION					
50–59	M	N(24)	49.9	D(25)	53.5
	F	N(24)	28.1	D(25)	30.4
60–69	M	N(25)	43.5	D(26)	45.1
	F	N(29)	25.7	D(29)	28.1
70–79	M	N(24)	41.7	D(26)	43.2
	F	N(25)	24.4	D(24)	24.1
SHOULDER LATERAL ROTATION					
50–59	M	N(22)	34.2	D(25)	35.1
	F	N(24)	21.6	D(25)	22.6
60–69	M	N(25)	29.5	D(26)	31.3
	F	N(29)	19.2	D(29)	19.9
70–79	M	N(25)	29.1	D(26)	29.9
	F	N(25)	17.9	D(25)	18.5
SHOULDER MEDIAL ROTATION					
50–59	M	N(25)	41.0	D(25)	43.4
	F	N(25)	22.7	D(25)	22.9
60–69	M	N(25)	35.1	D(26)	36.7
	F	N(29)	20.2	D(29)	20.8
70–79	M	N(25)	33.7	D(26)	34.1
	F	N(25)	18.9	D(25)	19.3
ELBOW FLEXION					
50–59	M	N(25)	61.2	D(24)	65.7
	F	N(25)	36.0	D(25)	37.5
60–69	M	N(25)	55.8	D(26)	58.2
	F	N(29)	33.9	D(29)	35.2
70–79	M	N(26)	52.0	D(26)	53.1
	F	N(25)	31.8	D(25)	31.1
ELBOW EXTENSION					
50–59	M	N(25)	39.9	D(25)	42.2
	F	N(25)	23.5	D(25)	24.4
60–69	M	N(26)	35.4	D(26)	36.7
	F	N(29)	21.7	D(29)	21.6
70–79	M	N(25)	34.4	D(26)	34.6
	F	N(25)	20.3	D(25)	20.7
WRIST EXTENSION					
50–59	M	N(25)	31.1	D(25)	33.5
	F	N(25)	18.6	D(24)	20.4

(*continued*)

TABLE 7–3 REFERENCE VALUES FOR FORCE OBTAINED WITH HANDHELD DYNAMOMETERS AS REPORTED BY MUSCLE ACTION, DECADE, GENDER, AND SIDE (*CONTINUED*)

Decade	Gender	Side		Force	
60–69	M	N(25)	27.3	D(26)	29.6
	F	N(29)	15.8	D(29)	17.8
70–79	M	N(25)	27.0	D(26)	28.1
	F	N(25)	16.0	D(29)	17.8
HIP FLEXION					
50–59	M	N(25)	46.3	D(25)	45.4
	F	N(25)	28.9	D(25)	30.3
60–69	M	N(26)	41.4	D(26)	41.0
	F	N(29)	27.3	D(29)	27.6
70–79	M	N(26)	36.2	D(26)	36.6
	F	N(25)	22.9	D(25)	23.3
HIP ABDUCTION					
50–59	M	N(25)	66.1	D(25)	68.2
	F	N(25)	44.9	D(25)	45.5
60–69	M	N(26)	60.1	D(26)	58.6
	F	N(29)	42.1	D(29)	42.4
70–79	M	N(26)	53.9	D(26)	56.5
	F	N(25)	36.1	D(24)	38.6
KNEE FLEXION					
50–59	M	N(25)	54.5	D(25)	56.4
	F	N(25)	38.1	D(25)	38.0
60–69	M	N(24)	50.6	D(26)	52.3
	F	N(29)	34.5	D(29)	35.3
70–79	M	N(26)	46.4	D(26)	48.6
	F	N(25)	31.8	D(24)	30.8
KNEE EXTENSION					
50–59	M	N(25)	98.7	D(25)	100.6
	F	N(25)	66.1	D(25)	67.0
60–69	M	N(23)	85.1	D(25)	81.5
	F	N(28)	55.7	D(29)	57.8
70–79	M	N(25)	81.9	D(26)	80.3
	F	N(24)	50.6	D(24)	50.7
ANKLE DORSIFLEXION					
50–59	M	N(25)	63.8	D(25)	65.4
	F	N(25)	42.5	D(25)	43.7
60–69	M	N(24)	54.5	D(25)	52.9
	F	N(29)	39.9	D(29)	38.5
70–79	M	N(24)	47.3	D(24)	49.8
	F	N(25)	34.5	D(25)	35.9

M=Male, F=Female; N=Nondominant, D=Dominant

2. Divide the weight at which the repetitions were performed by the corresponding percentage. This equals 1 RM.
3. Multiply the 1 RM by the percentage of desired repetitions to give the exercise weight.
4. For 3 sets, subtract an additional 15–20% from the number of repetitions.

Oddvar Holton Diagram

100% 1 repetition
95% 2
90%——4 Strength ⇒ Power Lifting
85%———7
80%—————11 ⇒ Body Builders
75%———————16 Strength/Endurance
70%—————————22
65%———————————25 Endurance
60%————————————30
Less than 60%————————→Frequency

Example: A patient is able to lift 2 pounds for 11 repetitions. What resistance would equal 1 RM?

$$\frac{X\ \text{lb}}{1\ \text{RM}} = \frac{2\ \text{lb}}{80\%\ 1\ \text{RM}}$$

$$X\ \text{lb} = \frac{2\text{lb} \times 1\ \text{RM}}{80\%\ 1\ \text{RM}}$$

$$\times\ \text{lb} = 2.5\ \text{lb}$$

To exercise at 60% of 1 RM:

$2.5\ \text{lb} \times 0.60 = 1.5\ \text{lb}$

To perform 3 sets of exercise at 60% of 1 RM, 20% would be removed from the repetitions. Therefore, the individual would perform the exercise at 1.5 lb, 3 sets of 24 repetitions.

After 1 RM has been calculated, an effective strength training program can be established within the parameters of an older person's ability. Progressive resistive exercise has been shown to be beneficial for strength as well as cardiovascular improvements and is not dangerous when properly prescribed and monitored.[36,37] Evans[38] has looked at strength training for all ages and has developed parameters for strength training specific to elderly persons. Previously, strength training programs consisted of determining the 1 RM and then having the client work out at 3 sets of 10 repetitions. Elderly patients should rest for 2 to 5 minutes between sets, which means the program would take 10 to 15 minutes to complete for each muscle group. This may be difficult for older persons and brings into question the mythical standard of 3 sets of 10 repetitions. Starkey's[39] findings indicate that 1 set consisting of between 8 and 12 repetitions can accomplish strength training. With this revised approach, each muscle group can be worked efficiently and quickly, putting less burden on the client. A guide for this program is as follows:

Protocol for Strength Training in Older Persons

Week 1
Rx 1 Assess 1 RM
Rx 2 Exercise at 50–80% (e.g., 7 lb) 1 RM 12 times
Rx 3 Exercise at 50–80% 1 RM 14 times

Week 2
Rx 4 Exercise at 50–80% 1 RM 16 times
Rx 5 Exercise at 50–80% 1 RM 18 times
Rx 6 Exercise at 50–80% 1 RM 20 times

Week 3
Rx 7 Reassess 1 RM or increase 10–15% (e.g., 8 lb)
Rx 8 Exercise at 8 lb 12 times
Rx 9 Exercise at 8 lb 14 times

Week 4
Rx 10 Exercise at 8 lb 16 times
Rx 11 Exercise at 8 lb 18 times
Rx 12 Exercise at 8 lb 20 times

Week 5
Rx 13 Reassess 1 RM or increase 10–15% (e.g., 9 lb)
Rx 14 Progress as above

Persons do best when strength training is scheduled 2 to 3 times per week,[38,39] and although it is important to coach our older patients and clients to exercise, it is imperative not to let them overdo it. Older muscles take longer to heal from fatiguing contractions, and doing a true strength training program to the same muscle group daily can do more harm than good.

As soon as an individualized 1 RM program has been established, weight can be increased 10 to 15 percent each week.[38] The suggested timing of lifting weights is a 2- to 3-second lift and a 4- to 6-second lower. An older person should inhale before a lift, exhale during the lift, and inhale again as the weight is lowered.[38]

If traditional progressive resistive exercise is the preferred method for strength training, considerations for isometric and isotonic strength training in older individuals are listed in Table 7–4.[40,41]

Pathologic Causes

Numerous strength-altering diseases affect all segments of the population. These causes of muscle weakness may contribute to an older person's loss of strength. One strength-altering disease of older people that has no neurologic basis, can be detected easily, and can be treated effectively is polymyalgia rheumatica.

TABLE 7–4 HOW TO TRAIN ELDERLY PATIENTS FOR STRENGTH

Isometric

1. Near maximum effort
2. 6–10 second hold (to recruit all fibers)
3. 5–10 repetitions
4. At least 3 times a day for maximum of 5 weeks
5. 10-second rest in between

Isotonic

1. Determine 1 RM (maximum amount a person can lift)
2. Exercise at 60–80% of 1 RM
3. Reevaluate RM each week
4. 3 sets of 8–10 reps
5. 1–2 minute rest between sets
6. Three times a week for minimum of 8 weeks

Polymyalgia rheumatica is a syndrome occurring in older individuals characterized by pain, weakness, and stiffness in proximal muscle groups along with fever, malaise, weight loss, and very rapid erythrocyte sedimentation rate. The areas most affected in these persons are the neck, back, pelvis, and shoulder girdle.[42]

The origin of this disease is not known, and it affects both men and women, mostly those older than 65. The most important aspect of this disease is that it responds dramatically and almost completely to corticosteroid therapy.[42] Therefore, corticosteroid therapy is not only the best intervention but also a diagnostic tool.

The rehabilitation professional should be aware of this disease as a possible cause for weakness, limitation, and pain in an older person. The professional should also realize that the only effective treatment in the acute phases is cortisone. Stretching and strengthening exercises may be useful later, along with heat (after the acute phase), if the older person has any residual weakness or limitation. When weakness is related to pathologic causes, additional symptoms may be present. Table 7–5 lists clues to diagnosing the cause of weakness in elderly patients.[43]

POOR POSTURE

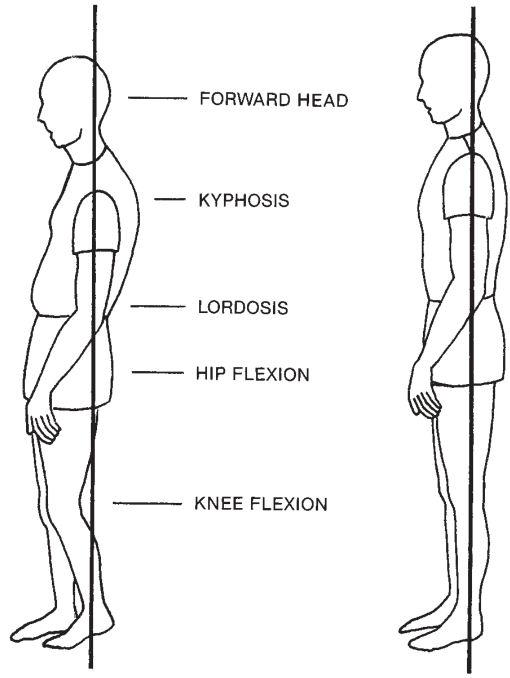
A decline in strength and flexibility will lead to poor posture. One of the most noticeable orthopedic changes with age is in posture. Normal or good posture traverses a plumb line of the individual in the standing position (Fig. 7–3).[44] The lateral view

TABLE 7–5 CLUES TO DIAGNOSING THE CAUSE OF WEAKNESS IN ELDERLY PATIENTS

Symptoms	Diagnostic Possibilities
Shortness of breath	Painless myocardial ischemic disease Interstitial pulmonary disease Subclinical bronchospastic disease
Pain	Arthritis Peripheral vascular disease
Paresthesia Dizziness Visual impairment	Neuromuscular disorder: subdural hematoma; cerebral TIAs; amyotrophic lateral sclerosis; peripheral neuropathy due to diabetes mellitus or alcoholism; Shy-Drager syndrome
Asymmetry of neuromuscular symptoms	Drug reaction Autoimmune disorder Vasculopathy
Depression Weight loss Muscle aches and pains Fever High ESR	Temporal arthritis with polymyalgia rheumatica
Gait disturbance Inability to turn and rise from chair	Parkinsonism
Weakness of arms when reaching over head Excessive fatigue when walking Poor visual accommodation	Myasthenia gravis
Fear of fainting or falling	Occult cardiac arrhythmia
Lack of motivation or interest in surroundings	Medication
Loss of appetite Difficulty sleeping	Depression
Weakness with cough	Tuberculosis
	Other causes of weakness: medication, interaction, overdoses, side effects; hypoadrenalism; hypothyroidism or hyperthyroidism; unrecognized or uncontrolled diabetes mellitus

Source: Gordon,[38] with permission.

of normal posture has the ear, acromion, greater trochanter, posterior patella, and lateral malleolus in a straight line. In an older person, these landmarks and various body curves change their position around the line. An older person's head tends to extend forward; shoulders may be rounded, and the upper back will have a slight kyphosis. Populations of older persons who tend to sit for longer periods of time overall have flatter lumbar spines. The lordotic curve may be flatter or more accentuated. The knees and hips will be in slight flexion. There are two major reasons for these changes: the changing structure of the intervertebral disk (IVD) and hypokinetics.[45] The REEDCO posture score sheet is an excellent tool for evaluating the posture of older persons (Fig. 7–4).[46,47]

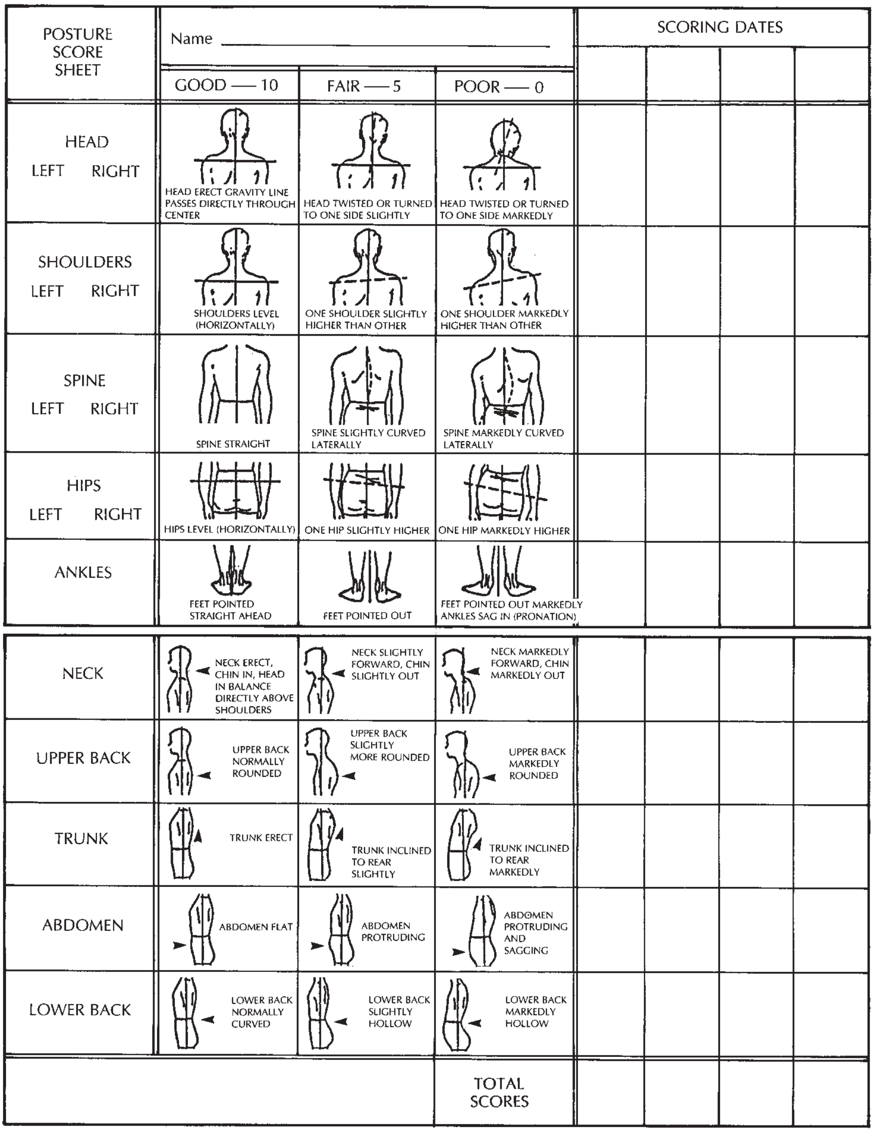


■ FIGURE 7–3. Posture changes with age.

Biologic Causes

The IVD is composed of two parts: the annulus fibrosis and the nucleus pulposus. The nucleus pulposus is composed mainly of water. In the sixth and seventh decades, intracellular water is decreased by 30 percent.[45] The annulus is composed of collagen, which becomes less elastic as a person ages. The decreased water in the nucleus and the increased fibrousness of the annulus cause the older person to have a flatter and less resilient disk. This structurally different disk can cause the spine's natural curves to become accentuated or more flexed because of the less resistant disk succumbing to the continued forces of gravity and muscle pull of the spine, along with the osteoporotic vertebrae crumbling as a result of pressure.

Intervention modifications of improving posture in an older person are based on exercise and education. An older person must learn the components of good posture. The patient or client should

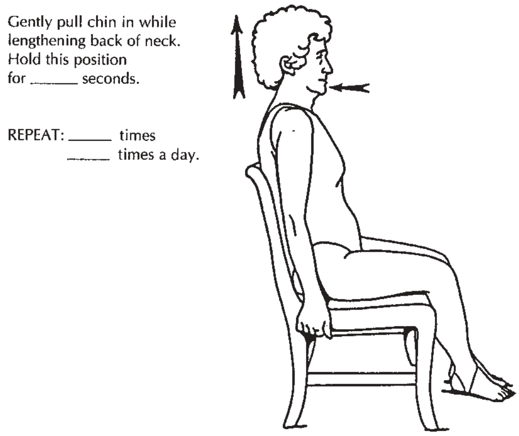


■ **FIGURE 7–4.** REEDCO Posture Sheet (From REEDCO Research,[42] with permission.)

then receive information on how his or her posture deviates from this model. Simple stretching exercises can be given along with instruction in adapting daily activity for improving posture. A simple exercise for a forward head is axial extensions (Fig. 7–5).[48] These exercises should be done 3 to 5 times twice daily. Trunk strengthening, specifically of the extensor groups and abdominal muscles, can be helpful in increasing lordosis and preventing the "flexed" posture associated with aging.

Hyperextension exercises can be tried for a decrease in lordosis. Because the elderly population spends so much time in flexed positions, resulting in kyphotic or decreased lordotic curves, these exercises may prove beneficial (Figs. 7–6 and 7–7). For the wheelchair-bound person, a towel roll in the lumbar area or a McKenzie pillow can help restore the lumbar curve and decrease pain.[48] Pectoral stretches can also be very beneficial in stretching muscles that are commonly tight in an older person (Fig. 7–8).[49]

Recreation classes should encourage good posture in exercise programs. Rehabilitation professionals should not assume that recreational specialists or activity directors understand the components of good posture. Often rehabilitation professionals can visit these classes as guest lecturers on the topic of good posture.



■ FIGURE 7–5. A simple stretching exercise can help reduce "forward neck." (From Lewis and Campanelli,[43] with permission.)

Functional Causes

Hypokinesis affects posture. Older persons sit for longer periods of time, whether in job situations or during leisure-time activities. The body's flexor muscles shorten because sitting requires bent hips and knees, decreases lordosis, and increases kyphosis. A clear relationship has been established between osteoporosis and inactivity. Increased stress on bone stimulates bone growth; lack of stress results in decreased bone formation and increased resorption. This is hypothesized to be the result of the piezoelectric effect of stress on crystals. In the case of human bone, weight-bearing produces stress, and the collagen acts as the crystal that transforms the stimulus into an osteoblastic effect. Bone tissue is laid down along the lines of stress. Lack of muscular stress on bone, as well as of a weight-bearing stimulus, will facilitate osteoporosis. Fracture of vertebral bodies will add to the postural deformities associated with aging.[3]

Treatment considerations are obvious. Increased activity in positions other than sitting are mandatory. Weight-bearing activities should be encouraged to obtain and to maintain extensor strength and bone health. The suggestions for hypokinesis presented earlier in both the strength and flexibility sections can be implemented here.

Pathologic Causes

Any neurologic disease, arthritic involvement, or cardiopulmonary decrement may affect posture. Muscle imbalance caused by neurologic disease can be examined and appropriate interventions instituted. Pain and joint limitation caused by arthritis can also be examined and intervention implemented, as can chest cavity limitations caused by cardiopulmonary complications. Any disease entity may cause a postural change in an older person; therefore, contributing factors of multiple disease should be analyzed and corrected.

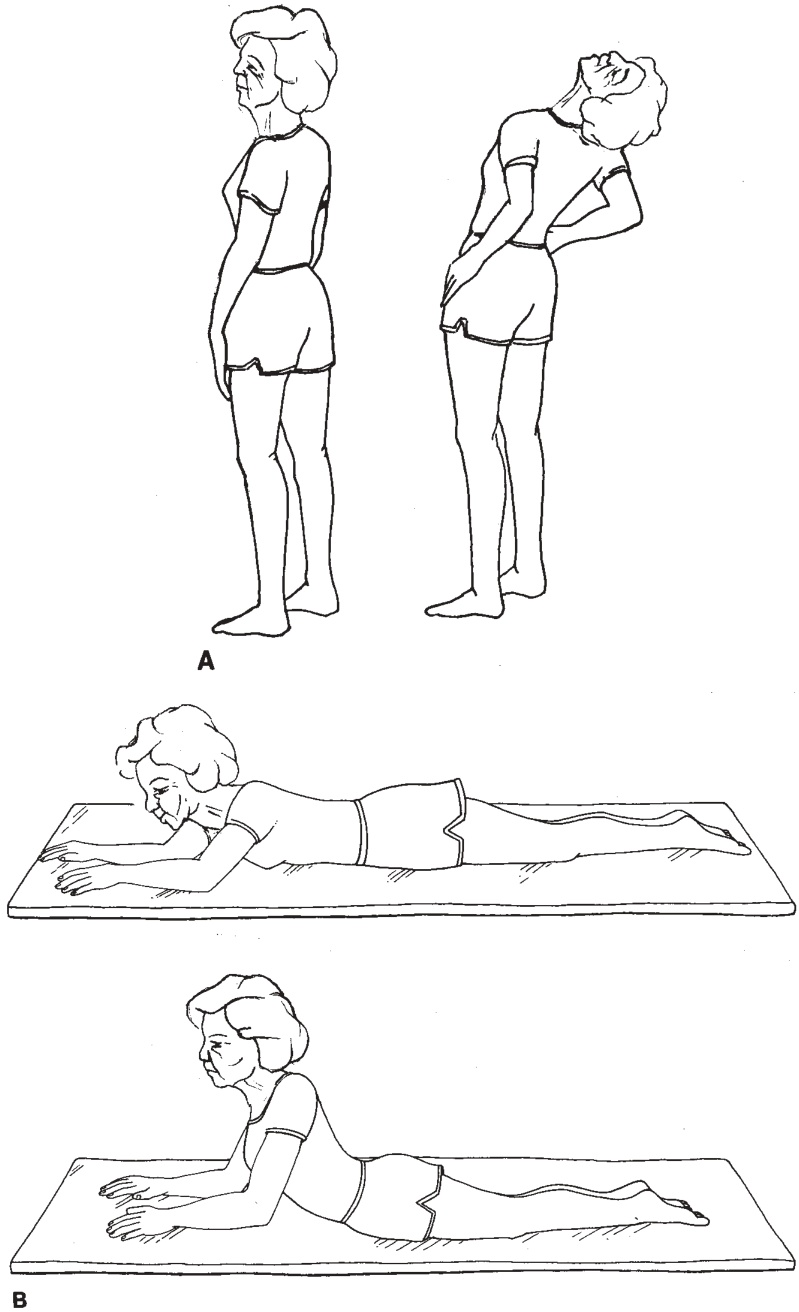
Even though poor posture may not directly impede an older person's functional activity, it is worth the small effort required for examination, evaluation, instruction, and treatment intervention. The approach of decreasing postural abnormalities not only has the possibility of preventing increased disability but also encourages improved self-image, body awareness, and body language.

The human body is most efficient in its upright state, allowing maximum length and contraction of its muscles and joints.

CHANGES IN GAIT

The functional application of motion is gait. Just as balance, strength, and flexibility provide for proper posture, so do these three elements provide the background to ensure adequate walking in a person of any age. Figure 7–9 depicts the normal gait cycle. Within this cycle are numerous changes with age as follows:

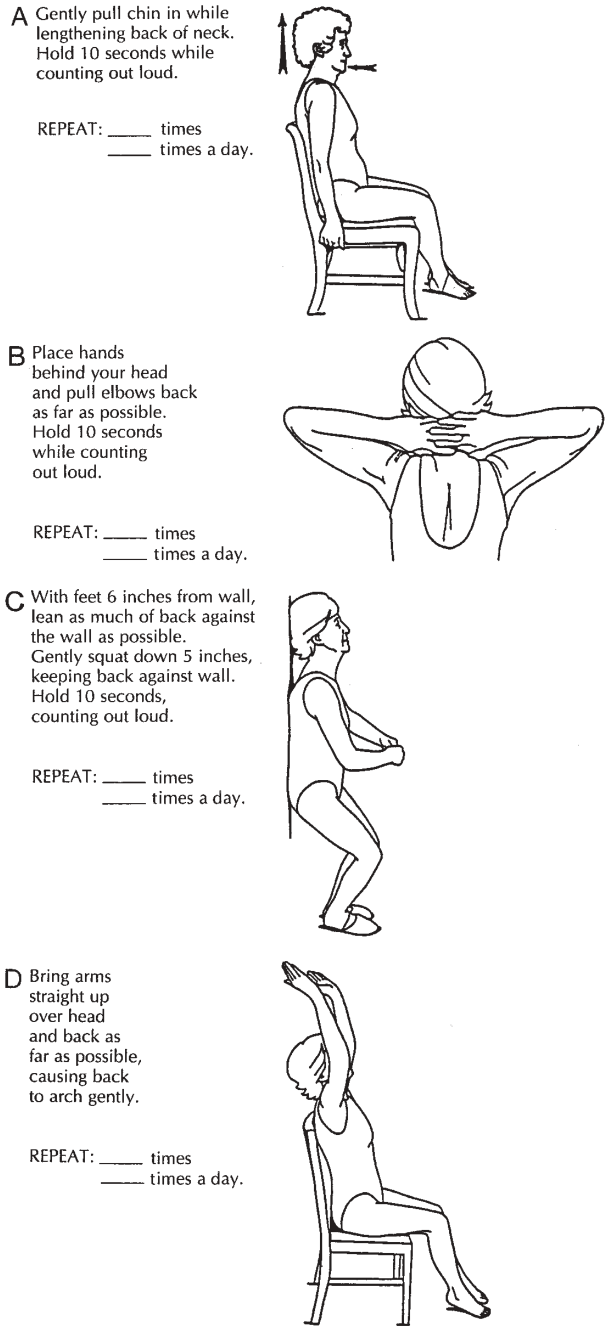
- Mild rigidity, proximal greater than distal (there will be less body motion)
- Fewer automatic movements, decreased in amplitude and speed (for example, arm swing will be less)
- Less ability to use gravity, thus increasing muscle work
- Less accuracy and speed, especially seen in the hip muscles
- Shorter steps, to ensure safety
- Stride width broader for a more stable base, to ensure safety
- Decrease in swing-to-stance ratio (this, too, improves safety by allowing more time in the phase of double support)
- Decrease in vertical displacement (this is usually secondary to stiffness)
- Decrease in excursion of leg during swing phase (the free leg extends to a lesser degree)
- Decrease in heel-to-floor angle (this may be due to the lack of flexibility of the plantar flexor muscles)



■ FIGURE 7–6. Hyperextension exercises. (*A*) Place hands in small of the back and gently bend backward from the waist. Hold 10 seconds and stand up straight. Repeat 5 times. (*B*) Lying on the stomach, slowly raise the trunk and head and prop on the elbows. Hold 10 seconds; then return to starting position. Repeat 5 times.

- Slower cadence (a slower gait is also another assurance of safety)
- Decrease in rotation of the hip and shoulder (the person appears to have a very stiff, unidimensional gait)
- Decrease in velocity of limb motions (arms and legs move at a slower rate when walking)[50]

Gait is simply the manner or style of walking. Momentum and the use of gravity are important aspects of effective, effortless walking. Many gait

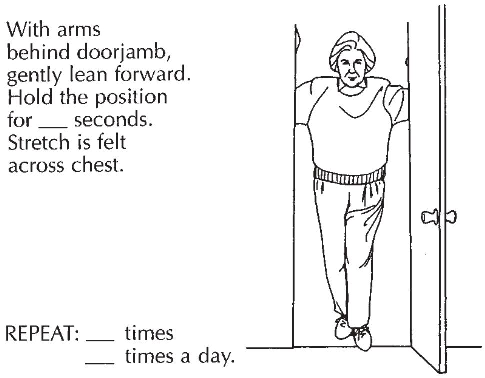


■ FIGURE 7–7. Other extension exercises for improving posture. (*A*) The chin tuck helps improve axial extension. (*B*) The elbows-back exercise can help in combating postural effects of osteoporosis as can (*C*) back wall slides and (*D*) arm reaches. (From Lewis and Campanelli,[43] with permission.)

problems due to loss and recovery of balance among elderly persons are related to the inability to maximize momentum and the use of gravity.

Biologic Causes

A combination of biologic causes of flexibility, strength, and posture limitations contribute to gait changes with age. Stiffness caused by decreased collagen mobility in joint and muscles will cause shorter strides, decreased ancillary limb movements, and less efficient use of gravity and momentum.[50] Decreased strength caused by chemical or circulatory deficiencies causes a shuffling gait with a dangerously decreased heel-to-floor angle that may cause an older person to fall and thus sustain a fracture.[51] Poor posture caused by changes in the internal structure of the bones or



■ FIGURE 7–8. Pectoral stretch exercises can help stretch tight muscles commonly found in older individuals. (From Lewis and Campanelli,[43] with permission.)

disks enhances the decreased vertical displacement as well as the slower cadence.[50]

Stretching, strengthening, and positioning techniques that closely resemble the deficient phase of gait can be implemented for these biologic changes. For example, standing someone with shortened hip flexors in a position of exaggerated hip extension will help increase the range of hip extension in the push-off phase of the gait cycle.

Functional Causes

Functional causes are related directly to hypokinesis. Gait can be affected by ill-fitting, nonsupportive shoes as well as by bony changes in the foot, influencing the normal biomechanics of the foot during gait. As an elderly person shuffles along and becomes less confident of the base of support because of balance, flexibility, and strength changes, his or her entire gait pattern becomes less than efficient. Proper-fitting shoes and orthotics should be used to maximize the stability of the foot. Foot comfort can greatly affect the amount and intensity of ambulation activities. Starting with the foot and working up the kinetic chain during examination—addressing muscle imbalance and loss of flexibility—will improve efficiency and enhance activity. Tightness and weakness in the flexor muscles compound the inefficient gait of elderly clients.

Daily routines of exaggerated hip extension, hip rotation, and arm movements practiced regularly will enhance the gait pattern.

Pathologic Causes

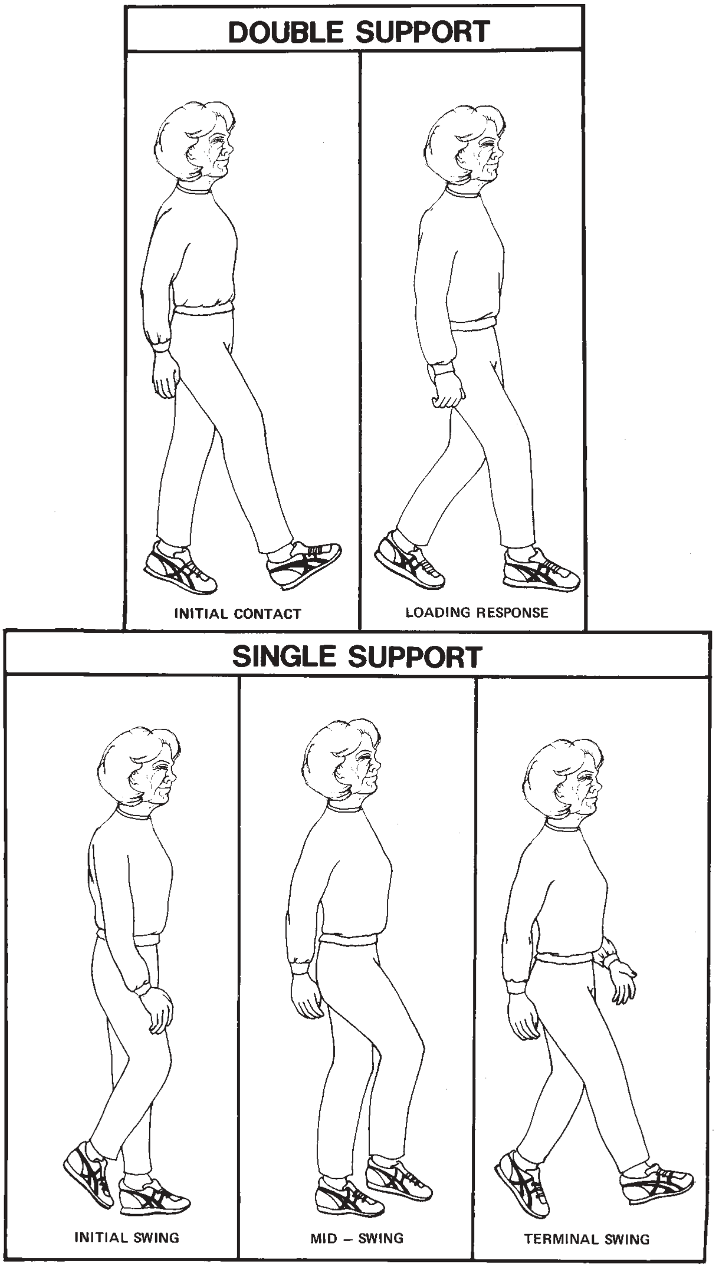
"By supporting a newborn infant on his feet, steppage movements can be elicited; however, the mechanism of antigravity support, postural function, and control of equilibrium takes time to develop. These responses depend on the integrity of many interrelated neurological mechanisms and final integration at the cerebral cortical level. Therefore, it is not surprising that performance in this area deteriorates with age and that this deterioration is accelerated by pathology changes."[51] (For specific information on nervous and sensory effects on gait, see Chap. 8.)

The particular type of patient or client who will be discussed here is a geriatric person with an amputation. A geriatric person with an amputation is considered to be anyone older than 55 years of age. These older persons stand out because they are more likely than their younger counterparts to have complications or associated problems. Some common complications are residual limb contractures, atrophy, skin breakdown, and difficulties with the other limb. Problems that a geriatric person with an amputation may have to cope with are financial problems, general weakness, arteriosclerosis, diabetes, and cardiovascular and neurologic deficits, in addition to decreased sensory input, difficulty with balance, and change in posture. Such a patient or client poses a tremendous challenge and is a prime candidate for continuous examination and prevention measures.

Ninety percent of persons older than 55 years with amputations have had the amputation as a result of a disease.[52] Seventy percent of the same population have had limbs amputated as a result of arterial disease.[52] These statistics point out how important it is in the rehabilitation process to consider an entire person with all the concurrent diagnoses and intervening variables.

The following are some treatment modifications to use when working with someone who is older and has had an amputation. If the therapist is fortunate and is able to see a patient before surgery, he or she should perform an examination to establish baseline abilities. A patient should not be allowed to drop below the baseline after surgery. In the case of lower-extremity amputation, you should check a person and teach transfer skills and three-point ambulation with a walker in preparation for postoperative programming.[52]

In prosthetic fitting, there are several rules to follow. The therapist should be cognizant of any belts or straps because they can possibility rub on various scars or pressure areas. An older person's skin is fragile—especially if that person is diabetic—



■ FIGURE 7–9. The normal gait cycle.

and breaks down quickly. Remember also—owing to an older person's decreased reporting of pain—he or she may not report pain until a sore has already developed.[52]

The prosthesis itself should be easy to maneuver in gait and application. Many times arthritis of the hands can lead to difficulties in using buckles and straps. Therefore, alternative methods of fastening, such as Velcro or a suction socket, may be needed. A prosthesis should be as light as possible because of an older person's decreased strength; however, the lightness should not compromise security.

The most critical phase of a gait cycle in a geriatric person with an amputation is at the point of heel contact and immediately following. This phase relates directly to the stability of the knee. Two factors can cause instability of the knee in a prosthesis. One is the loss of extensor power. This instability can be compensated as follows:

- Exercising to increase the quadriceps strength
- Redesigning the prosthesis
- Changing the body alignment
- Attaching elastic to help pull the knee into extension
- Using a knee lock[51]

The second factor causing instability at heel contact is too much plantar flexion. Using a soft-SACH heel or a single-axis heel can alleviate this instability.

The older person's energy expenditure in using a prosthesis is also an important variable. It has been shown that the energy expenditures required for an elderly person to walk with an above-knee prosthesis is 55 percent greater than that for a normal elderly person.[53] Remember too that a large portion of this energy is being expended by the upper extremities. Any time the upper extremities are used in an activity, there is a tendency for systolic blood pressure to rise.[51] If a patient already has difficulties with cardiovascular compromise, an upper-extremity stress test should be done to evaluate the his or her ability to ambulate successfully with the prosthesis.

Finally, in working with a geriatric person with an amputation, it is extremely important to have a team approach. Encourage frequent and intensive follow-ups, and define success of prosthetic wear in terms of functional usage and psychosocial support for the patient. Ideally, an internist should be part of the rehabilitation process of an older person because of the numerous complications he or she may face. The team is extremely useful if it can encourage and perpetuate ongoing patient and client groups for those having similar amputation and prosthetics challenges. There are numerous psychological and social problems that are faced by persons with amputations, despite their ages. The ability to participate, learn, and share with others who may have similar problems can be very helpful. Frequent and intensive follow-ups are very important in this population because of their continual change in status. Such problems as arthritis, cerebrovascular accidents, weight change, and vascular problems can cause severe complications if assessment is not done frequently.

The success of a patient's prosthesis must be judged not only in terms of its aid in enhancing the patient's functional ambulation but also in terms of its enhancing the patient's quality of life. If wearing the prosthesis improves a wheelchair-bound person's self-esteem and social participation, then that prosthesis is not only functional but, in the long run, cost-effective. In many instances, because a person has "two legs," he or she will do his or her own dressing, feeding, and daily hygiene without fear of social rejection. Using this independent functioning instead of relying on costly personnel to help with these endeavors can be very cost-effective. Providing a prosthetic device to someone without adequate mentality, motivation, or vigor is inappropriate; however, if the person can appreciate how this device improves the quality of life, the device's worth is unquestionable.

A geriatric person with an amputation requires special care. Modifying the examination procedure to include specific aging variables, along with altering the intervention programs to fit the pace and complications commonly occurring in older persons, is essential. The most important aspect of treatment, however, is a team approach that probes and encourages individual maximum functional independence.

PAIN

In all the functional criteria previously mentioned, pain can be a limiting factor or the cause for functional limitations themselves.

Biologic Causes

There are two major causes of pain differences in older persons. One is the difficulty that older people have in localizing pain.[54] Clinically, this difficulty should alert a practitioner to be very specific when asking an older person about pain. An elderly person should also be encouraged to point to the exact location of the pain.

The second difficulty involves the pain pathways. Associated with the pathway that sends most of the chronic pain messages, the *spinothalamic pathway,* are a number of cells that secrete enkephalin. *Enkephalins* are the body's own opiates, or painkillers. In older patients, the production and liberation of enkephalin are reduced, and chronic discomfort becomes more of a problem.[54]

Clinically, you should use techniques for relieving chronic pain before acute interventions. Such programs as visual imagery, relaxation, and biofeedback transcutaneous electrical nerve stimulation (TENS) can be very effective with older clients in the treatment of chronic pain.[55]

Functional Causes

The primary functional difference in the ways that younger and older clients react to pain is social origin. An older person does not want to complain about pain. Older people as well as younger people adhere to the stereotype of "the complaining old crock." To avoid fitting into this mold, older persons tend not to report pain as often as do their younger counterparts.

Any complaints of pain expressed by an older person should receive very serious attention from the health professional. Knowing that an older person complains of pain less should encourage the practitioner to solicit responses from older persons about their feelings of pain through specific questioning techniques.

Pathologic Causes

The two most common disease-induced causes of pain in elderly persons are fractures and arthritis. Fractures in an older person are more common for a number of reasons. On the physiologic level, the osteoporotic bone fractures with significantly less force. An older person's equilibrium and vision may be poorer. These decrements make daily activities less safe for older people and make them more likely candidates for falls.[56]

The most common areas for fractures in an older person are the hips and wrists.[56] The increased incidence of fracture in these areas is directly related to falls. A wrist fracture usually occurs because an older person attempts to catch himself or herself on an extended wrist. The increased incidence of hip fractures often occurs because of the position of the fall and the less efficient kinesiologic leverage of the elderly person's hip joint.

A fracture in an older person differs from that in a younger person for several reasons. First, an older person heals more slowly. Second, an older person is more prone to developing complications during the healing process.[56] Some common complications are pneumonia, osteoporosis, decubiti, and mental status problems. An older person may also have fewer support systems (family and friends) to aid in the rehabilitation process.

When examining an elderly person with a hip fracture, include very specific questions about complaints of pain. Also include evaluation of his or her equilibrium, five senses, strength, flexibility, posture, and gait.

Pain in a fractured hip should subside in a few days or, at most, in a week. If a person still complains of pain, the problem should receive additional consideration to determine the source of the pain. Pain in a fractured hip, for example, could be attributed to nonunion, osteomyelitis, aseptic necrosis, displaced fixation device, bursitis, referred pain from the hip or spine, or fibrositis.[57] This list has specific implications for modification of interventions.[58] For example, a person may need an additional intervention for bursitis that developed as a result of a new gait compensation.[59] It is important that the underlying cause of pain be found and treated so that the person can resume exercise and ambulation activities.

Stress fracture can occur easily with daily activities. The signs of stress fracture are unusual complaints of pain after an exercise, local tenderness, and local swelling.[45]

In working with an older person who is suspected of having a stress fracture, encourage activity as long as it does not cause pain from the suspected fracture site. It is important that an older person stay as active as possible to avoid future complications. Caution must be taken, however, in any activity to avoid any undue strain on the possible fracture site. In other words, an elderly person can exercise as long as no pain is elicited from the suspected fracture site. (This last bit of information may be very helpful for persons working in facilities that seem to take forever to get the needed physician services.)

Arthritis can cause pain because of the presence of osteophytes that stretch the periosteum and that may stretch, pinch, or wear nerve endings. Finally, muscle spasms can compound the effects of this pain.[58]

Interventions for the treatment of osteoarthritis begin by incorporating some of the drugs prescribed by a physician. These drugs do not cure osteoarthritis, but they can relieve the symptoms. The interventions that can be used by an older person in a home program with instruction from a rehabilitation professional are heat, cold, and exercise. Heat can be applied in the simplest forms for relief of pain and for relaxation. Caution should be stressed in checking for burns. Heat pads should never be turned above low for home use. An older person should be warned about the dangers of sleeping with heat on a body part. Bandages may be advantageous as a form of superficial heat. They are easy for an older person to apply, and they keep in the body heat. The bandages should be checked to ensure enough looseness so that there is no restriction of motion or compromise of the venous system. Many older persons also use liniments as a form of heat. This practice need not be discouraged if the person receives benefits. Many times liniments act as a counterirritant and may work as well as more expensive interventions. The application of cold, if tolerated by an older person, works to decrease pain and in many cases allows better joint mobilization than does heat.

When exercise is used as an intervention, it can do more than just increase ROM. Increasing strength around a weight-bearing joint can help decrease the shock on that joint during weight-bearing activitiess. A study done by Radin[59] found that active contraction of a muscle against tension can absorb tremendous amounts of stress. Therefore, strengthening programs are very important, especially in the weight-bearing joints, to aid in relieving stress and improve function.

Mobilization techniques can be used with an older person who has osteoarthritis; however, care should be used. Carefully consider the person's ability to assess and report pain accurately. Inaccurate reporting of pain can lead to possible damage of fragile joint structure during a mobilization technique.

Some additional intervention comments on osteoarthritis are specific to the different body parts. Osteoarthritis of the shoulder in an older person is usually rare.[60] There is not much degeneration in the shoulder joint, but there is frequently degeneration of the rotator cuff muscles and capsulitis, which may be the cause of pain and limitation. These pathologies respond extremely well to a program of ultrasound, exercise, and mobilization.

The problem of hip pain should instantly alert the rehabilitation professional to make a thorough investigation of a person's daily activities. Too often, older people do not complain of hip pain and continue to walk beyond their pain limits. This actually aggravates the pain, degeneration, and limitation associated with osteoarthritis. The person is putting more stress on an already stressed joint, and he or she should be instructed to follow an incremental ambulation program and perform non-weight-bearing exercises. Older persons can have bursitis. The intertrochanteric bursa is a very common place for inflammation. Many times bursitis around the hips mimics deep joint pain; therefore, careful examination is needed. Hip bursitis responds well to rest and use of heat, ultrasound, and cold applications.

Osteoarthritis in the knee relates strongly to a person's past or present weight and occupation.[61] This inflammation is usually very localized. Ultrasound and cold applications for 20 minutes 3 times a day, along with exercises to strengthen muscles and decrease stress, may be very helpful. Weight reduction is imperative to help decrease the stress on the knee joint.[61] Again, non-weight-bearing exercises are extremely beneficial in providing the shock-absorbing mechanism discussed earlier.[62]

An older person's cervical region presents quite an enigma in many instances. Lehman[63] claims that there is no such thing as disk herniation in an older person, and yet, there are frequent reports of older persons complaining of radiculitis. Because osteoarthritis of the cervical spine is a continuous process beginning at maturity, it is common to see osteophyte formation at the apophyseal joints that may impinge on the intervertebral foramina or any other pain-sensitive structure in the cervical spine. There may also be hyperostosis at the vertebral margins, especially at C-5 and C-6, which may cause neurologic involvement.[63] Any of the above dysfunctions can be exacerbated by a recent injury, such as whiplash. A recent trauma may also bring out an asymptomatic spondylosis in the cervical spine. If a person's pain relates to an acute incident, then rest, positioning, and use of a collar are indicated until the acute episode subsides. Once the person has received some mild relief or is in a chronic stage of pain, such interventions as heat, ultrasound, traction (beginning gently), and slow ROM exercises are indicated. When the older person finally has little or no pain, teach a regular and gradual strengthening and posture program before discharge. The strengthening exercises will aid in strengthening muscles to prevent future injuries and complications. The common hyperostosis in the cervical area needs special mention in regard to a very common problem in elderly persons—falling. Because disks are smaller and the vertebral margins are larger because of hyperostosis, the vertebral arteries begin to pursue a very tortuous path. These arteries can be compromised by even a simple motion, such as neck extension or rotation. One of these motions and its effect on the artery can cause decreased blood flow to the brain, and a person may fall or become dizzy. The therapist should check supine head movements in extension and rotation to be sure that a person who falls subsequent to head movements does not have vertebral artery syndrome.

SUMMARY

Looking back on our meeting of Emily and Rachel, we now see two patients at two stages of aging. We understand how and where they differ on some functional criteria. Now we can modify our intervention and examination strategies accordingly and also become more adept at outlining the best plan of care for a geriatric client.

Case Study

History

Mr. Phillips is an 89-year-old retired schoolteacher who has come to the skilled nursing physical therapy department with a diagnosis of a vertebral compression fracture of T-6 and T-7. During the initial examination, he reports that he began to experience extreme pain in the middle of his back 2 months ago while rising from a chair. He states the radiograph revealed compression fractures of two vertebrae. Subsequently, he has had difficulty sitting and has had relief of symptoms only when lying down. Mr. Phillips states that he continues to experience extreme pain when moving from a sitting to a standing position as well as when sitting. However, once he is in a standing position, he is more comfortable than when he is sitting. He also complains of tenderness in the thoracic musculature. His reported goals are to decrease thoracic pain and restore ability to sit without pain.

Physical Findings

On objective examination with the REEDCO chart, it is observed that Mr. Phillips has a severe forward head of 0/10, rounded shoulders of 0/10, and flat lumbar spine of 5/10. The ROM of the neck assessed goniometrically is limited to 15 degrees of flexion, 28 degrees of extension, and lateral rotation of 20 degrees bilaterally. Trunk flexion is 10 degrees with pain, and trunk extension is 5 degrees and pain-free. Palpation reveals moderate muscle spasm in the paraspinal musculature in the thoracic and lumbar region. The patient ambulates independently with a walker. Using a scale from 0 to 10, he rates the pain with sitting and bending as a 10/10 and walking and turning a 7/10.

What are your goals for this patient? The goals are to decrease pain to 0/10, decrease muscle spasm completely, improve posture of forward head and rounded shoulders to 5/10 on the REEDCO Scale, create an independent home exercise program, increase sitting tolerance to 2 hours pain-free, and increased ROM to 50 degrees trunk flexion and extension.

Plan

1. Hot pack and electrical stimulation to T-4 to T-8
2. Sitting with a towel roll in lumbar area
3. Progressive thoracic extension exercises:
   - Rhomboid pinches
   - Theraband rows
   - Body extension
   - Chair extension
   - Alternate arm extension
4. Body mechanics to limit flexion when rising from a chair and bed

Raise walker height to encourage extension

References

1. Wilmore, J: The aging of bone and muscle. Clinics in Sports Medicine 10(2):231–43, 1991.
2. Nelson, CL, and Dwyer, AP (eds): The Aging Musculoskeletal System. Physiological and Pathological Problems. DC Health, Lexington, Mass., 1984.
3. Ross, P, et al: Pre-existing fractures and bone mass predict vertebral fracture incidence in women. Ann Intern Med 114(11):919–23, 1991.
4. Barrett-Connor, E: Post-menopausal estrogen and prevention bias. Ann Intern Med 115(6):455–56, 1991.
5. Bloomfield, SA, et al: Non-weight-bearing exercise may increase lumbar spine bone mineral density in healthy postmenopausal women. Am J Phys Med Rehabil 72:204–09, 1993.
6. Napier, K, and Dunkin, M: Osteoporosis: Resisting the silent crippler. Arthritis Today. March/April, 18–24, 1994.
7. Agnew, L (ed): Dorland's Illustrated Medical Dictionary, ed 24. WB Saunders, Philadelphia, 1965.
8. Smith, E, and Serfass, R: Exercise and Aging: The Scientific Basis. Enslow Publishers, Hillside, N.J., 1981.
9. Bick, EM: Aging in the connective tissues of the human musculoskeletal system. Geriatrics 11:445, 1971.

10. Robertson, WVB: The biochemical role of ascorbic acid in connective tissue. Ann NY Acad Sci 258:159–67, 1975.
11. Schneider, WL: Nutrition: Basic Concepts and Applications. McGraw-Hill, New York, 1983.
12. Roe, DA: Geriatric Nutrition. Prentice Hall, Englewood Cliffs, N.J., 1983.
13. Leslie, D, and Frekaney, G: Effects of an exercise program on selected flexibility measurements of senior citizens. Gerontologist 15:182, 1975.
14. Lentell, G, et al: The use of thermal agents to influence the effectiveness of low-load prolonged stretch. JOSPT 16(5):200–07, 1992.
15. James, B, and Parker, AW: Active and passive mobility of lower limb joints in elderly men and women. Am J Phys Rehabil 68:162–67, 1994.
16. Young, A: Exercise in geriatric practice. Acta Med Scand 711:227–32, 1986.
17. Rodman, G: Primer on the rheumatic diseases. J Am Geriatr Soc 224:5, 1973.
18. Mitolo, M: Electromyography on aging. Gerontology 14:54, 1968.
19. Carlson, KE, et al: Electromyographic study of aging in skeletal muscle. Am J Phys Med 43:141, 1964.
20. Gutmann, E, and Hanzlikova V: Fast and slow motion units in aging. Gerontology 22:280, 1976.
21. Fries, JF: Aging, natural death and the compression of morbidity. N Engl J Med 309:130–35, 1980.
22. Schneider, EL, and Brody, JA: Aging, natural death, and the compression of morbidity: Another view. N Engl J Med 309:854–56, 1983.
23. Basu, NM, and Biswas, P: The influence of ascorbic acid on contractions and the incidence of fatigue of different types of muscles. Indian J Med Res 28:405–17, 1940.
24. Basu, NM, and Ray, GK: The effect of vitamin C on the incidence of fatigue in human muscle. Indian J Med Res 28:419–26, 1940.
25. Riccitella, ML: Vitamin C therapy in geriatric practice. J Am Geriartr Soc 20(1):34–42, 1972.
26. Kutsky, RJ: Handbook of Vitamins, Minerals and Hormones, ed 2. Van Nostrand Reinhold, New York, 1981.
27. Hamilton, EM, and Whitney, E: Nutrition: Concepts and Controversies, ed 2. West, 1982.
28. Isaacson, A, and Sandow, A: Effects of zinc on responses of skeletal muscle. J Gen Physiol 46:655–77, 1978.
29. Krotkiewki, M, et al: Zinc's relationship to muscle strength and endurance. Acta Physiol Scand 116:309–11, 1982.
30. Murray, P: Strength of isometric and isokinetic contractions in knee muscles of men aged 20 to 86. Phys Ther 60:4, 1980.
31. Browse, N: The Physiology and Pathology of Bed Rest. Charles C Thomas, Springfield, Ill., 1965.
32. Bohannon, RW, et al: Decrease in timed balance test scores with aging. Phys Ther 649(7):1067–70, 1984.
33. Newcomer, KL, et al: Validity and reliability of the timed-stands test for patients with rheumatoid arthritis and other chronic diseases. J Rheumatol 20:21–7, 1993.
34. Csuka, M, and McCarty, DJ: Simple method for measurement of lower extremity muscle strength. Am J Med 78:77–81, 1977.
35. Andrews, et al: Phys Ther March 76(3), 1996.
36. Pollock, ML, et al: Resistance exercise in individuals with and without cardiovascular disease: Benefits, rationale, safety, and prescription. Circulation 101:828–33, 2000.
37. Kelley, GA, and Kelley KS: Progressive resistance exercise and resting blood pressure: A meta-analysis of randomized controlled trials. Hypertension35:838–43, 2000.
38. Evans, WJ: Exercise training guidelines for the elderly. Med Sci Sports Exerc 31(1):12–17, 1999.
39. Starckey, D, et al: Effect of resistance training volume on strength and muscle thickness. Med Sci Sports Exerc28(10):1311–20, 1996.
40. Atha, J: Strengthening muscle. Exercise and Sport Science in Review 9:1–73, 1981.
41. Fonterra, WR, et al: Strength training and determinants of VO_2 max in older men. J Appl Physiol 68(1):329–33, 1990.
42. Hicks, J: Exercise in patients with inflammatory arthritis and connective tissue disease. Rheum Dis Clin North Am 16(4):845–76, 1990.
43. Gordon, M: Differential diagnosis of weakness: A common geriatric symptom. Geriatrics 41(4):75–80, 1986.
44. Kendall, H, and Kendall, F: Posture and Pain. Williams & Wilkins, Baltimore, 1980.
45. Borenstein, DG, and Burton, JR: Lumbar spine disease in the elderly. J Am Geriatr Soc 41(2):167–75, 1993.
46. O'Neil, M, et al: Physical therapy assessment and treatment protocol for nursing home residents. Phys Ther 72(8):596–603, 1992.
47. REEDCO Research: REEDCO Posture Score Sheet. Auburn, NY, 1974.
48. Lewis, C, and Campanelli, L: VHI Geriatric Exercise and Rehabilitation: Exercise Kit. Visual Health/Stretching Charts, Takoma, WA, 1993.
49. McKenzie, R: The Lumbar Spine. Spinal Publications, Waekanae, New Zealand, 1981.
50. Imns, F, and Edholm, F: The assessment of gait and mobility in the elderly. Age Aging 8:261, 1979.
51. Adams, G: Essentials of Geriatric Medicine. Oxford Univ. Pr., New York, 1977.
52. Pedersen, H: The Geriatric Amputee: Principles of Management. Government Printing Office, Washington, DC, 1971.
53. Ebert, H: The Geriatric Amputee. National Academy of Sciences, National Research Council, Washington, D.C., 1961.
54. Herr, K, and Mobly, PR: Complexities of pain

assessment in the elderly: Clinical considerations. J Gerontol Nurs 17:12–19, 1991.
55. Ziebell, B: Wellness: An Arthritis Reality. Kendall/Hunt, Dubuque, Ill., 1981.
56. Kalchthaler, T, et al: Falls in the institutional elderly. J Am Geriatric Soc 26:424, 1978.
57. Sweezy, R: Pseudoradiculopathy in subacute trochanteric bursitis of subgluteus maximus bursa. Arch Phys Med Rehabil 57:387, 1976.
58. Adams, P, et al: Biochemical aspects of development and aging of the human lumbar intervertebral disks. Rheumatol Rehabil 16:22, 1979.
59. Radin, E: Mechanical effects of osteoarthritis. Bull Rheum Dis 26:7, 1976.
60. Stecher, R: Osteoarthritis and old age. Geriatrics 16(4):167, 1961.
61. Felson, DT, et al: Weight loss reduces the risk of symptoms of osteoarthritis in women. Ann Int Med 115:535–39, 1992.
62. Kriendler, H, et al: Effects of three exercise protocols on oesteoarthritis of the knee. Top Geriatr Rehabil 2(3):32–44, 1989.
63. Lehman, L: Cervical spondybolic myelopathy: A diagnostic challenge in aging patients. Postgrad Med 88:240–43, 1990.