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Age-Related Hyperkyphosis: Its Causes, Consequences, and Management

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Abstract

Age-related postural hyperkyphosis is an exaggerated anterior curvature of the thoracic spine, sometimes referred to as Dowager's hump or gibbous deformity. This condition impairs mobility,[2,31] and increases the risk of falls[33] and fractures.[26] The natural history of hyperkyphosis is not firmly established. Hyperkyphosis may develop from either muscle weakness and degenerative disc disease, leading to vertebral fractures and worsening hyperkyphosis, or from initial vertebral fractures that precipitate its development.

Keywords

aging/geriatrics; kyphosis; osteoporosis; postural relationships; thoracic spine

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It is also possible that different individuals may develop the same magnitude of hyperkyphosis from different processes, some from vertebral fractures and others from muscle weakness, degenerative disc disease, or other genetically determined processes. Regardless, there are significant negative consequences of hyperkyphosis, and early intervention and treatment of hyperkyphosis could have important clinical and public health benefits.

Our objectives are to review the prevalence and natural history of hyperkyphosis, along with associated health implications if left untreated. We will discuss evidence-based treatment options and potential contraindications, and observations about the direction for future study of hyperkyphosis.

DEFINITION AND PREVALENCE

While a small amount of anterior curvature of the thoracic spine is normal and present due to the shape of the vertebral bodies and intervertebral discs, a kyphosis angle greater than 40°, which is the 95th percentile of normal for young adults, is defined as hyperkyphosis.[15,62] In childhood and through the third decade of life the angle of kyphosis averages from

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20° to 29°.[15] After 40 years of age, kyphosis angle begins to increase—more rapidly in women than men[15]—from a mean of 43° in women aged 55 to 60 years to a mean of 52° in women 76 to 80 years of age.[12] Reports of prevalence and incidence of hyperkyphosis in older adults vary from approximately 20% to 40% among both men and women.[32,60] As kyphosis angle increases, physical performance and quality of life often declines, making early intervention for hyperkyphosis a priority.

MEASUREMENT

The gold-standard orthopaedic technique for assessment of thoracic kyphosis is standing lateral spine radiographs. In elderly persons, spinal radiographs may be taken in the supine position for comfort. The Cobb's angle of kyphosis is calculated from perpendicular lines drawn on a standard thoracic spine radiograph: a line extends through the superior endplate of the vertebral body, marking the beginning of the thoracic curve (usually at T4), and the inferior endplate of the vertebral body, marking the end of the thoracic curve (usually at T12) (FIGURE 1).[29] While this method is the gold-standard, it is limited by the need for radiography.

Acceptable alternatives are the Debrunner kyphometer and the flexicurve ruler.[41] Both methods are performed standing. The kyphometer measures the angle of kyphosis, the arms of the protractor-like device are placed at the top and bottom of the thoracic curve, usually over the spinous processes of T2 and T3 superiorly, and T11 and T12 inferiorly (FIGURE 2).[41] The flexicurve ruler is a plastic, moldable device that is aligned over the C7 spinous process to the L5–S1 interspace; the ruler is molded to the curvature of the spine and the thoracic and lumbar curves are traced (FIGURE 3). The kyphosis index is calculated as the width divided by the length of the thoracic curve, multiplied by 100 (FIGURE 3).[47] A kyphosis index value greater than 13 is defined as hyperkyphotic.[40]

Lundon et al41 compared the reliability of standing radiographic, kyphometer, and flexicurve methods of measuring kyphosis in a group of 24 postmenopausal women with osteoporosis. There was excellent intrarater and interrater reliability (intraclass correlation coefficients [ICCs] = 0.87–0.92) for each method, indicating the strength of each instrument for measuring kyphosis.41 Kado et al29 compared the agreement between standing kyphometer and supine radiologic measure of Cobb's angle of kyphosis in older women. While the overall agreement was acceptable (ICC = 0.68), the agreement between the kyphosis measurements greater or equal to 50° was poor (ICC = 0.44). Thus, while all measures can be used to reliably quantify kyphosis, the standing kyphometer method for measuring a kyphotic spine may overestimate the degree of kyphosis compared with supine radiographs. However, the external methods do not involve radiographic exposure and are inexpensive and easy to use in the clinical setting.

Other clinical measures are sometimes used to quantify hyperkyphotic posture. Standing measurements of tragus to the wall or occiput to the wall, and supine measurement of the number of 1.5-cm blocks needed to support the head have been described[2,33]; however, reliability of these methods has not been investigated and there are no studies comparing these measures to the gold-standard radiograph.

CLINICAL CONSEQUENCES OF HYPERKYPHOSIS

Functional Limitations

Excessive kyphosis has detrimental effects on physical performance, the ability to perform activities of daily living, and overall quality of life.[2,52,60] Women with hyperkyphotic posture demonstrate difficulty rising from a chair repeatedly without using their arms,[2,31] significantly poorer balance and slower gait velocity, wider base of support with stance and gait, and decreased stair-climbing speed[2]—impairments that have been associated with increased risk for falls. In addition, osteoporotic women with hyperkyphosis have increased postural sway compared to those with normal posture.[42]

Hyperkyphosis is also associated with self-reported decline in physical functioning. Women with hyperkyphosis report greater difficulty reaching and performing heavy housework and score lower on the basic activities of daily living scale compared with their peers.[2,10,52,60]

Musculoskeletal Alterations

As kyphosis increases, there are concomitant alterations in the normal sagittal plane alignment that may cause pain and risk of dysfunction in the shoulder and pelvic girdle, and cervical, thoracic, and lumbar spine. Forward head posture, scapula protraction, reduced lumbar lordosis, and decreased standing height are often associated with hyperkyphosis. [2] These postural changes increase the flexion bias around the hip and shoulder joints that can interfere with normal joint mechanics and movement patterns.

Hyperkyphosis is a significant risk factor for future vertebral and extremity fractures.[12,13,26] Older women with hyperkyphosis have a 70% increased risk of future fracture, independent of age or prior fracture, and the risk for fracture increases as hyperkyphosis progresses.[26]

Quality of Life

Women with hyperkyphosis report more physical difficulty, more adaptations to their lives, and greater generalized fears than women without hyperkyphosis.[44] Additionally, community-dwelling men and women aged 65 years and older with hyperkyphosis report poorer satisfaction with subjective health, family relationships, economic conditions, and their lives in general.[60]

Mortality

Hyperkyphotic posture has been associated with increased mortality, with higher mortality rates associated with the severity of kyphosis.[32] Reduced vital capacity is associated with hyperkyphosis, and severe hyperkyphosis is predictive of pulmonary death among community-dwelling women.[28,38] Women in the highest quartile of kyphosis were more likely to die of pulmonary death compared with those in the lower quartiles of kyphosis.[28] Two recent cohort studies confirm these adverse health effects of hyperkyphosis even after adjusting for vertebral fractures and bone mineral density.[30,32]

RISK FACTORS

The causes of hyperkyphosis have yet to be fully elucidated. However, multiple musculoskeletal, neuromuscular, and sensory impairments are significant predictors of age-related hyperkyphosis.

Vertebral Fractures

Kyphosis increases with the number of vertebral fractures and is more strongly related to thoracic fractures than lumbar fractures.[12] Hyperkyphosis is most prominent in women with multiple thoracic anterior wedge fractures.[12] Women without vertebral fractures, who have greater degrees of kyphosis, are more likely to experience a subsequent vertebral fracture. [26] Biomechanical models of stress loading on the spine suggest that forces applied to the osteoporotic spine during daily living can cause vertebral wedging and compression fractures.[5,37] The severity of wedging increases as bone mineral density decreases, resulting in greater numbers of vertebral compression fractures and a further cascade of increasing hyperkyphosis.[16,21,46]

Degenerative Disc Disease

Many people consider vertebral fractures to be the underlying cause of age-related hyperkyphosis, although studies of older adults report only approximately 40% of men and women with the most severe hyperkyphosis have vertebral compression or wedge fractures.[53] A common radiographic finding associated with hyperkyphosis among older adults is degenerative disc disease.[16,43,53] In a study of healthy women aged 39 to 91 years, there was a significant correlation between anterior disc height and kyphosis angle ($r = -0.34$, $P<.001$)[43]; as the anterior disc height decreased, the angle of kyphosis increased. Others have reported that the majority of older adults 50 to 96 years of age with hyperkyphosis had degenerative disc disease and no evidence of vertebral fractures or osteoporosis,[53] suggesting that hyperkyphosis doesn't predict fractures or osteoporosis. However, a strong association between vertebral body anterior- to-posterior height ratio and kyphosis angle suggests that it is the combined influence of both degenerative disc disease and anterior vertebral deformities that accounts for significant variation in kyphosis.[16,53]

Muscle Weakness

Several studies confirm that hyperkyphosis is associated with spinal extensor muscle weakness.[27,56,57] In healthy postmenopausal women, strength of the spinal extensor muscles is inversely associated with kyphosis ($r = -0.30$, $P = .019$).[27,56] There is also an inverse relationship between grip and ankle strength and kyphosis,[2] suggesting that age-related hyperkyphosis may be part of a larger geriatric syndrome associated with adverse health outcomes that negatively impact physical function.[6,9]

Decreased Mobility

Decreased spinal extension mobility occurs with aging, interfering with the ability to stand erect and maintain normal postural alignment.[22] Cadaver studies suggest that calcification and ossification of the anterior longitudinal ligament in the thoracic region might contribute to increased Cobb's angle of kyphosis.[4] Furthermore, shorter pectoral and hip flexor muscles are linked to severe hyperkyphosis, although it is not known whether the short muscles pull the shoulders and hips anteriorly, or whether the kyphotic posture results in shorter anterior musculature. [2] There are likely other contributing muscular, ligamentous, connective tissue, and joint impairments that have not been identified.

Sensory Deficits

Age-related deficits in the somatosensory, visual, and vestibular systems likely contribute to the loss of upright postural control. With a loss of proprioceptive and vibratory input from the joints in the lower extremities in elderly adults compared with young adults,[14] the perception of erect vertical alignment becomes impaired. [14,25] Similar declines occur in the visual system with aging,[54] and primary age-related diseases in the eyes, including cataracts and macular degeneration, exacerbate decline in visual acuity. Head pitch position was found to be greater during locomotion for normal elderly compared to young adults,[23] and increased even further among older adults wearing bifocals during stair descent.[20] Additionally, age-related sensory loss in the vestibular system[24] increases the reliance on already declining visual and somatosensory cues, and can further impact upright postural alignment.

TREATMENT OF HYPERKYPHOSIS

There is a lack of efficacious medical interventions for hyperkyphosis. Physical therapy should be a first-line approach, particularly because many of the causes of hyperkyphosis are of musculoskeletal origin. Recognition and treatment of hyperkyphosis could contribute to reduced risk of falls, fractures, and functional limitations. Several physical therapy interventions aimed at reducing hyperkyphosis are currently available (TABLE 1).

Medicines and Surgery

Many men and women with prevalent hyperkyphosis are treated with osteoporosis antiresorptive or bone-building medications because they have low bone density or spine fractures. While osteoporosis treatment helps to prevent incident spine fractures, no medications have been shown to improve hyperkyphosis. Vertebroplasty and kyphoplasty are surgical procedures primarily used to treat refractory pain following vertebral fracture, and they have been shown to reduce kyphosis angle in select patient populations only.[8,61] However, evidence suggests that physical disability and pain relief may be improved after vertebroplasty and kyphoplasty compared to medical management but only within the first 3 months after intervention.[45] Furthermore, recent evidence from 2 randomized controlled trials suggests that clinical improvement in physical disability and pain is similar among patients undergoing vertebroplasty, compared to sham procedure for painful vertebral fractures, at 1-month and 6-month follow- up.[7,35] High-quality randomized trials with long-term follow-up are needed to investigate benefits of these procedures on subsequent vertebral fractures. No studies have investigated the effects on kyphosis of combined treatment with medications, surgical interventions, and physical therapy interventions.

Exercise: Indications and Contraindications

Seminal research by Sinaki et al[59] suggests that the forces applied to the spine during exercise can alter the occurrence of subsequent vertebral compression fractures in women with prior fracture. In this study, 68% of the women who performed flexion exercises developed a subsequent fracture within the following 6 months, compared with only 16% of those who performed extension exercises, suggesting that flexion exercises increase fracture risk.[59] In addition, the conceptual models of spinal loading suggest that flexion stress on the spine increases the risk for fractures when the underlying bone strength is impaired[5] and may partially explain why older women with hyperkyphosis have an increased risk of future fracture independent of age or prior fracture.[26] Hence, it is important to train individuals with age-related hyperkyphosis to avoid flexion stresses on the spine during exercise and activities of daily living (TABLE 2), regardless of whether they have had a prior fracture. Furthermore, training using trunk stabilization should avoid curl-up exercises to reduce flexion bias on the spine.

In a randomized trial of prone trunk extension exercises in 60 healthy postmenopausal women, the angle of kyphosis and back extension strength improved among women with the most severe kyphosis and significant weakness of the spinal extensor muscles at baseline, suggesting that hyperkyphosis may be modified by spinal extensor muscle strengthening exercises.[27] Subjects in the intervention group performed 10 repetitions of prone trunk extension exercises 5 times a week for a year while wearing a weighted backpack (FIGURE 4).[27] At the 10-year follow-up, the number of vertebral compression fractures was significantly lower in the intervention group compared to controls, regardless of kyphosis or strength, even though the intervention was not continued in the intervening time.[57]

In a randomized controlled trial among 118 men and women 60 years and older with kyphosis greater or equal to 40°, participation in modified classical yoga 3 days a week for

24 weeks resulted in a 5% improvement in kyphosis index (P = .004), and 4.4% improvement in kyphosis angle measured from the flexicurve (P = .006).[17] The intervention did not result in statistically significant improvement in kyphometer angle, measured physical performance, or self-assessed health-related quality of life (each P>.1).[17] The yoga intervention was limited to poses that included stretching into shoulder flexion, quadruped alternate arm/leg lift, prone trunk extension, and standing lunges with shoulder flexion.[17]

In an uncontrolled trial of a multidimensional exercise intervention among 21 older women with kyphosis greater or equal to 50°, kyphosis improved 11% after 3 months of exercise.[36] The exercise intervention was designed to target multiple strength, range-of-motion, and sensory impairments associated with kyphosis, and included prone and quadruped spinal extension strengthening with weights, lower trapezius and transversus abdominus strengthening, spine mobility, shoulder and hip stretching, and postural alignment training twice a week for 12 weeks in a group setting.[36] Participants maintained gains in spinal extension strength and physical performance, and demonstrated additional improvements in measured kyphosis 1 year after completing the 12-week exercise program with no further intervention in the interim. These results present evidence that targeted exercises that reduce hyperkyphosis provide long-term benefits.[48]

In an investigation among 81 women, aged 50 to 59 years, participants were instructed to perform spinal extension strengthening exercises 3 times per week for 1 year.[1] Only 15 of these women complied with the exercises 3 times a week and 20 did not do any of the exercises. The group of 15 women who were compliant were compared to the group of 20 who were not compliant.[1] Kyphosis and forward head posture were significantly reduced among the compliant exercise group compared with the noncompliant group.[1]

Renno et al[50] employed respiratory muscle exercises combined with back extensor muscle strengthening and aerobic exercises in a study of 14 women with osteoporosis. They found that respiratory pressures improved 12% to 23%, exercise tolerance increased 13%, and thoracic curvature was reduced 5%.[50] While it is not clear whether reducing hyperkyphosis, respiratory muscle exercises, or aerobic exercise training explains the improved respiratory pressures and exercise tolerance, this study suggests the importance of addressing lung capacity and breathing exercises in this population.

Manual Therapy/Mobilization

Three case reports suggest that myofascial, spinal, and scapular mobilization techniques improve postural alignment in patients with hyperkyphosis.[11,39,51] Physical therapists reported reduced kyphosis after soft tissue myofascial,[11] neurodevelopmental, spinal, and scapular mobilization, [51] and active therapeutic movement techniques.[39] These techniques have not been subjected to rigorous evaluation in clinical trials.

Therapeutic exercise, such as self-mobilization lying supine on a foam roller, has been used successfully in a multidimensional exercise program that reduced kyphosis among hyperkyphotic women.[36] This type of self-mobilization technique may be appropriately applied in this population.

Bracing

In a randomized controlled trial with 62 community-dwelling older women with osteoporosis and kyphosis greater or equal to 60°, wearing a Spinomed (Medi, Whitsett, NC) spinal orthosis 2 hours a day for 6 months resulted in an 11% decrease in kyphosis angle, improved standing height, increased spinal extensor strength, and decreased postural sway.[49] Although the orthosis appeared to be beneficial, passive bracing does not provide the beneficial effects of exercise on bone.63 While not yet studied, bracing used in combination with therapeutic exercises may provide additional beneficial effect.

The spinal weighted kyphosis orthosis is another bracing alternative for hyperkyphosis (FIGURE 5).[55] This lightweight vest device reportedly improves balance and reduces pain among osteoporotic hyperkyphotic women.[55]

Taping

Therapeutic taping may also reduce kyphosis angle according to preliminary research in 15 women with osteoporotic vertebral fractures; those with the greatest initial kyphosis had the greatest reduction in kyphosis with taping (FIGURE 6).[19] Taping during 3 individual 40-second static standing tasks reduced kyphosis angle immediately after the tasks, compared with sham taping or no taping.[19]

FUTURE RESEARCH

Existing evidence supports the use of exercise, bracing, and taping interventions to reduce hyperkyphosis, improve quality of life, and reduce risk for future fractures for men and women. Additional research, especially large, well-controlled randomized clinical trials are required to confirm the optimal type, duration, and long-term effects of interventions. The effects of combined treatments of bracing or taping with exercise, or medications, surgical interventions, and exercise, warrant further study. Further work is needed to determine whether reducing hyperkyphosis is associated with improved physical performance. Research is also needed to determine the threshold of hyperkyphosis associated with functional impairments. This information could be used to develop screening guidelines that would assist clinicians to time interventions. Prevention strategies for hyperkyphosis require testing to determine whether appropriately timed interventions might prevent age-related hyperkyphosis and reduce the associated cascade of fractures and functional impairments. While at this time evidence is lacking to support manual therapy techniques to reduce hyperkyphosis, case reports suggest that appropriately applied manual treatments may have a place in a comprehensive treatment approach.

CONCLUSION

Kyphosis is common in older individuals, increases risk for fracture and mortality, and is associated with impaired physical performance, health, and quality of life. Screening for hyperkyphosis could be easily implemented in the clinical setting and the evidence to date suggests that relatively simple, available, and inexpensive conservative interventions may have a beneficial effect. Further research and, particularly, large, well-controlled randomized clinical trials are needed to develop optimal strategies to treat hyperkyphosis and prevent its serious associated complications.

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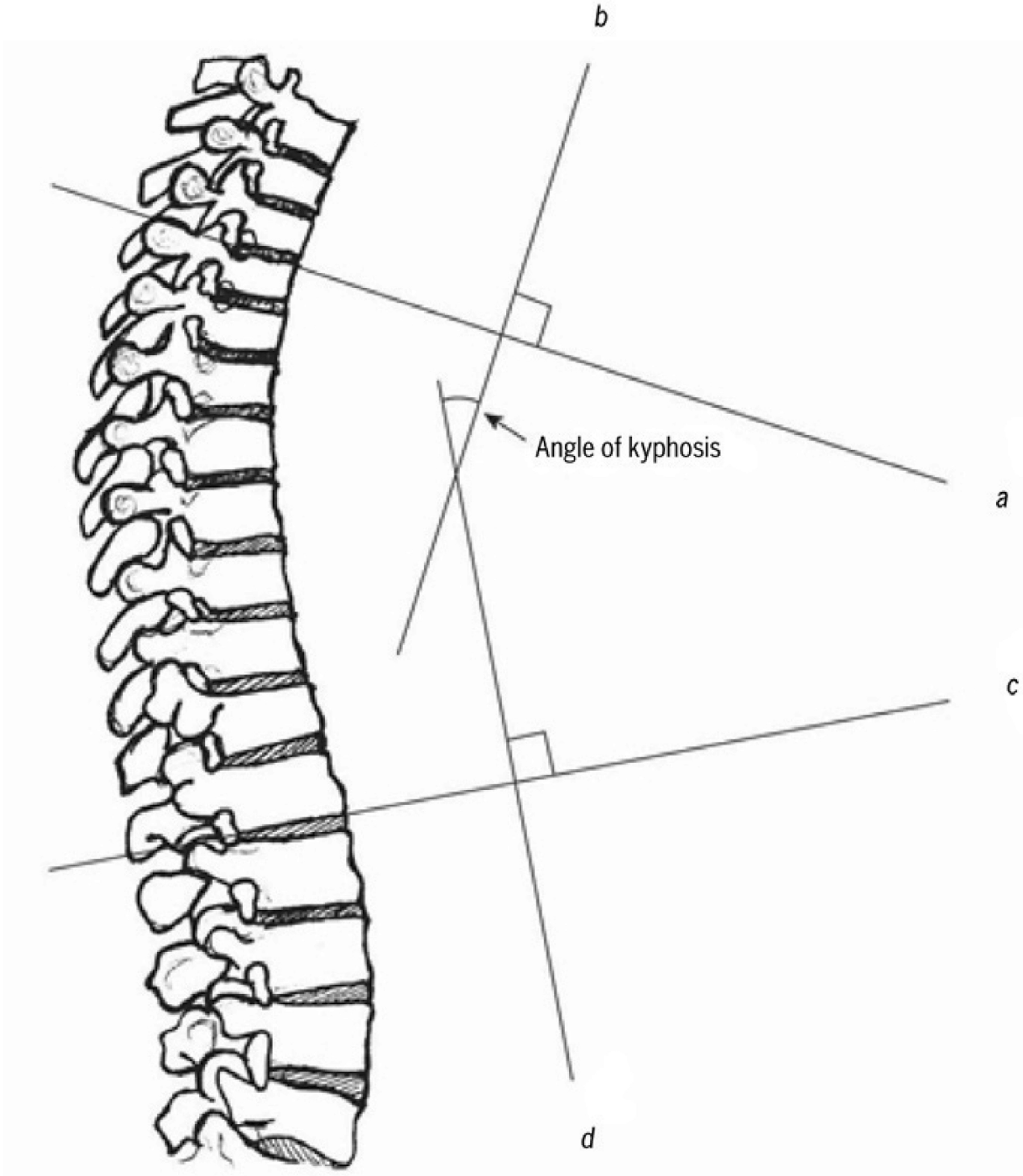

FIGURE 1.

Cobb's angle of kyphosis, calculated from a lateral radiograph. (A) Draw the first line (line *a*) through the superior end plate of T3, and a second line (line *b*) that is perpendicular to line *a*. (B) Draw a third line (line *c*) through the inferior endplate of T12, and a fourth line (line *d*) that is perpendicular to line *c*. Cobb's angle of kyphosis is the measured angle at the intersection of lines *b* and *d*. Diagram from Kado DM, Prenovost K, Crandall C. Narrative Review: Hyperkyphosis in Older Persons. *Ann Int Med*. 2007;147:330–338, with permissions from *Ann Int Med*.[33]

FIGURE 2.
Debrunner kyphometer measurement of kyphosis. (A) Place the upper foot of the kyphometer over the interspace of T2 and T3 spinous processes, and the lower foot of the kyphometer over the interspace of T11 and T12 spinous processes. (B) Ask the patient to exhale and measure the usual kyphosis, and then “stand as straight and tall as you can” to measure the best kyphosis. (C) Read the Cobb’s angle measurement of kyphosis from the device.

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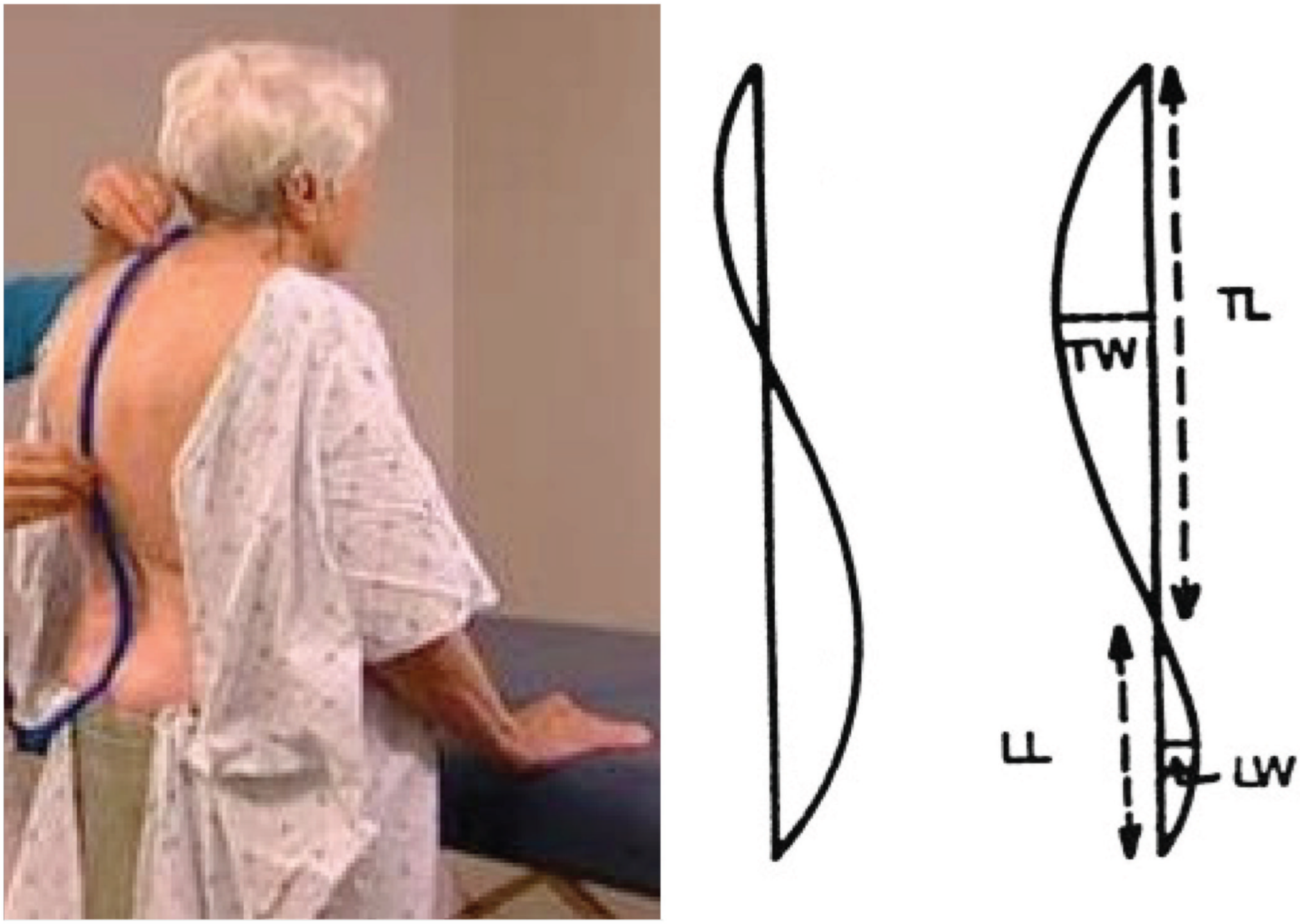

FIGURE 3.

Flexicurve ruler measurement of kyphosis. (A) Mark the C7 spinous process and the L5–S1 interspace on the patient's skin with a grease pencil. (B) Place the superior end of the ruler at C7 and the inferior end over the lumbar spine, molding the ruler to the curves of the thoracic and lumbar spine. (C) Mark the level of the C7 spinous process and the L5–S1 interspace on the ruler. (D) Carefully transfer the molded ruler to tracing paper, with the C7 spinous process and the L5-S1 interspace marks aligned along a vertical line. (E) Trace the thoracic and lumbar curvatures from the ruler onto the paper, drawing a horizontal line from the vertical line to the apex of the thoracic curve. (F) Measure thoracic width (TW) and thoracic length (TL); calculate kyphosis index (KI): (TW/TL) × 100. (G) Lumbar width (LW) and lumbar length (LL) can also be measured. Photograph and diagram used with permission from Carleen Lindsey, PT, MSc, GCS, and the Section on Geriatrics, APTA.[38]

FIGURE 4.
Prone trunk lift with weighted backpack. (A) Patient lies prone over a pillow, wearing a backpack secured to the upper back. (B) Squeeze shoulder blades together, tighten gluteal muscles and lift chest off the mat, keeping cervical and lumbar spine in neutral. (C) Begin with 1 set of 10 repetitions and progress with weights in backpack, up to a maximum weight of 30% of 1-repetition maximum.[27] In lieu of a weighted backpack, patients can use handheld dumbbells and perform the exercise with their elbows bent and their hands by their ears. Progress the dumbbells to 2.27 kg in each hand, and perform 3 sets of 8 repetitions.36

FIGURE 5.
Weighted spinal kyphosis orthosis.[55] (A) Place the weighted kyphosis orthosis over the thoracic spine and adjust the straps such that the bottom of the pouch is located at the waistline. (B) Begin with a 115-g weight in the orthosis, and progress to a 225-g weight to provide sensory feedback to improve postural alignment. (C) Instruct the patient to wear the device when ambulating.

FIGURE 6.
Thoracic taping for hyperkyphosis. (A) Instruct the patient to stand and elongate the crown of the head towards the ceiling. (B) Apply cover roll as needed to protect the skin. (C) Apply therapeutic tape from the anterior aspect of acromioclavicular joint, over the muscle bulk of the upper trapezius, and diagonally over the spinous process of T6. (D) Apply tape in this method bilaterally, intersecting the strips of tape at T6.

TABLE 1

Evidence-based treatment interventions

Procedure	Dosage	Goal
Strengthening		
Prone trunk lift to neutral	3 sets of 8 repetitions (0-to 2.3-kg dumbbells or wrist cuff weights); progress from arms by side, to arms in "W" position, to fists by ears	Strengthen spinal extensors,[27] strengthen middle and lower trapezius[36]
Prone trunk lift to neutral with weighted backpack (FIGURE 4)	1 set of 10 repetitions; 5 times per wk; 30% of 1-repetition maximum weight in backpack	Strengthen spinal extensors[27,50]
Quadruped alternate arm/leg lift	3 sets of 8 repetitions (0- to 2.3-kg wrist and thigh cuff weights)	Strengthen spinal extensors, scapula and trunk stabilization, reduce anterior tightness[18,36]
Ankle plantar flexion with resistance bands	3 sets of 8 repetitions	Increase ankle strength[2]
Stretching/mobility		
Chest stretching and diaphragmatic breathing on foam roller	60 s	Lengthen pectoralis muscles, expand ribcage[2,38]
Prone hip extension/knee flexion	Passive 30	Lengthen iliopsoas and rectus femoris[2]
Supine knee extension with hip at 90° flexion	Passive 30	Lengthen hamstrings[2]
Sidelying thoracic rotation	3 sets of 8 repetitions, progress to resistance bands to combine mobility and strength	Thoracic extension range of motion, strengthen spinal extensors and rotators[22]
Alternating shoulder flexion with diaphragmatic breathing on foam roller	Repeat 10–30 times	Mobilize thoracic spine[22]
Postural alignment		
Postural correction	Performed throughout the day sitting or standing; arms by side or hands behind head and retract scapula; practice standing alignment visualizing lengthening through the crown of the head with sternum lifted	Improve spinal proprioception[3,36,48,55] and postural alignment
Neutral spine sit to stand	Performed throughout the day	Integrate neutral spine alignment into activities
Bracing		
Spinomed	Wear 2 h/d	Provides proprioceptive input to facilitate upright postural alignment and facilitates spinal extensor muscle activity[49]
Weighted spinal kyphosis orthosis (FIGURE 5)	Wear when ambulating	Provides proprioceptive input to facilitate upright postural alignment[55,58]
Taping		
Apply therapeutic tape from the acromioclavicular joint diagonally across trapezius to T6 bilaterally (FIGURE 6)	Tape can be applied for wear during exercise (skin prep necessary)	Passive support from the tape[19]

TABLE 2

Postural alignment during exercise and activities of daily living

Dos	Don'ts
Maintain good postural alignment during exercise	Avoid seated rowing machines or upper body ergometers
Strengthen core stabilizer muscles, such as transversus abdominus, obliques, and multifidus	Avoid crunches, curl-ups, or flexed position (traditional sit-ups)
When bending or lifting objects, keep the spine in neutral, and bend at the hips and knees (hip hinge); keep objects close to the body	Don't twist or bend your spine when lifting objects
When getting out of bed, roll onto the side before sitting up (log roll)	Don't sit straight up from a horizontal position
When coughing or sneezing, stabilize trunk in neutral by hugging a pillow, or placing hands on knees while hip hinging, or place hand in small of back to help keep back in neutral	Avoid forceful trunk flexion while coughing or sneezing
Maintain the natural curves in your neck and back while sitting and standing. Imagine that you are lengthening through the crown of your head	Avoid leaning over towards your work, or standing in a pelvic tilt
Adjust height of the walker and walk within the frame when ambulating	Don't bend to reach, or push walker