Final Course Paper
Deidra Debnam
December 4, 2014
PHYT 875 – Advanced Orthopaedic Assessment & Treatment

Rheumatoid Arthritis: Exercise & Physical Therapy

Disease Overview

Rheumatoid arthritis (RA) is an "inflammatory disease that causes swelling, stiffness, and loss of function in the joints."[9] Although the disease affects multiple body systems, this paper will focus on its influence on the musculoskeletal system. The common feature of RA is persistent polyarthritis that affects the hands and feet.[6] Joints may appear swollen and patients may demonstrate a loss of range of motion in the involved joints.[15] Individuals with RA may also have observable joint deformities in the affected joints.[2]

Estimates suggest that RA affects 1.3 million adults in the United States, representing 0.6% of the population.[11,18] Worldwide, it is estimated that RA affects 1% of the population.[6,7] In general, autoimmune diseases affect women more than men, and the same is true for rheumatoid arthritis.[26] The sex ratio is typically around 3:1 (female:male).[26]

RA is a "multisystem disorder of unknown etiology, characterized by chronic destructive synovitis"[11 (p. 17)] The immune system, which normally fights infection, attacks the synovial lining of joints in patients with RA.[11] RA causes the joints to become stiff, swollen, and painful; the joints of the feet and hands are usually affected first.[11] Although the etiology of RA is unknown, it is hypothesized that the disease is the result of an "interaction of genetic susceptibility, environmental triggers, and chance."[6 (p. s129)]

Among the genetic factors linked to increased susceptibility to RA, the strongest genetic risk factor is found within the human leukocyte antigen (HLA) complex, specifically the HLA-

DRB1 allele.[16] Another significant genetic contribution comes from the protein tyrosine phosphatase N22 (PTPN22) gene.[1] Tumor necrosis factor alleles have also been linked to RA.[23]

A variety of environmental triggers have been identified as potential triggers for RA. Evidence suggests that environmental factors related to gender have an influence on individuals who may be more susceptible to RA.[23] Female sex hormones influence one's susceptibility to RA.[23] Women who actively take oral contraceptives have a lower incidence of RA compared to those who do not take oral contraceptives.[6,7,23] Additionally, the immediate postpartum period after pregnancy has been identified as a risk period for developing RA.[23] Furthermore, women who breastfeed after their first pregnancy appear to have an increased risk of RA. [6,7,23] Subfertility also places women at higher risk of developing RA.[23] Other potential environmental triggers include viral infections, such as the Epstein-Barr virus, parvovirus, and bacterial infections.[7 (p. s297), 23] There is also evidence of interactions between genetic factors and environmental factors. For example, there is an increased incidence of RA in HLA-DRB1 individuals who smoke.[16] Numerous studies have looked at the presence of other comorbidities that present more frequently in patients with RA. The most widely investigated include other autoimmune diseases, type 1 or insulin-dependent diabetes and autoimmune thyroid disease.[23]

The diagnosis of RA is primarily based on physical examination findings.[7] The most current classification criteria for RA includes morning stiffness, joint involvement, serology, acute phase reactants, and the duration of symptoms.[7] Each criterion is scored based on the patient's clinical presentation and a score of ≥6/10 contributes to a diagnosis of RA.[7] See Appendix A for a complete overview of the classification criteria.[7]

Physical Therapy Management

There are numerous pharmacological interventions (disease modifying anti-rheumatic drugs and biologic agents) that effectively reduce signs and symptoms of rheumatoid arthritis (RA) and help prevent or mitigate joint destruction, but physical therapy is also an important component in disease management. RA has a substantial impact on quality of life, function, and productivity and research suggests that physical therapy can influence these and other health domains.[13]

With the hands being commonly affected by RA, studies have investigated the effectiveness of hand exercises used in addition to usual care. In one study, an exercise program included five exercises session with a physical or occupational therapist, with patients also expected to complete the exercises daily on days they were not participating in clinic sessions.[17] Exercises consisted of "seven mobility exercises, four strength or endurance exercises against resistance provided by bands, balls, or therapeutic putty."[17 (p. 3)] Specific exercises included "MCP flexion, tendon gliding, radial walking, eccentric wrist extension, gross grip, finger abduction, wrist circumduction, combined shoulder and elbow range of motion, finger pinch, and finger adduction."[10 (p. 128)] Figures illustrating each exercise can be found in Appendix B.[10] Results from the trial indicate that a tailored hand exercise program is an effective, low-cost intervention to us as an adjunct to a drug regimen.[17] Investigators administered the Michigan Hand Outcome Questionnaire (MHQ), using the overall hand function subscale, at 4 months and 12 months following baseline measurements and found that the exercise group's reported level of improvement was "more than double" the control group's ratings.[17 (p. 7)] Similar findings were also shown in other areas such as overall hand function, activities of daily living, pain, work performance, and confidence to self-manage symptoms.[17]

In addition to the hands, RA frequently affects foot and ankle function, often leading to pain, difficulty ambulating, and disability.[22] Foot and ankle deformities can develop in the early stages of the disease and, if left untreated, can progress to severe or fixed deformities that can impact function.[22] Shrader emphasizes the importance of adequate medical control of the disease, as interventions will not be as beneficial if performed when the disease is in an uncontrolled state.[22] Physical therapy management objectives for the foot and ankle involve "prevention of deformity and pain and preservation of functional abilities."[22 (p. 710)] However, if foot and ankle deformities have already occurred, then objectives include "correcting or accommodating them and restoring functional abilities."[22 (p. 710)]

Proliferative synovitis is mainly responsible for the development of foot pathomechanics in RA.[22] This condition primarily affects the metatarsal phalangeal (MTP) joints, but also occurs at the talonavicular, subtalar, and tibiotalar joints.[22] Shrader provides an outline for a foot and ankle examination, which can be found in Appendix C.[22] Common deformities of the foot and ankle associated with RA include metatarsalgia, hallux valgus, claw and hammer toe deformities, corns, hallux rigidus, forefoot supinatus deformity, valgus rearfoot deformity, as well as structural and functional limb length discrepencies.[22] The gradual onset of foot and ankle deformities can create focal areas of high pressure and pain, making it difficult for patients to find comfortable, well-fitting shoe wear.[22] A physical therapist, knowledgeable in footwear design, fit, and prescription can help manage foot and ankle problems associated with RA.[22] The use of supportive footwear, shoe modifications, foot orthosis, and ankle-foot orthosis has been found to be beneficial for managing foot and ankle problems associated with RA.[22] In regards, to foot and ankle function, patient education should focus on "energy conservation, joint protection,

exercise, a basic understanding of normal and abnormal foot mechanics, and fit and function of footwear and foot orthosis."[22 (p. 715)]

Therapeutic exercise is an important component in the treatment of foot and ankle problems.[22] Common exercises prescribed for rehabilitation of the foot and ankle include strengthening of the foot intrinsic and posterior tibialis muscles and stretching the plantar fascia, Achilles, and fibularis muscle-tendon complex.[22] Active foot and ankle range of motion is often accomplished by having the patient write the alphabet with his/her foot.[22] Gentle toe extensor self-stretching may also help in delaying toe deformity onset or progression.[22] Aerobic conditioning should also be apart of an exercise program as well and this can be facilitated with various activities such as walking, dancing, cycling, etc.[22] Physical therapists will often have to modify exercise techniques to minimize the joint stresses imposed on joints proximal and distal to the target tissue.[22]

The use of splinting remains a common form of conservative therapy.[2] Splinting helps limit the progression of instability (e.g. an unstable MCP joint) and "reduces the stress on damaged and/or overstretched connective tissues."[2 (p. 510)] Additionally, splinting helps optimize alignment reducing onset or progression of deformities.[2] Splints can provide varying amounts of immobilization, facilitating rest and protection during periods of inflammation and pain, as excessive movement can cause damage to an inflamed joint.[2] In general splinting aims to reduce pain, improve the cosmetic appearance of instability, and improve function.[2] However, splinting for joint protection must be used cautiously when managing patients with RA because it can promote joint stiffness, one of the primary symptoms of RA.[15]

Another important component for joint protection is patient education. Teaching patients to modify activities that place stress on unstable joints is necessary for optimal joint protection.

Patients can benefit from instruction on altered movement patterns to use when performing everyday activities.[20] Patients should be instructed to limit the magnitude and duration of potentially harmful activities, alter the mechanics of how the activity is performed, or use an assistive device.[2] For example, in patients with unstable MCP joints, tightening a jar places ulnar deviation forces on the MCP joint.[2] Furthermore, vigorously ringing out a towel achieved with flexion of the fingers "places unnecessary flexion forces at the base of the proximal phalanges."[2 (p. 514)] Patient education has been shown to enhance the health status of patients with RA, in the form of decreased pain and disability.[20] With a chronic condition such as rheumatoid arthritis, it's important that clinicians promote self-efficacy and improved self-management of the disease.[20]

Exercise Prescription

Physical activity can help protect the joints through strengthening of the muscles and tissues surrounding the joints.[21] A physical activity program can help reduce pain and fatigue while also improving mobility and physical fitness.[21] The Arthritis Society recommends several different forms of exercise to help reduce joint pain and stiffness, these include: range of motion exercises, strengthening exercises, moderate stretching exercises, and endurance exercises.[21]

It's important that acute joint inflammation is controlled prior to exercise, since inflamed joints are more vulnerable to injury.[22] When only one or a few joints are inflamed, splinting or bracing can help protect the joints to allow for participation in exercise.[22] If the inflammation is difficult to control or when joint damage is severe, "gentle isometrics and a few repetitions of range of motion may be prescribed."[22 (p. 714)] Aquatic exercises are also effective in these cases. There are many that advocate that exercise treatment should be restricted to gentle range of

motion exercises during active rheumatoid arthritis (RA).[24] More conservative mode of exercise are usually employed due to the fear of enhancing joint inflammation and accelerating cartilage destruction. However, studies have shown that intense exercise can be valuable as long as the exercises don't increase the symptoms of RA.

Van den Ende et al. conducted a study that examined the consequences of intense exercise on disease activity in patients with RA.[24] All 64 patients in the study followed the conservative exercise program, which consisted of ROM and isometric exercises.[24] Patients in the intervention group also completed extra exercises that were performed in addition to the conservative exercises.[24] These exercises consisted of muscle strengthening of the lower and upper extremities.[24] Knee isometric and isokinetic strength was trained on an isokinetic dynamometer and shoulder musculature was isometrically trained against manual resistance.[24] In addition to muscular strengthening, patients cycled three times a week for 15 minutes on a home trainer.[24] The investigators add that there was a strict policy about "adjusting exercise load in cases of excessive pain and fatigue during and after exercise."[24 (p. 616)] The findings of the study demonstrated that an intensive exercise program is well tolerated by patients with active RA.[24] The patients in the intensive exercise program showed a significant improvement in muscle strength and on measures of physical function.[24] This study provided more insight regarding the intensity of exercises prescribed to patients with RA and demonstrated that intense exercises do not have deleterious effects on disease activity.[24]

Dynamic exercise is supported in the literature as an effective mode of exercise to help improve muscle strength and aerobic capacity in patients with RA. The findings of a systematic review concluded that this form of activity was not detrimental to disease activity or pain.[25] A more recent review conducted by Hurkmans et al. concluded that aerobic training and muscle

strength training is recommended in patients with RA.[12] The review looked at dynamic exercise interventions that met the following criteria: "exercise frequency of at least 20 minutes twice a week, duration of exercise program at least six weeks, exercise program performed under supervision, aerobic exercise intensity at least 55% of the maximum heart rate (or intensity starting at 40-50% of the maximum oxygen uptake reserve or HR max reserve), aerobic exercise intensity increased up to 85% during intervention, and progressive exercise strengthening starting at 30-50% and increasing to 80% of maximum."[12 (p. 5)] The 8 randomized controlled trials included in the review included dynamic exercise training program consisting of "short-term aerobic capacity training (land and water based), aerobic capacity training combined with muscle strength training (land based), and long-term aerobic capacity training combined with muscle strength training (land based)."[12 (p. 19)] The results of the review suggest that dynamic exercise programs (land based and water based) consisting of aerobic training have a positive impact on aerobic capacity after the intervention.[12] When the aerobic training was performed in water, a positive effect was observed for functional ability as well.[12] Dynamic exercise programs (long term and short term) that included both aerobic training and strength training had a positive influence on aerobic capacity and muscle strength.[12] Long term dynamic exercise programs that incorporated aerobic and strength training had a positive effect on functional ability.[12] It's important to note that again, no deleterious effects were found in any of studies included in the review, suggesting the dynamic land and water based exercise programs are safe for patients with rheumatoid arthritis.[12]

Long-term follow-up studies also indicate that intense exercise programs are safe for patients with rheumatoid arthritis. A follow-up study was conducted 18 months after patients with rheumatoid arthritis participated in a in a 2-year high-intensity exercise program (the

RAPIT study).[4] The Rheumatoid Arthritis Patients In Training (RAPIT) exercise program consisted of 1.25-hour exercise sessions that incorporated cycling, an exercise circuit, and sporting or games.[4] Participants who completed the 2-year program continued to demonstrate the functional gains they had made over the course of the exercise program.[4] Notably, participants who continued to exercise (with average, similar intensity and decreased frequency) had better aerobic fitness and functional ability, and lower disease activity than those who reported low intensity or no exercise.[4] The findings from the follow-up also found that the high-intensity exercise regimen did not cause detrimental effects on disease activity or radiological damage of large joints.[4]

Another study by Häkkinen et al. followed up with patients five years after a 2-year home based strengthening program.[8] The strengthening program targeted muscle groups of the arms (biceps curl, lateral pull down, forward single up-rise), legs (knee flexion and extension, hip extension and abduction, squats), and trunk (abdominal crunches and supine leg lifts, back hyperextension in prone position).[8] Resistance was provided by body weight, rubber bands, and dumbbells.[8] The subjects were instructed to exercise "twice a week with moderate loads (50-70% of repetition maximum), two sets for each exercise, and 8-12 repetitions per set."[8 (p. 911)] Subjects in the control group performed range of motion and stretching exercises for the upper and lower extremities twice a week.[8] In addition, all subjects were encouraged to perform aerobic activities 2-3 times per week.[8] The study showed that regular physical exercise can lead to long-term increases in muscle strength in patients with RA.[8] There were larger strength gains in the intervention group that performed the strengthening program twice a week.[8] Bone mineral density (assessed at the femoral neck and lumbar spine) remained constant throughout the study,

and radiographs indicated that even at 5 years, joint damage remained low, indicating the strength training is not detrimental to disease activity.[8]

Jahanbin et al. conducted a clinical trial to investigate the effects of conditioning exercises on the health status and pain in patients suffering from RA.[14] Sixty-six women were included in the study and were randomized into two groups, an exercise intervention group and a control group.[14] The exercise intervention group participated in a variety of exercises including aerobic, isometric, and isotonic exercises.[14] The researchers found a statistically significant difference in the between-group comparison of the experimental groups.[14] Individuals in the exercise intervention group also had decreased pain scores when compared to the control group.[14]

A systematic review by Cairns and McVeigh presents a well-organized summary of findings on the effects of dynamic exercises on patients with RA.[3] The review includes quality randomized controlled trials that assessed interventions that included any form of dynamic physical exercise including aerobic exercise, strength training, or a combination of the two.[3] The studies included in the review present findings that suggests that dynamic exercise positively influences a variety of outcomes including aerobic capacity, VO_2 max, pain, muscle strength and endurance.[3] Of the seventeen studies included in the review, none of them reported negative outcomes for function, disease activity, or aerobic capacity in intervention groups using dynamic exercises.[3]

Rheumatoid arthritis places individuals at an increased risk of osteoporosis. Evidence indicates that exercise has little affect on bone mineral density in patients with rheumatoid arthritis.[19,27] Madsen et al. concluded that the effect on of exercise on bone mineral density might become more substantial if maintained over a number of years.[19] De Jong et al. analyzed data

from the RAPIT trial to determine whether a long-term, high intensity, weight bearing exercise program has an effect on bone mineral density.[5] Researchers found small changes in bone mineral density at the spine and hip over two years in both the control and exercise intervention groups.[5] The results of the study found a smaller mean rate of decrease in hip bone mineral density in the patients participating in the high-intensity exercise program.[5] The change in hip bone mineral density was associated with both muscle strength and aerobic fitness.[5] Although strong evidence linking physical exercise to improvements in bone mineral density is lacking in this patient population, findings suggest that weight bearing exercises slow down bone loss of the hip and correlations of aerobic fitness and muscle strength to improved bone mineral density suggest that physical activity may have a positive impact on bone health in patients with rheumatoid arthritis.[5]

In conclusion, as with any exercise program, it must be tailored to meet the individual's needs and monitored for potentially adverse reactions. An exercise program for patients with RA must take into consideration the degree and severity of the disease, joint involvement, and the presence of other comorbidities. There are numerous health benefits associated with exercise and physical activity in patients with RA, but programs should be individually tailored for each patient to promote the overall health and safety of the individual.

References:

1. Barton A, Worthington J. Genetic susceptibility to rheumatoid arthritis: an emerging picture. *Arthritis Rheum.* 2009;61(10):1441-1446.
2. Bielefeld T, Neumann DA. The unstable metacarpophalangeal joint in rheumatoid arthritis: anatomy, pathomechanics, and physical rehabilitation considerations. *J Orthop Sports Phys Ther.* 2005;35(8):502-520.
3. Cairns AP, McVeigh JG. A systematic review of the effects of dynamic exercise in rheumatoid arthritis. *Rheumatol Int.* 2009;30(2):147-158. doi: 10.1007/s00296-009-1090-5.
4. de Jong Z, Munneke M, Kroon HM, et al. Long-term follow-up of a high-intensity exercise program in patients with rheumatoid arthritis. *Clin Rheumatol.* 2009;28(6):663-671. doi: 10.1007/s10067-009-1125-z.
5. de Jong Z, Munneke M, Lems WF, et al. Slowing of bone loss in patients with rheumatoid arthritis by long-term high-intensity exercise: results of a randomized, controlled trial. *Arthritis Rheum*. 2004;50(4):1066–1076. doi:10. 1002/ art. 20117
6. Gibofsky A. Epidemiology, pathophysiology, and diagnosis of rheumatoid arthritis: a synopsis. *Am J Manag Care.* 2014;20(7 Suppl):S128-135.
7. Gibofsky A. Overview of epidemiology, pathophysiology, and diagnosis of rheumatoid arthritis. *Am J Manag Care.* 2012;18(13 Suppl):S295-302.
8. Häkkinen A, Sokka T, Kautiainen H, et al. Sustained maintenance of exercise induced muscle strength gains and normal bone mineral density in patients with early rheumatoid arthritis: a 5 year follow up. *Ann Rheum Dis.* 2004;63(8):910-916.

9. Handout on Health: Rheumatoid Arthritis. Bethesda, Maryland: National Institute of Arthritis and Musculoskeletal and Skin Diseases, National Institutes of Health, 2013.
10. Heine PJ, Williams MA, Williamson E, et al. Development and delivery of an exercise intervention for rheumatoid arthritis: strengthening and stretching for rheumatoid arthritis of the hand (SARAH) trial. *Physiotherapy.* 2012;98(2):121-130. doi: 10.1016/j.physio.2011.03.001.
11. Helmick CG, Felson DT, Lawrence RC, et al. for the National Arthritis Data Workgroup. Estimates of the Prevalence of Arthritis and Other Rheumatic Conditions in the United States. Part I. *Arthritis Rheum* 2008;58(1):15-25. doi: 10.1002/art.23177.
12. Hurkmans E, van der Giesen FH, Vliet Vlieland, et al. Dynamic exercise programs (aerobic capacity and/or muscle strength training) in patients with rheumatoid arthritis. *Cochrance Database Syst Rev.* 2009;4:CD006853. doi: 10.1002/14651858.CD006853.pub2.
13. Jacobs P, Bissonnette R, Guenther LC. Socioeconomic burden of immune-mediated inflammatory diseases--focusing on work productivity and disability. *J Rheumatol Suppl*. 2011;88:55-61. doi: 10.3899/jrheum.110901.
14. Jahanbin I, Hoseini Moghadam M, Nazarinia MA, et al. The effect of conditioning exercise on the health status and pain in patients with rheumatoid arthritis: a randomized controlled clinical trial. *Int J Community Based Nurs Midwifery.* 2014;2(3):169-176.
15. Jonas B. October 2, 2013. Rheumatoid Arthritis. Class lecture at UNC. Chapel Hill, NC.
16. Karlson EW, Chang SC, Cui J, et al. Gene-environment interaction between HLA-DRB1 shared epitope and heavy cigarette smoking in predicting incident rheumatoid arthritis. *Ann Rheum Dis.* 2010;69(1):54-60. doi: 10.1136/ard.2008.102962.

17. Lamb SE, Williamson EM, Heine PJ, et al. Exercises to improve function of the rheumatoid hand (SARAH): a randomized controlled trial. *Lancet.* 2014; S0140-6736(14)60998-3. doi: 10.1016/S0140-6736(14)60998-3.
18. Ma VY, Chan L, Carruthers KJ. Incidence, prevalence, costs, and impact on disability of common conditions requiring rehabilitation in the United States: stroke, spinal cord injury, traumatic brain injury, multiple sclerosis, osteoarthritis, rheumatoid arthritis, limb loss, and back pain. *Arch Phys Med Rehabil.* 2014;95(5):986-995. doi: 10.1016/j.apmr.2013.10.032.
19. Madsen OR, Sorensen OH, Egsmase C. Bone quality and bone mass as assessed by quantitative ultrasound and dual energy x-ray absorptiometry in women with rheumatoid arthritis: relationship with quadriceps strength. *Ann Rheum Dis.* 2002;61:325-329.
20. Masiero S, Boniolo A, Wassermann L, et al. Effects of an educational-behavioral joint protection program on people with moderate to severe rheumatoid arthritis: a randomized controlled trial. *Clin Rheumatol.* 2007;26(12):2043-2050.
21. Rheumatoid Arthritis. *The Arthritis Society.* Available at: http://www.arthritis.ca/page.aspx?pid=982. Accessed December 2, 2014.
22. Shrader JA. Nonsurgical management of the foot and ankle affected by rheumatoid arthritis. *J Orthop Sports Phys Ther.* 1999;29(12):703-717.
23. Silman AJ, Pearson JE. Epidemiology and genetics of rheumatoid arthritis. *Arthritis Res.* 2002;4(Suppl 3):S265-S272.
24. Van den Ende CH, Breedveld FC, le Cessie S, et al. Effect of intensive exercise on patients with active rheumatoid arthritis. *Ann Rheum Dis.* 2000;59(8):615-621.

25. Van den Ende CH, Vliet Vlieland TP, Munneke M, et al. Dynamic exercise therapy in rheumatoid arthritis: a systematic review. *Br J Rheumatol.* 1998;37(6):677-687.

26. Van Vollenhoven RF. Sex differences in rheumatoid arthritis: more than meets the eye. *BMC Med.* 2009;7:12. doi: 10.1186/1741-7015-7-12.

27. Westby MD, Wade JP, Rangno KK, et al. A randomized controlled trial to evaluate the effectiveness of an exercise program in women with rheumatoid arthritis taking low dose prednisone. *J Rheumatol.* 2000;27(7):1674-1680.

Appendix A.

Table 1. Comparison of Historical and Current Classification Criteria for RA[7,8]

	1987 Criteria[7]		2010 Criteria[8]	
Criteria	**Description**	**Score**	**Description**	**Score**
Morning stiffness	In and around joints, for at least 1 hour	1	Clinical synovitis/swelling in at least 1 joint not explained by another disease	NA
Joint involvement	Physician observed soft tissue swelling or fluid in 3 of 14 possible joints	1	1 large joint 2-10 large joints 1-3 small joints (with or without large joint) 4-10 small joints (with or without large joint) >10 joints (at least 1 small)	0 1 2 3 5
Arthritis of hand joints	At least 1 swollen hand or wrist area	1	NA	NA
Symmetric arthritis	Simultaneous bilateral involvement	1	NA	NA
Rheumatoid nodules	Subcutaneous nodules over bony prominences, extensor surfaces, or in juxtaarticular regions observed by physician	1	NA	NA
Serology	Positive RF serum test	1	Negative RF and negative ACPA Low-positive RF or ACPA High-positive RF or ACPA	0 2 3
Radiographic changes	Erosions or unequivocal bony decalcification in or adjacent to the involved joints, but not consistent with osteoarthritis	1	NA	NA
Acute phase reactants	CRP and ESR	NA	Normal CRP and ESR Abnormal CRP or ESR	0 1
Duration of symptoms	First 4 criteria must be present for at least 6 weeks	NA	<6 weeks ≥6 weeks	0 1
Criteria score required		≥4/7		≥6/10

ACPA indicates anti-citrullinated protein antibody; CRP, C-reactive protein; ESR, erythrocyte sedimentation rate; NA, not applicable; RF, rheumatoid factor.

Appendix B

MCP flexion

Finger abduction

Tendon gliding

Wrist circumduction

Combined shoulder & elbow ROM

Radial walking

Eccentric wrist extension

Finger pinch

Gross grip

Finger adduction

Appendix C.

TABLE 3. Foot and ankle examination outline.

Non–weight-bearing tests and measures

Inspection/Palpation

- Temperature, swelling, erythema, skin integrity, color, right–left foot shape symmetry[20]
- Identification of forefoot deformities
- Palpation for effusion and pain of each foot joint with emphasis on metatarsal phalangeal, talonavicular, subtalar, and ankle joints (Figure 4). Important to differentiate between true ankle joint involvement and subtalar involvement
- Lateral compression test used for assessment of forefoot disease activity but must also rule out neuroma and bunion or bunionette pain (Figure 4)
- Soft tissue palpation of posterior tibialis, peroneal, Achilles, and extensor digitorum longus tendons and sheaths and plantar fascia

Pain

- Critical baseline measure frequently used to guide treatment and assess its effectiveness; brief pain inventory[7] provides small body charts to identify multiple sites. Ten questions to relate pain to functional activities, mood, sleep, recreation, etc

Sensation

- Semmes Weinstein monofilament testing[1,49] indicated with orthoses prescription

Selective tissue tensioning

Manual muscle testing

Structural limb length discrepancy

- Left–right measurement difference must be compared with functional limb length measurement difference; procedure described by Fromherz[17] and Gross[21]

Intrinsic foot deformities

- Criticized for poor validity and reliability[42]
- Identify presence or absence with qualitative descriptions of mild, moderate, severe; procedure described by Root[61]

Range of motion[17, 20]

- First metatarsal phalangeal extension from non–weight-bearing. Isolated ankle range of motion, with knee flexed and extended, without allowing calcaneal eversion, which will give ankle joint credit for more sagittal plane motion than it actually has; calcaneal eversion and inversion

Additional orthopedic testing for proximal structures

- Hip and knee strength testing and range of motion
- Identify tight hip internal rotators[17]
- Knee stability testing
- Other special tests frequently included based on history and subjective complaints

Weight-bearing tests and measures

Postural alignment

- Described by Fromherz[17]; resting calcaneal stance position for measurement of calcaneal valgum and first metatarsal phalangeal joint extension[17,23]
- Navicular drop test[23,55] primarily used as qualitative measure of excessive midfoot pronation

Plantar pressure distribution

- Podoscope[17] (Figure 5) or inked foot impinter[67] provides valuable qualitative plantar pressure information

Functional limb length discrepancy[17,23]