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13. ABSTRACT *(Maximum 200 words)*

The objective of this prospective cohort study is to develop predictive models for stress fractures and other overuse musculoskeletal injuries seen in female military trainees. Subjects are USMC female recruits reporting to MCRD, Parris Island, for boot camp. Prior to training, all subjects complete a baseline questionnaire addressing exercise and lifestyle history. A subset of subjects has anthropometric measurements and bone structural analysis performed using a dual energy x-ray absorptiometry (DEXA) scanner, a noninvasive commercial bone mineral scanning system. Recruits are followed prospectively through 13 weeks of basic training. Injuries are documented by medical review and an on-site outpatient computer tracking system. Progress includes: human use approval; hiring and training of on-site staff; and development of questionnaire, measurement, and DEXA procedures. Since March 1995, 800 of the 894 female recruits reporting to MCRD, Parris Island, have been enrolled. Following installation of the DEXA scanner in June 1995, the last 100 subjects also had scans. At the current enrollment rate, the required sample size of subjects will be realized by third quarter FY96. It is anticipated that study results will guide the design and implementation of preventive interventions to reduce the occurrence and cost of injuries and attrition in female Marine recruits.

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FOREWORD

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R.A. Sheff 8/22/95

PI - Signature Date

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INTRODUCTION

Stress fractures cause significant morbidity during recruit training, particularly in elite programs requiring intense physical conditioning such as the U.S. Marine Corps.[1-3] Estimates of the incidence of stress fractures in female military training populations range from as high as 34% to as low as 1.1%.[4-12] Recent information from Marine Corps Recruit Depot (MCRD), Parris Island, indicates that women suffer lower extremity stress fractures during basic training at a rate of 3.8%.[13] Further, discussion with Recruit Training Regiment staff indicates an increase in pelvic stress fractures in women as high as 15% during the end of 1993 and the beginning of 1994.

Stress fractures, which occur predominantly in the lower extremity, are believed to result from bone structural failure caused by repetitive weight-bearing loads. Weight-bearing under training regimens subjects bones to repetitive axial compression, torsion, and bending stresses.[14] Within a bone subject to a given load, stress magnitudes are determined by bone structural geometry, while the bone's ability to resist these stresses is defined by bone material properties.[15,16] Since bone material properties are much less variable than structural geometry, it is likely that most of the individual differences in bone strength can be explained by geometry.[17]

For a given long bone, the most important geometric properties are the cross-sectional area (CSA) and, for bending in a plane, the cross-sectional moment of inertia (CSMI). These structural properties in the long bones of the lower extremity are known to vary with age and sex in the human. For example, previous work by Drs. Beck and Ruff suggests that sex differences in elderly fracture rates may relate to the ability of aging bone to alter the CSMI to compensate for increased mechanical stresses due to bone loss in osteoporosis.[18] Evidence also exists that bone is structurally remodeled to minimize stresses in limbs subjected to increased loads over shorter time scales; moreover, these changes are evident in the cross-sectional properties.[19]

One might hypothesize that stress fractures in military recruits subjected to intense exercise results from stress levels that exceed the short-term remodeling capacity of the bone. Knowledge of structural geometry should enable us to estimate bone strength and thus, susceptibility to stress fracture. Not surprisingly, Giladi[20] and colleagues in a prospective study of 295 Israeli infantry recruits showed that those with narrow tibias had higher stress fracture rates than those with wider tibias. Bone width is mathematically related to the CSMI, and hence an index of strength in bending and torsion. Later work by the same group[21] confirmed that stress fractures are best predicted by measurement of the tibial CSMI.

Work in progress at MCRD, San Diego, by this collaborative group has developed a predictive model for musculoskeletal injury in male recruits. A number of intrinsic risk factors have shown promise for predicting stress fracture susceptibility in male recruits. The preliminary analysis of these risk factors indicates that as much as 60% of incident stress fractures during training can be predicted based on a profile composed of various measures of body structure, fitness, injury history, and exercise history. Many of the factors in this profile can be targeted for modification, which can then reduce stress fractures during training. For example, the data indicate that if male recruits were to exercise for physiological benefit more than twice a week for at least two months prior to arrival at MCRD, lower extremity stress fractures could be reduced by 44% during basic training. A number of other factors are proving to be involved that can either be modified or used to indicate a need for further physical training before a recruit begins Training Day 1. One, therefore, can clearly hypothesize that similar models, profiles, and modifications can be developed for females.

Ongoing research by Beck, et al., has involved a method to determine bone strength in vivo, based on bone structural geometry and cross-sectional properties derived from bone mineral scan data.[22] In Milgrom's[21] study of Israeli infantry recruits, the CSMI was estimated in a laborious fashion using caliper measurements of cortical width on radiographs, with the assumption of an idealized shape for the tibial cross-section. We have developed an automated, reproducible measurement of the CSMI of any long bone using a technique that is rapid, and, unlike the work of Milgrom et al., does not make assumptions about bone cross-sectional shape. We will also measure the CSA, which is an index of bone strength in axial compression and shear, as well as of the bone width.

Measurements are made from data acquired with an unmodified commercial dual energy x-ray absorptiometry (DEXA) scanner. Scans take approximately 2 to 10 minutes per location, depending on the size of the scanned region. Radiation dose is extremely low (on the order of a few millirads); scanned regions in the extremities of adults do not contain radiation-sensitive tissues, thus repeated examinations are ethically justified. The instrument is approximately the size of an x-ray table, with an adjacent computer console. Because radiation levels outside the direct beam are negligible, the system does not require a shielded room. The scanner as well as the data files are unmodified, so both are also available for the conventional bone mineral analyses.

The general objective of this study is to derive predictive models of stress fracture susceptibility in female military personnel by use of noninvasive measurements of bone structure acquired with a DEXA scanner. These data are to be coordinated with epidemiological data in planning strategies for the prevention of overuse injuries among susceptible Navy and Marine Corps personnel. This study intends to determine if computed bone strength measurements can reliably predict susceptibility to stress fractures in women. The most appropriate measurement locations for quick screening will be determined, and the structural weakness of the bones examined. In a later phase, researchers will study the association of rigorous physical conditioning to the rates and magnitudes of improvements in the structural rigidity of long bones. A secondary objective of this study is to examine the ability of absorptiometric methodology in the detection of early reactive changes in bone, leading to the development of a stress fracture.

METHODS

The study involves the scanning of recruits using a commercial bone mineral scanning system and the collection of individual characterization data that might influence fracture susceptibility. The two phases of the study are a prospective phase and a bone remodeling phase. The goal of the prospective study is to gather data to allow an examination of the statistical relationships between stress fracture incidence and initial bone geometry. The effects of ethnicity, beginning physical fitness, height, weight, and other characterization parameters are also being examined.

The main purpose of this phase will be to determine the specific effects of training on bone structural geometry. In other words, to determine how and to what extent the weight-bearing bones of recruits remodel to adapt to the increased loading effects of training.

Study Population

We are enrolling approximately 800 female Marine Corps recruits from MCRD, Parris Island, between the ages of 17 and 30 into the study. Subject recruits will be followed through the training period to determine cases of injury. All stress fractures among subjects are routinely confirmed either radiographically or scintigraphically, according to standard case definitions. The numbers, locations, time of onset of symptoms, disposition of subject, and other indicated parameters will be recorded.

Enrollment Procedures

All procedures are scheduled, without interference, during the first four days of the recruits' medical processing prior to the commencement of training. The Information to Participants, California Experimental Subject's Bill of Rights, consent form, and questionnaire are administered on the first day of medical processing and require approximately 30 minutes to complete. The questionnaire addresses recent physical activity and running practices, motivational factors, previous injuries, and tobacco and alcohol use. Scanning and anthropometric measurements take place on processing days two to four and require approximately 20 to 30 minutes for completion.

Subjects are enrolled at a rate of approximately 50 to 70 subjects per week. Subject enrollment and follow-up through training should be completed in 10 months, but may be prolonged if stress fracture incidence is lower than expected. For each subject, physical fitness and characterization data will be recorded, lower extremity dimensions measured, and each subject's right leg scanned at the distal third of the tibia ("boot-top height") and at midfemur.

Measurements

We will perform anthropometric measurements of the lower extremities to assess anatomical and mechanical variations. All analyses of results will be reported in aggregate form, without the identification of individuals. Access to individual records will be strictly limited to project staff with a need to know. Individual records will be protected by advanced computer security methods employing multilevel password entry.

Scanning will involve a small amount of ionizing radiation (x-rays). Each scan will involve exposure to radiation equivalent in quantity to less than that received from normal background sources in one month (5 to 10 mrem). Depending on the study phase, participants may receive anywhere from 1 to 10 scan sets (each set consisting of four small region scans). The total radiation exposure equivalent (Effective Dose Equivalent) from a maximum of 10 scan sets to the tibia will amount to less than one year's natural background radiation (< 100 mrem).

Outcome Data

All subjects are followed throughout basic training for outcomes of injury, including stress fracture, and graduation versus attrition. Stress fracture data for the prospective phase are collected by review of each subject's medical record at the completion of training or at the time of separation from the Marine Corps. Data extracted from the record includes date of visit, onset of injury, site of injury, specific final diagnoses, and the nature and duration of restricted duty due to injuries. Stress fracture is defined as partial or complete fatigue fracture of insidious onset in nondiseased bone. Diagnosis of stress fracture is defined as partial or complete fatigue fracture of insidious onset in nondiseased bone. Diagnosis of stress fracture is based on (1) clinical presentation of localized pain of insidious onset, without prior acute trauma, aggravated by repetitive weight-bearing activities and relieved with rest; and (2) a confirmatory (+) radiograph and/or (+) bone scan at a site consistent with clinical presentation. A (+) radiograph is defined as presence of periosteal reaction, endosteal callus formation, and/or a fracture line in otherwise normal bone. A positive bone scan is defined as the presence of 3+ to 4+ intensity localized fusiform uptake at the site of pain.

In the bone remodeling phase, subjects will be followed with serial scan data. A random sample of 100 subjects will be enrolled in the bone remodeling phase at the rate of approximately 20 per week. Subjects will be characterized as in the pilot; however, scanning will occur at enrollment and at biweekly intervals over the 13-week training period. Analysis will concentrate on the relationships between quantitative measures of physical condition, lower extremity anatomy, the timing of specific phases of the training program, and rates of change in bone structure as well as computed indices of bone structural strength. This information will be critical in the interpretation of clinical data and in the design of intervention programs.

No individuals will be (or have been) excluded from this study. In all phases, recruits will be enrolled without coercion and with informed consent.

RESULTS

The progress to date for this project has included: (1) development and approval of a human use protocol for the enrollment of the recruit volunteers; (2) the hiring and training of 4 research assistants on-site in Parris Island; and (3) development of the questionnaire, measurement procedures, and DEXA protocols. Since MCRD processes incoming female recruits for basic training every 2 to 3 weeks, enrollment procedures are done in high volume cycles with approximately 75 to 100 women enrolled over each 3- to 4-day processing period. Staff have been hired through a number of mechanisms, which has allowed the enrollment of the maximum number of subjects during these high-intensity times. During each enrollment period, an investigator is on-site to oversee the process. Close collaboration with 4th Battalion Recruit Training Regiment staff has resulted in a high-precision, "no interference" enrollment process.

Enrollment of female recruits began on 28 March 1995. Although contracting delays had prevented the DEXA scanner from arriving on site at that time, the decision was made to begin enrolling recruits with informed consent, the questionnaire, and anthropometric measurements. During this time, on-site research staff administered to all consenting volunteers, the self-report questionnaire. Throughout the remainder of the recruits' first week at Parris Island, anthropometry was performed on as many of these volunteers as the recruit processing schedule allowed. These modified enrollment procedures continued until 27 June 1995 when the DEXA scan protocol was added to the enrollment procedures at the same time as the anthropometry was performed.

From 28 March to 1 August 1995, 734 female recruits arrived at MCRD, Parris Island, to begin basic training, and 688 of these recruits volunteered to participate in this study. All 688 females completed the questionnaire, of which, 464 also were measured according to the anthropometry protocol. Following the installation of the DEXA scanner in June 1995, the final 100 of these subjects also had a DEXA scan performed. Based on the enrollment experience to this point, and expected further refinement of enrollment procedures, 60 to 70% of all females arriving for basic training can be enrolled with questionnaire, anthropometric, and DEXA scan data. At this expected rate of enrollment the required sample size of 800 subjects with DEXA scan data can be realized by the second or third quarter of FY96.

Initiation of the study enrollment prior to the installation of the DEXA scanner has achieved numerous goals, including: (1) refinement of subject enrollment procedures such that they are smoothly integrated into the MCRD process for long-term subject recruitment; (2) establishment of a large cohort of women undergoing U.S Marine Corps basic training, which can be used to determine detailed rates and the impact of specific disease and injury diagnoses; and (3) an increase in the cohort size for greater statistical power in calculating risk profiles for stress fracture based on questionnaire data.

CONCLUSIONS

The impact of stress fractures in military training and operational populations is significant. Although stress fractures are not the most prevalent injury in these groups, the cost of each occurrence is high. Recent data in male recruits at MCRD, San Diego, show that with an incidence rate of 3.7%, the cumulative costs of stress fractures are $12 million annually, with an associated readiness cost of greater than 53,000 lost training days.[13] In a study of intrinsic risk factors for injury during training, gender was associated with training injuries, and other[11] studies have documented women to be at greater risk of musculoskeletal injury during military training than are men.[4-12] Stress fracture risk has been reported to be 2 to 12 times that of men in similar training situations.

The current study proposes to precisely determine the incidence rates, fiscal and readiness costs, and predictive profiles for stress fractures in female Marine recruits. The progress to date has shown this to be a highly feasible study with voluntary enrollment exceeding 85% of all incoming female recruits. Continuation of the study through FY96 is critical to achieving the primary study objectives. An identical study in male recruits has been in progress at MCRD, San Diego, for 3 years and has resulted in preventive interventions that have significantly reduced the incidence of stress fractures with an estimated cost savings in excess of $4 million per year. In addition, the bone geometry information has proved very successful in predicting stress fractures in men.

This is a high-visibility program that required briefings at the Commanding General level for Marine Corps approval and initiation. It also has required close collaborative interaction with the operational community at Parris Island. Early termination of the program prior to determination of the primary study objectives may have a negative impact for future operational research with the Marine Corps. Since the incidence of stress fractures in female Marine recruits is higher and the injuries are more severe, it is anticipated that the impact of this study may be more significant in terms of ultimately lowering injury rates and fiscal costs. Finally, the findings of this study are particularly critical given the anticipated increase of the female Marine physical fitness test standard.

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Female Recruit Prospective Questionnaire (Rev. 6/28/95)

PRIVACY ACT STATEMENT: Authority - 5 USC 301. Information will be collected to enhance basic medical knowledge and aspects of clinical preventive services for research purposes only. Participation is voluntary. No rights or benefits will be affected by nonparticipation.

Your answers to the following questions will be used for the purpose of scientific research and will be read by the research staff only. Your answers will not be used for disciplinary purposes, nor will your answers affect your military training in any way.

PLEASE READ ALL DIRECTIONS AND QUESTIONS CAREFULLY.

ANSWER THE FOLLOWING QUESTIONS AS THEY APPLY TO YOU OR YOUR LIFESTYLE DURING THE 2 MONTHS BEFORE COMING TO PARRIS ISLAND (unless otherwise specified). ANSWER ALL QUESTIONS BY CIRCLING THE APPROPRIATE ANSWER AND/OR FILLING IN THE BLANK(S).

IT IS VERY IMPORTANT YOU ANSWER ALL QUESTIONS HONESTLY AND COMPLETELY, to the best of your recollection. Research staff are available to assist you. WE APPRECIATE YOUR TIME AND CARE IN COMPLETING THIS QUESTIONNAIRE.

1. Are you pregnant or do you THINK you might be pregnant?

   1 - No   2 - Yes

2. Social security number: _ _ _ - _ _ - _ _ _ _

3. Full name:
   - 3a. Last name: ____________
   - 3b. First name: ____________
   - 3c. Middle initial: __

4. Today's date: _ _ - _ _ - _ _ (year month day)

5. Platoon number: _ _ _ _

6. Handedness (circle one): 1 - Left   2 - Right

7. Shoe size: _ _ . _

8. In your exercise or leisure activities, how often do you "work up a good sweat?" (circle one answer)

1	2	3	4	5
Never	Occasionally	Fairly often	Quite a lot	Most or all the time

9. How intensely do you usually exercise? (circle one answer)

   0 - I don't usually exercise
   1 - Very leisurely - breathing easy, as during a slow walk
   2 - Leisurely - breathing and effort slightly greater than a slow walk
   3 - Average - breathing increased but not uncomfortable
   4 - Intense - breathing hard, have to 'push' to keep going
   5 - Very Intensely - breathing labored, difficult to keep going

10. Compared to others your same age and sex, how would you describe your overall physical activity before reporting to PARRIS ISLAND?
    1 - Inactive
    2 - Not very active
    3 - Average
    4 - Fairly active
    5 - Very active

11. How would you rate your current physical fitness compared to others your same age and sex? (circle one answer)

1	2	3	4	5
Poor	Fair	Good	Very good	Excellent

12. During the **LAST 2 MONTHS** before reporting to PARRIS ISLAND, how often did you exercise or play sports? (circle one answer)

0 - Never
1 - 1 time or less per week
2 - 2 times per week
3 - 3 times per week
4 - 4 times per week
5 - 5 times per week
6 - 6 times per week
7 - 7 or more times per week

13. In the 2 **MONTHS** prior to reporting to PARRIS ISLAND, on average, how intensely did you participate in sports or strenuous labor?

0 - None, I did not participate in sports or strenuous labor.
1 - Very leisurely - breathing easy, as during a slow walk
2 - Leisurely - breathing and effort slightly greater than a slow walk
3 - Average - breathing increased but not uncomfortable
4 - Intense - breathing hard, have to 'push' to keep going
5 - Very intense - breathing labored, difficult to keep going

14. How did your level of exercise or sports participation change in the **LAST 2 MONTHS** before reporting to PARRIS ISLAND; compared to your usual level in the previous year? (circle one answer)

1 - **Much less** exercise in the last 2 months
2 - **Less** exercise in the last 2 months
3 - **About the same** amount of exercise in the last 2 months
4 - **More** exercise in the last 2 months
5 - **Much more** exercise in the last 2 months

15. What were the most common sports or types of strenuous labor that you participated in, other than running/jogging? Please write in "1" for the most frequent, "2" for the second most frequent and "3" for the third most frequent. If there were none, please check the first line, "None".

Also, please tell us how many years of VARSITY level participation you have had in any of the sports. Include HIGH SCHOOL and COLLEGE participation. Please read all before answering.

Rank		Varsity Participation
____	None, I did not participate in sports or strenuous labor.	
____	Basketball	1A - ____(years)
____	Football	2A - ____(years)
____	Baseball/Softball	3A - ____(years)
____	Hockey	4A - ____(years)
____	Field Hockey	5A - ____(years)
____	Track (running events)	6A - ____(years)
____	Track (field events)	7A - ____(years)
____	Volleyball	8A - ____(years)
____	Soccer	9A - ____(years)
____	Lacrosse	10A - ____(years)
____	Cross Country	11A - ____(years)
____	Rowing	12A - ____(years)
____	Gymnastics	13A - ____(years)
____	Swimming	14A - ____(years)
____	Wrestling	15A - ____(years)

____ Racket Sports 16A - ____(years)
____ Aerobics 17A - ____(years)
____ Walking 18A - ____(years)
____ Rugby 19A - ____(years)
____ Bicycling 20A - ____(years)
____ Tennis 21A - ____(years)
____ Roller Blading 22A - ____(years)
____ Weight Lifting 23A - ____(years)
____ Farming
____ Furniture moving
____ Construction
____ Other Sports (please specify sports): ____________
27A - ____(years)
____ Other types of strenuous labor(please specify sports): ____________
28A - ____(years)

Questions #16-19 refer to running or jogging as a separate and distinct activity. Do not include running or jogging during another kind of sports activity unless you consistently ran or jogged to warm-up or train for that activity.

16. During the 2 MONTHS BEFORE coming to PARRIS ISLAND, on average, how many times per week did you run or jog?
0 - Never
1 - 1 time or less per week
2 - 2 times per week
3 - 3 times per week
4 - 4 times per week
5 - 5 times per week
6 - 6 times per week
7 - 7 or more times per week

17. If you ran or jogged during the LAST 2 MONTHS, for how long in total had you been CONSISTENTLY (2 or more times per week) running or jogging before coming to PARRIS ISLAND? (circle one answer) (*If you did not run or jog during the last 2 months, circle "0".)

0 - Does not apply. I did not run or jog during the 2 months before coming to PARRIS ISLAND.
1 - 1 month or less
2 - 2 months
3 - 3 months
4 - 4-6 months
5 - 7-11 months
6 - 1 year or more

18. During the 2 MONTHS BEFORE coming to PARRIS ISLAND, how far did you usually run or jog per workout? (*If you did not run or jog during the last 2 months, circle "000".)

__ __ . __ __ (number of) miles
000 - I did not run or jog during the 2 months before coming to PARRIS ISLAND.

19. During the 2 MONTHS BEFORE coming to PARRIS ISLAND, how much time did it usually take you to complete a single running or jogging workout? (*If you did not run or jog during the last 2 months, circle "000".)

__ __ __ minutes
000 - I did not run or jog during the 2 months before coming to PARRIS ISLAND.

20. On days, that you participated in sports or strenuous labor activities, on average, how many minutes did you participate in sports or strenuous labor activities?

__ __ __ average number of minutes of sports or strenuous labor.

000 None, I did not participate in sports or strenuous labor.

21. In your life, have you ever injured bone, muscle, tendon, ligament, and/or cartilage in one or both of your lower limbs (hip to toe)? (for example, broken bone, pulled muscle, tendinitis, sprain or strain, tear, stress fracture) (circle one answer)

1 - No [if NO then also circle "0" for questions 22 and 23]
2 - Yes

22. Did any of these injuries prevent you from fully participating in your normal physical activities for at least a week? (*If you have never been injured, circle "0".) (circle one answer)

0 - Does not apply (I have never injured bone, muscle, tendon, ligament or cartilage in one or both of my lower limbs.)
1 - No
2 - Yes

23. Following these injuries, were you able to return to 100% of the level of physical activity you had maintained prior to the injury? (*If you have never been injured, circle "0".) (circle one answer)

0 - Does not apply (I have never injured bone, muscle, tendon, ligament or cartilage in one or both of my lower limbs).
1 - No, as a result of at least one injury, I have never been able to perform at 100% of the level of physical activity I had maintained before I was injured.
2 - Yes, I have been able to return fully (100%) to the level of physical activity I had maintained before I was injured.

24. In your life, have you ever been told by a medical provider that you had a stress fracture in one or both of your lower limbs (hip to toe)? (circle one answer)

1 - No [go to question #25]
2 - Yes, please specify:
    a. How many total stress fractures have you had? ____

    b. How long ago did the most recent stress fracture occur?
    ____ months/years (circle either months or years)

    c. In what location(s) have you had a stress fracture? (circle all that apply)
        1 - Hip
        2 - Upper leg (below hip, above knee)
        3 - Knee
        4 - Lower leg (below knee, above ankle)
        5 - Ankle
        6 - Foot

    d. Were you able to return to 100% of the level of physical activity you maintained prior to any of these stress fractures?
        1 - No, I have never been able to perform at 100% of my previous level of physical activity.
        2 - Yes, I have been able to return fully (100%) to my previous level of physical activity.

25. Have you had a heat injury before coming to PARRIS ISLAND?

1 - No
2 - Yes - specify year:
    The year was 19____.

26. Have you ever had a urinary tract infection (UTI, infection of bladder or kidneys)? For women, this does not include vaginal infections like yeast, trich, etc.

1 - No 2 - Yes

27. Have you ever had a wound infection (infection in a cut or surgical wound)?

1 - No 2 - Yes

28. Have you ever had an infection of your uterus or uterine tubes (sometimes called PID or pelvic inflammatory disease)? This does not include vaginal infections like yeast, trich, etc.

1 - No 2 - Yes

29. Has your appendix been removed?

1 - No [If no, skip to question 32] 2 - Yes

30. Why was your appendix removed?

1 - I definitely had appendicitis.
2 - I think I had appendicitis.
3 - They thought I had appendicitis, but after it was removed, they found my appendix was normal.
4 - My appendix was removed because I had surgery for another reason and they simply decided to take my appendix out because the surgeon had opened my stomach.
5 - I don't know why my appendix was removed.

31. Did you have a ruptured appendix?

1 - No, I had appendicitis but my appendix was definitely not ruptured.
2 - Unlikely, I had appendicitis and I think my appendix was not ruptured.
3 - Possibly, I had appendicitis and I think my appendix was ruptured.
4 - Yes, I had appendicitis and my appendix was definitely ruptured.

32. Do you take any medications (including birth control) on a regular basis?

1 - No
2 - Yes: If yes, please list: ____________________
____

33. Do you take any vitamin or mineral supplements?

1 - No
2 - Yes: If yes, please list: ____________________
____

34. For your height and build, do you consider your current weight to be:

0 - Too heavy 1 - Normal 2 - Too thin

35. Are you happy with your current weight?

1 - No 2 - Yes

36. How many meals do you usually eat per day? (circle one answer)

0 1 2 3 4 5 or more

37. How many snacks do you usually eat per day? (circle one answer)

0 1 2 3 4 5 or more

38. How many servings of milk, cheese, and/or other dairy products do you have per day? (circle one answer)

0 1 2 3 4 5 or more

39. Are there certain foods you avoid for any reason (e.g. meats, breads, etc.)?

1 - No
2 - Yes: If yes, please circle all that apply:
  1 - milk/dairy products
  2 - fruits
  3 - vegetables
  4 - breads/grains/cereals
  5 - red meats
  6 - pork
  7 - fish
  8 - chicken/poultry
  9 - fats
  10 - other (specify) ____________________

40. Have you ever been on a calorie-restricted diet?

1 - No   2 - Yes

41. Have you ever used any of the following methods to lose weight:

a.	Diet pills	1 - No	2 - Yes
b.	Laxatives	1 - No	2 - Yes
c.	Vomiting	1 - No	2 - Yes
d.	Diuretics	1 - No	2 - Yes

42. At what age did you start to menstruate (have periods)?

__ __ years old
001 - does not apply, I have not started menstruation.

43. How many periods did you have during the last 12 months? (circle one answer)

1 - 10-12
2 - 7-9
3 - 5-6
4 - 1-4
5 - None

44. In the last 12 months, how long was your usual menstrual cycle (from the start of one period until the start of the next period)? (For most women, a cycle is 25-35 days).

__ __ days

45. When you had a period during the last 12 months, how many days did the flow usually last? (For most women, the flow usually lasts 2-5 days.)

__ __ days

46. Were you ever pregnant during the last 12 months?

1 - Yes   2 - No

47. In the last 12 months, have your menstrual periods been irregular?

1 - Yes   2 - No

48. In the last 12 months, have you gone more than six months between any menstrual periods (other than for pregnancy)?

1 - Yes   2 - No

49. During the last 12 months, did you ever use birth control pills or any other hormonal therapy?

1 - Yes   2 - No

50. In the six months before reporting to PARRIS ISLAND, on the average, how many cigarettes did you smoke per day?

0 - None, I did not smoke.
____ average number of cigarettes smoked per day. (There are 20 in a pack.)

51. How many years have you regularly smoked cigarettes?

0 - I have not regularly smoked cigarettes.
____ number of years I have regularly smoked cigarettes.

52. What is the maximum number of cigarettes you have smoked per day on a regular basis?

0 - I have not regularly smoked cigarettes.
____ maximum number of cigarettes smoked per day on a regular basis. (There are 20 in a pack.)

53. In the six months before reporting to PARRIS ISLAND, on average, how many times (DIPS) per week did you use smokeless tobacco?

0 - None, I did not use smokeless tobacco.
____ average number of times (DIPS) per week.

54. How many years have you used smokeless tobacco?

0 - None, I have not regularly used smokeless tobacco.
____ number of years I have regularly used smokeless tobacco.

55. What is the maximum number of times (DIPS) per week you have used smokeless tobacco on a regular basis?

0 - None, I have not regularly used smokeless tobacco.
____ maximum number of times (DIPS) per week I used smokeless tobacco.

56. In the six months before reporting to PARRIS ISLAND, what is the most number of alcoholic drinks that you consumed in one 24 hour period? (one shot of whiskey, one glass of wine, or one 12 ounce beer represent one drink.)

0 - None, I did not consume any alcoholic drinks in the six months prior to reporting to PARRIS ISLAND.
____ most number of alcoholic drinks consumed in a 24 hour period.

57. In the six months before reporting to PARRIS ISLAND, what is the most number of alcoholic drinks that you consumed in any 7 day period?

0 - None, I did not consume any alcoholic drinks in the six months prior to reporting to PARRIS ISLAND.
____ most number of alcoholic drinks consumed in any 7 day period.

58. How many years have you regularly consumed one or more alcoholic drinks per week?

0 - None, I do not regularly drink alcohol.
____ number of years I have regularly consumed one or more alcoholic drinks per week.

59. What is the maximum number of alcoholic drinks you have consumed per week on a regular basis?

0 - None, I do not regularly drink alcohol.
____ maximum number of alcoholic drinks consumed per week on a regular basis.

60. Have you ever cared for farm animals like horses, cows, chickens, pigs, etc.?

1 - No

2 - Yes

61. How long did you care for farm animals?

____ No, I have not cared for farm animals.
____ number of years I cared for farm animals.

This booklet was generated as part of the
Defense Women's Health Research Proposal study entitled

Use of Noninvasive Bone Structural Measurements to Evaluate Stress Fracture Susceptibility Among Female Recruits in U.S. Marine Corps Basic Training

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DATA SHEET
MCRD - PARRIS ISLAND
Demographics and Anthropometrics

I. DEMOGRAPHICS

1. Are you pregnant or do you think you could be pregnant?

   1 - NO
   2 - YES

2. Name Last ______________________ First ________________ MI ____
3. Social security number ___ ___ ___ - ___ ___ - ___ ___ ___ ___
4. Today's date ___ ___ - ___ ___ - ___ ___ (month-day-year)
5. Gender (circle one):
   1 - Female
   2 - Male

6. Race (circle one):
   1 - Caucasian (White), not Hispanic
   2 - Asian
   3 - Black
   4 - Hispanic
   5 - Pacific Islander
   6 - Native American
   7 - Other (specify) ________________

7. Have you ever had a lower extremity surgery (below the waist)?

   0 - No
   1 - Yes (specify) ____

II. ANTHROPOMETRICS

STANDING

8. Height ___ ___ ___ . ___ inches
9. Weight ___ ___ ___ . ___ pounds
10. Neck circumference: ___ ___ . ___ cm
11. Waist circumference: ___ ___ ___ . ___ cm
12. Hip circumference: ___ ___ ___ . ___ cm
13. Pelvis width: ___ ___ . ___ cm
14. Trochanteric width: ___ ___ . ___ cm
15. Knee varus/valgus 1 - valgus 2 - varus 3 - neutral 4 - both
    a. Medial malleoli distance (valgus) ___ ___ . ___ cm
    b. Femoral condyle distance (varus) ___ ___ . ___ cm
16. Height of navicular (navicular to floor)
    a. Right ___ . ___ cm
    b. Left ___ . ___ cm
17. Length of foot (tuber calcanei to first MP joint)
    a. Right ___ ___ . ___ cm
    b. Left ___ ___ . ___ cm

SITTING (on exam table)

18. Thumb to forearm? 0 - No 1 - Yes

19. Sit and reach ___ ___ . ___ cm 1 - positive (past toes) 2 - negative (lacks toes)

20. Elbow hyperextension
   a. Right ___ ___ degrees 1 - positive 2 - negative (hyperextension)
   b. Left ___ ___ degrees 1 - positive 2 - negative (hyperextension)

SUPINE (on back)

21. Upper leg length (ASIS to the medial knee joint space)
   a. Right ___ ___.___cm
   b. Left ___ ___.___cm

22. Tibial length (medial knee joint space to the medial malleolus)
   a. Right ___ ___.___cm
   b. Left ___ ___.___cm

23. Q angle (ASIS to center of patella to tibial tubercle)(toes pointing to the ceiling)
   a. Right ___ ___degrees 1. - valgus 2. - varus 3. - neutral
   b. Left ___ ___degrees 1.- valgus 2. - varus 3. - neutral

24. Knee range of motion (heel on top of the other foot)
(greater trochanter to lateral knee joint space to lateral malleolus)
   a. Right extension ___ ___degrees 1. - positive 2. - negative (hyperextension)
   b. Left extension ___ ___degrees 1. - positive 2. - negative (hyperextension)
   c. Flexion symmetric? (both knees to buttocks) 100-Yes 0-No ___ ___degrees difference

25. Straight leg raise (hold heel to tightness)(opposite knee flat on table)(hips flat on table)
   a. Right ___ ___ ___degrees
   b. Left ___ ___ ___degrees

26. Ankle dorsiflexion (knee extended)(90 degrees is neutral (0))
   a. Right ___ ___degrees 1. - positive (plantar flexion) 2. - negative (dorsi flexion)
   b. Left ___ ___degrees 1. - positive (plantar flexion) 2. - negative (dorsi flexion)

27. Ober Test (ilio-tibial band)(measurer should describe)
   a. Right 1. - positive (above horiz.) 2. - negative (below horiz.) 3. - intermediate (horiz.)
   b. Left 1. - positive (above horiz.) 2. - negative (below horiz.) 3. - intermediate (horiz.)

PRONE (on stomach)

28. Ankle dorsiflexion (knee flexed)(axis of rotation is the lateral malleolus)(knee to lateral aspect of the foot)
   a. Right ___ ___degrees 1.-positive (plantar flexion) 2.-negative (dorsi flexion)
   b.. Left ___ ___degrees 1.-positive (plantar flexion) 2.-negative (dorsi flexion)

29. Internal hip rotation (knees together, 90 degree flexion, both legs flare out at the same time)
   a. Right ___ ___degrees
   b. Left ___ ___degrees

30. External hip rotation (knees together, 90 degree flexion, one leg at a time)(crosses the midline)
   a. Right ___ ___degrees
   b. Left ___ ___degrees

31. Hindfoot inversion (feet at the end of the table)(axis of rotation is the Achilles insertion of the calcaneus)
(grab foot, pull toward midline of lower leg)
   a. Right ___ ___degrees
   b. Left ___ ___degrees

32. Hindfoot eversion (similar to #31, grab foot pull away from midline of lower leg)
   a. Right ___ ___degrees
   b. Left ___ ___degrees

SKIN MARKINGS by order of appearance in the data sheet/protocol.

1. Navicular: (standing) locate and place a mark along the lower edge of the navicular (figures D, 1,2) on both feet.

2. First M-P joint of feet: (standing) locate and place a mark at the first M-P (metatarsophalangeal) joint on the medial side of both feet (figures D, 3).

3. Medial knee joint space: (supine) locate the patellar tendon (figures B, 4) and place thumb in depression just medial to it (figure 5). Slide thumb medially while flexing and straightening the subject's knee until a groove is felt between the medial tibial and femoral condyles (figures A, 6-8). Mark this spot on both knees.

4. Lateral knee joint space: (supine) locate the patellar tendon (figures B, 4) and place thumb in depression just lateral to it (figure 5). Slide thumb laterally while flexing and straightening the subject's knee until a groove is felt between the lateral tibial and femoral condyles (figures A, 6-8). Mark this spot on both knees.

5. Medial malleolus: (supine) locate and place a mark at the distal end of the tibia, at the bottom edge of the medial malleolus of both legs (figures D, 9).

6. Lateral malleolus: (supine) locate and place a mark at the distal end of the tibia, at the bottom edge of the lateral malleolus of both legs.

7. Center of patella: (supine) locate and mark the center of the patella (knee cap) on both legs (figures A, B).

8. Tibial tubercle: (supine) locate the patellar tendon at the bottom of the patella (kneecap), follow it to the tibial tubercle. Mark the tubercle on both legs (figures A, B, 11, 12).

9. Midline of calcaneus (heel): (prone)
   a. place subject in the prone position.
   b. flex subject's knee and raise the lower leg until the sole of the subject's foot is facing up.
   c. facing the heel, grasp the heel on either side with thumb on one side and forefingers on the other, firmly delineating the calcaneus (heel bone) (figures 13, 14).
   d. place a line along the midline of the heel on both feet (figure 15).

10. Insertion of Achilles tendon: (prone) Place subject in prone position. Place thumb or forefinger on subject's heel and, while flexing the subject's ankle back and forth, move thumb/forefinger towards lower leg to locate the top of the calcaneus at the insertion of the Achilles tendon. Mark this spot centrally on both heels (figure 15).

11. Midline of distal calf: (prone) Place subject in prone position. Lay subject's leg down on the table and locate the midline of the calf. Extend a line along the midline of the distal calf on both legs, approximating the long axis of the tibia (figure 15).

II ANTHROPOMETRICS

STANDING

8. Height.

Materials - hospital grade counterbalance scale with measuring slide rule. Subject should stand with shoes off, in light PT gear, on a hospital grade counterbalance scale facing outward with heels together. Subject should inhale maximally, hold the head with chin up to a height a little lower than the bottom of the earlobe. Subject should step out. Measure the height to the closest 0.1 inches.

9. Weight.

Materials - hospital grade counterbalance scale. Subject should stand with shoes off, in light PT gear, on a hospital grade counterbalance scale facing forward with heels together. Measure weight to the closest 0.1 pounds.

10. Neck circumference.

Materials - metric nylon tape measure. Require the subject to look straight ahead, with the chin slightly up so that the head is in a neutral position. Place the tape measure around the neck at a level just below the larynx. Because of the shape of the neck, the tape will usually slope downward to the front.

11. Waist circumference.

Materials - metric nylon tape measure. The subject should lift clothing in order to expose the midsection. The level of the abdominal circumference is located about halfway between the umbilicus and the xiphoid process. Record the measurement at the end of a normal expiration.

12. Hip circumference.

Materials - metric nylon tape measure. The subject should stand with heels together. While facing the subject's side, place the tape around the hips so that it is level with the floor and passes over the greatest protrusion of the gluteal muscles. Because the tape passes over clothing, extra tension should be applied so that the tape conforms closely to body contours.

13. Pelvis width.

Materials - caliper.
A. Have subject stand with feet slightly apart and toes pointed straight ahead.
B. Place arms of caliper firmly on either side of subject's pelvis (figure 16).
C. Measure and record the width of the pelvis girdle (pelvis width) at its widest point (iliac tubercle, figures 17, 18).

14. Trochanteric width.

Materials - caliper.
A. Have subject stand with feet slightly apart and toes pointed straight ahead.
B. Place arms of caliper firmly on both sides of subject's hips at the level of the greater trochanters (figure 19).
C. Measure and record the width of the hips at the greater trochanters to the nearest 0.1 cm.

15. Knee varus/valgus.

Materials - triangle caliper or tape measure.
A. Ask subject to stand with knees locked and feet shoulder width apart.
B. Then, ask subject to slowly move one leg toward the other until either the ankles of knees come together.
C. Place the triangle or tape measure between the subject's knees (femoral condyles) or ankles (medial malleoli) and press firmly against the subject to delineate interfemoral or intermalleoli width.
D. Measure and record the distance between the medial malleoli (valgus) or between the medial femoral condyles (varus) to the nearest 0.1 cm (figure 20). If valgus, record medial femoral condyle distance as zero; if varus, record medial malleoli distance as zero. If knees and ankles come together as the same time, record both distances as zero and circle "neutral". If there is measurable distance between both the femoral condyles and the medial malleoli, record both measurements and circle "both".

16. Height of navicular (navicular to floor).

Materials - skin marker, metric ruler with demarcations beginning precisely at the edge of the ruler.
A. Ask subject to take weight off left leg, bend the left leg at the knee, and extend it slightly to the rear. Subject should be braced against a table or wall (figure 21).
B. Measure and record the vertical distance between the floor and the lower edge of

the navicular of the right foot (previously marked) to the nearest 0.1 cm (figures D, 22).

C. Repeat height of the navicular for the left foot.

17. Length of foot (tuber calcanei to first MP joint).

Materials - skin marker, metric ruler.

A. Using the line of tile on the floor or a preestablished straight line (such as tape, or clip board at the rear of the foot), align the subject's medial side of the right foot along the line.

B. Ask subject to take weight off left leg, bend left leg at the knee, and extend left leg backward slightly, thus keeping weight balanced and evenly distributed on right foot with knee locked (figure 21).

C. Measure and record the distance from the tuber calcanei (heel edge) to the first MP joint (previously marked) on the floor along the medial edge of the foot to the nearest 0.1 cm (figures D, 22).

D. Repeat length of foot measurement for the left foot.

SITTING

18. Thumb to forearm?

Materials - none (actually, a thumb and a forearm)

A. Ask subject to flex wrist as if shooting a basketball.

B. Ask if subject can push thumb with other hand down to the forearm.

19. Sit and reach.

Materials - metric ruler or tape.

A. Ask subject to sit with legs straight out in front of them, and with toes and feet pointed straight up toward the ceiling.

B. Ask subject to slowly bend from the waist toward the toes, with arms outstretched as far as possible.

C. Measure and record the distance from the middle fingertip to the great toenail. If the middle fingertip is past the toes, circle "positive"; if it doesn't reach the toes, circle "negative".

20. Elbow hyperextension.

Materials - goniometer.

A. Ask subject to outstretch right arm forward, with the palm up toward the ceiling.

B. Ask subject to extend the right elbow (push upward toward the ceiling) as far as possible.

C. Place axis of goniometer in the center of the lateral side of the right elbow. Line up stationary *arm* of goniometer with midpoint of the right shoulder, and the moveable *arm* of goniometer with radial styloid process (figures 24, 25).

D. Measure and record the angle of the elbow (figure 25). If the elbow is flexed (elbow points toward floor), circle "positive". If the elbow is hyperextended (elbow points toward ceiling), circle "negative" (figure 25).

E. Repeat the measurement for the left elbow.

SUPINE (on back)

21. Upper leg length (ASIS to medial knee joint space).

Materials - skin marker, metric tape.

A. Locate anterior superior iliac spine (ASIS) on the pelvis of the right leg (figures 17, 18).

B. Place and hold the zero end of the metric tape at the slight concavity just below the ASIS.

C. Tautly extend the measuring tape to the medial knee joint space mark and record the upper leg length to the nearest 0.1 cm (figure 26).

D. repeat the measurement on the left leg.

****The following steps are to be taken only when immediately scanning afterward****

E. While holding the tape in place, mark 1/2 the total distance of the subject's right thigh.

F. Using a ruler, extend this mark into a line mediolaterally across the thigh (femoral scan site and mid thigh girth)(figure 26).

G. Draw two other lines: one 0.5 cm above the first line, and one 0.5 cm below the first line (scan length)(figure 26).

22. Tibial length (medial knee joint space to medial malleolus).

Materials - skin marker, metric tape.

A. Place the zero end of metric tape at the medial knee joint space mark on the right leg.

B. Tautly extend the measuring tape to the medial malleolus mark and record the tibial length to the nearest 0.1 cm (figure 27).

C. Repeat the measurement on the left leg.

****The following steps are to be taken only when immediately scanning afterward****

D. While holding the tape in place, mark 2/3 the total distance (1/3 distal tibia) of the subject's right lower leg.

E. Using a ruler, extend this mark into a line mediolaterally across the lower leg (tibial scan site)(figure 27).
F. Draw two other lines: one 0.5 cm above the first line, and one 0.5 cm below the first line (scan length)(figure 27).

23. Q Angle.
Materials - goniometer.
A. Position the subject's right leg with toes pointed toward the ceiling.
B. Position the subject vertically. Have the subject place his/her forefinger on the ASIS (figure 18) of the subject's right leg as a visual aid.
C. Place the axis of the goniometer on the mark at the midpoint of the patella (central kneecap) on the right leg (figures A, B, 28). Line up the stationary arm of the goniometer with the ASIS, and line up the movable arm of the goniometer through the tibial tubercle (figure A, B).
D. Measure and record the angle between the stationary arm (ASIS-midpatella) and the movable arm (midpatella-tibial tubercle) to the nearest degree (figure 28). Indicate valgus (><), varus (<>), or neutral (neither valgus nor varus) alignment of the knee (figure 28).
E. Repeat Q angle measurement and indication of valgus, varus, or neutral alignment for the left leg.

24. Knee range of motion.
Materials - goniometer.
Right and left knee extension.
A. Ask the subject to place the right heel on the left foot, and to extend or relax the right knee down toward the table as far as possible. The foot and toes should be pointing toward the ceiling. Or have the recorder hold the right heel about 8 inches off the table and tell the subject to relax.
B. Place the axis of the goniometer at the center of the lateral joint space of the knee (figures 29, 30). Line up the stationary arm of the goniometer with the right greater trochanter (figure 19). Line up the movable arm of the goniometer with the lateral malleolus (figures C, 31).
C. Measure and record the angle of the knee extension (figure 32). If the knee is flexed (bent - with knee pointed up toward the ceiling), circle "positive". If the knee is hyperextended (knee pointed down toward the table), circle "negative" (figure 32).
D. Repeat the measurement on the left leg.
E. **Flexion symmetric?** Grab the subject's ankles and push both heels toward the buttocks. If both ankles stop the same distance from the buttocks, then circle "100-Yes". If not symmetric, then measure each inflexion using the same landmarks as used for the extension measurement (the axis of rotation is the lateral joint space, and the arms of the goniometer are in line with the greater trochanter and the lateral malleolus). Record only the degree difference between the two knees.

25. Straight leg raise.
Materials - goniometer.
A. Position the subject's left leg straight down on the table. Lift the right leg up by holding the ankle and slowly moving toward the ceiling (figure 33). The subject must relax the leg while the examiner lifts the leg. At the point where either knee begins to bend, or where the examiner feels tightness or resistance, the leg is stopped and the assistant holds the leg in this position.
B. Place the axis of the goniometer at the right greater trochanter (figure 19). Line up the stationary arm of the goniometer parallel to the table, pointing toward the foot. The movable arm of the goniometer lines up with the right lateral malleolus (figures C, 31).
C. Measure and record the angle (figure 33).
D. Repeat the measurement on the left leg.

26. Ankle dorsiflexion (knee extended).
Materials - goniometer.
A. Ask the subject to pull the right foot up <u>maximally</u> keeping the knee straight (figure 34).
B. Place the axis of the goniometer on the lateral malleolus with the stationary arm of the goniometer parallel to the fibula. Line up the movable arm of the goniometer parallel to the lateral midline of the fifth metatarsal.
C. Measure and record the angle between the stationary arm (parallel to fibula) and the movable arm (parallel to plane of the foot) at maximal flexion to the nearest degree. Indicate whether motion is dorsiflexion and is measured in negative degrees, plantar flexion and measured in positive degrees, or without flexion and measured in neutral degrees (zero-neither dorsiflexion not plantar flexion) (figure 34).
D. Repeat ankle dorsiflexion measurement for the left ankle.

****Note: The neutral point is 90 degrees on the goniometer, but this is recorded as 0 degrees****

27. Ober test.

Materials - table and a body.

A. Ask the subject to lie on the left side with both knees slightly bent. The examiner (you) stands behind the subject.

B. Support the right leg in your right arm. Hold the upper side of the subject's pelvis with your left hand to prevent truck motion.

C. Lift the leg up toward the ceiling maximally, then pull the leg firmly back toward you maximally (figure 35). At this point, allow the leg to slowly lower toward the table, keeping the hip in maximal extension (figure 36).

D. The assistant will determine if the leg is horizontal (intermediate), above the horizon (positive), or below horizontal (negative). Record.

E. Repeat measurement sequence on the left leg.

PRONE (on stomach)

28. Ankle dorsiflexion (knee flexed).

Materials - goniometer.

A. Ask the subject to bend the right knee to approximately 90 degrees. Ask the recorder to pull the subject's foot toward the knee (dorsiflex) maximally (figure 34).

B. Place the axis of the goniometer on the lateral malleolus with the stationary arm of the goniometer parallel to the fibula. Line up the movable arm of the goniometer parallel to the lateral midline of the fifth metatarsal.

C. Measure and record to the closest degree the angle between the stationary arm (parallel to the fibula) and the movable arm (parallel to plane of the foot) at maximal flexion. Indicate whether the motion is dorsiflexion (measured in negative degrees), plantar flexion (measured in positive degrees), or without either dorsi or plantar flexion (measured as neutral). If neutral, place zeros in both data lines. (figure 34).

D. Repeat ankle dorsiflexion measurement for the left ankle.

****Note: The neutral point is 90 degrees on the goniometer, but this is recorded as 0 degrees****

29. Internal hip rotation.

Materials - goniometer.

A. Flex the subject's right knee to 90 degrees and perpendicular to the transverse line across the ASIS of the pelvis, midway between external and internal rotation (figures 37, 38).

B. Place the axis of the goniometer over the central patella of the right leg with the stationary arm of the goniometer parallel to the axis of the tibia and perpendicular to the floor and exam table. Line up the movable arm of the goniometer along the midline of the tibia (figure 38).

C. Press one hand firmly down onto the pelvis in order to prevent it from rocking, while the other hand rotates the leg away from the midline of the trunk (with thigh as axis of rotation) until resistance is felt (figure 38).

D. Measure and record to the closest degree the angle between the stationary arm (perpendicular to floor and exam table) and the movable arm (along midline of tibia) at maximal rotation (figure 38).

E. Repeat the internal hip rotation measurement for the left leg with the left knee flexed and the right knee extended.

30. External hip rotation.

Materials - goniometer.

A. Flex the subject's right knee to 90 degrees and perpendicular to the transverse line across the ASIS of the pelvis, midway between external and internal rotation (leaving left leg extended) (figures 37, 38).

B. Place the axis of the goniometer over the central patella of the right leg with the stationary arm of the goniometer parallel to the axis of the tibia and perpendicular to the floor and exam table. Line up the movable arm of the goniometer along the midline of the tibia (figure 38).

C. Firmly press down on the pelvis in order to prevent it from rocking, while the other hand rotates the leg toward the midline of the trunk (with thigh as axis of rotation) until resistance is felt (figure 38).

D. Measure and record to the closest degree the angle between the stationary arm perpendicular to floor and exam table) and the movable arm (along midline of tibia) at the central patella during maximal rotation (figure 38).

E. Repeat external hip rotation measurement for the left leg with the left knee flexed and right knee extended.

31. Hindfoot inversion.

Materials - goniometer.

A. Subject is positioned with legs extended and feet off the edge of the exam table.

B. Place the axis of the goniometer on upper heel mark of right leg at the insertion of the Achilles tendon (figure 15). Line up the stationary arm of the goniometer parallel to the axis of the tibia, and line up the movable arm of the goniometer parallel to the long axis of the heel along the midheel mark (figures 15, 39).

C. Firmly grasp the right heel in the cup of your hand with your thumb on the lateral side of the subject's heel and your forefingers on the medial side of the subject's heel.
D. Passively turn the subject's heel inward, while focusing on movement of only the subtalar joint (figures 40, 41).
E. Measure and record to the closest degree the angle between the stationary arm (midline of the lower leg) and the movable arm (midline of the calcaneus) at the upper heel during maximal inversion (figure 41).
F. Repeat hindfoot inversion measurement for the left subtalar joint.

32. Hindfoot eversion.
Materials - goniometer.
A. Position the subject with legs extended and feet off the edge of the table.
B. Place the axis of the goniometer on the upper heel mark of the right leg at the insertion of the Achilles tendon. Align the stationary arm of the goniometer parallel to the long axis of the tibia, and align the movable arm of the goniometer parallel to the long axis of the heel along the midheel mark (figure 15).
C. Firmly grasp the right heel in the cup of your hand with your thumb on lateral side of the subject's heel and your forefingers on the medial side of the subject's heel.
D. Passively turn the subject's heel outward, while focusing on movement of the subtalar joint only (figures 40, 42).
E. Measure and record to the closest degree the angle between the stationary arm (midline of the lower leg) and the movable arm (midline of the calcaneus) at the upper heel during maximal eversion (figure 42).
F. Repeat hindfoot eversion measurement for the left subtalar joint.

ILLUSTRATIONS

Figures A, B, C, D, and 1 through 43.

Use of goniometer - figure 43.

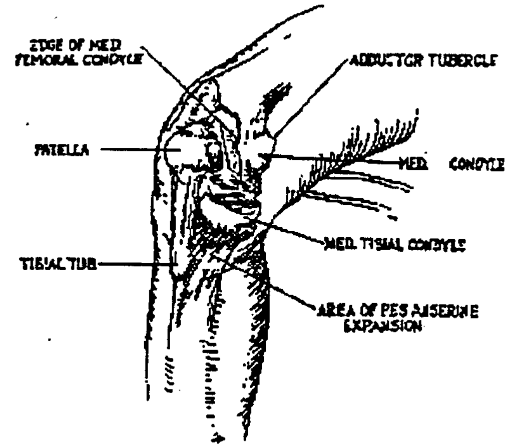


Figure A - General orientation of medial knee landmarks.

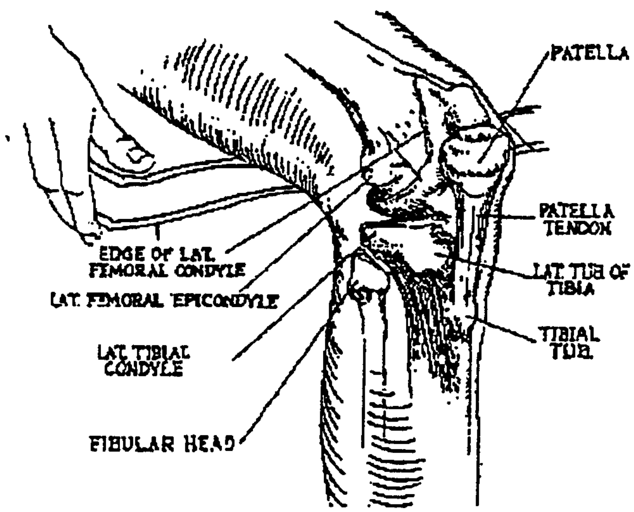


Figure B - General orientation of lateral landmarks.

Figure D - General orientation of foot.

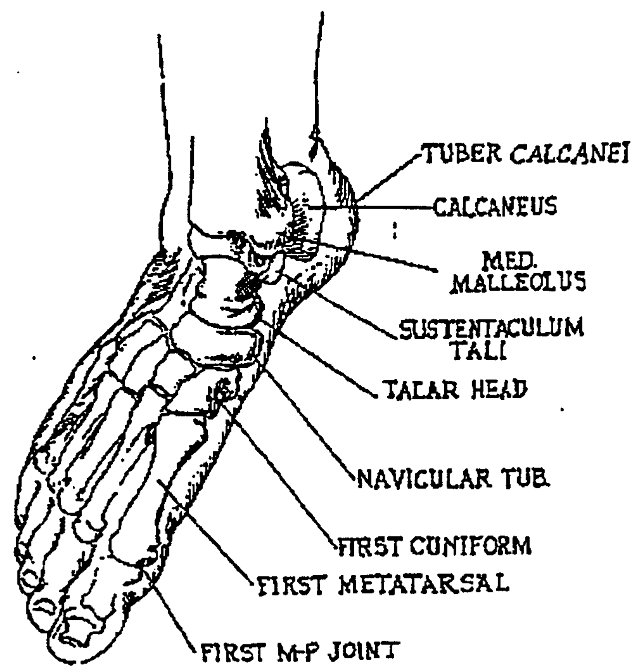
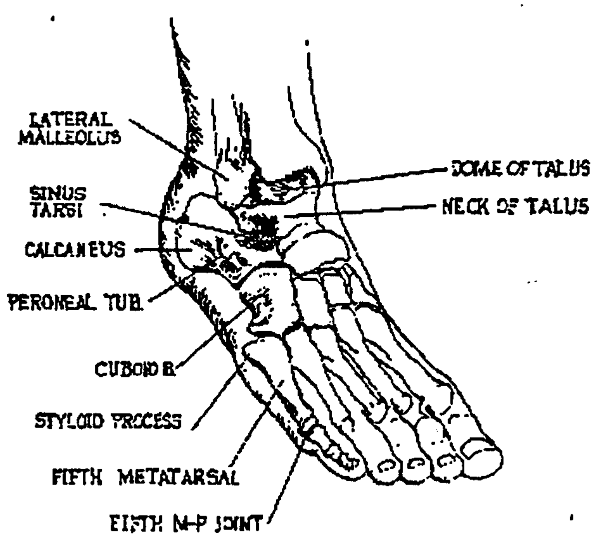


Figure C - General orientation of foot.



Figures 1 through 3 - Locating navicular and first MP joint.

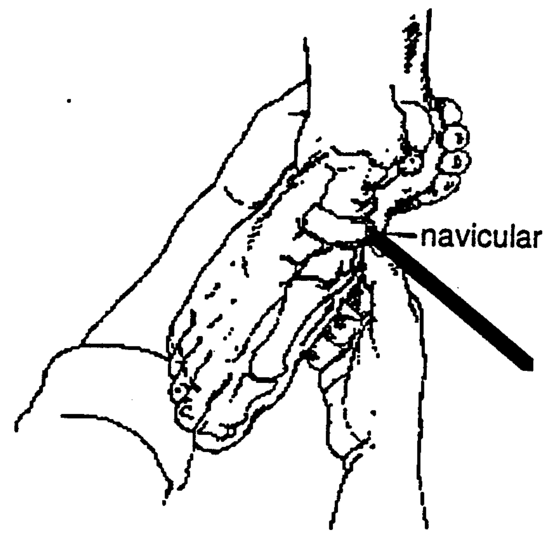


Figure 1

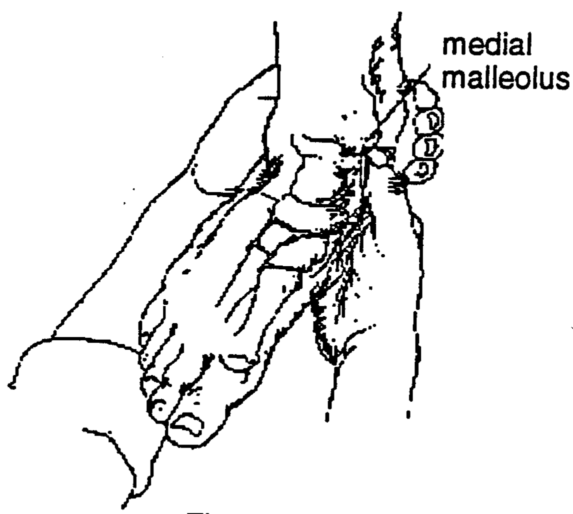


Figure 2

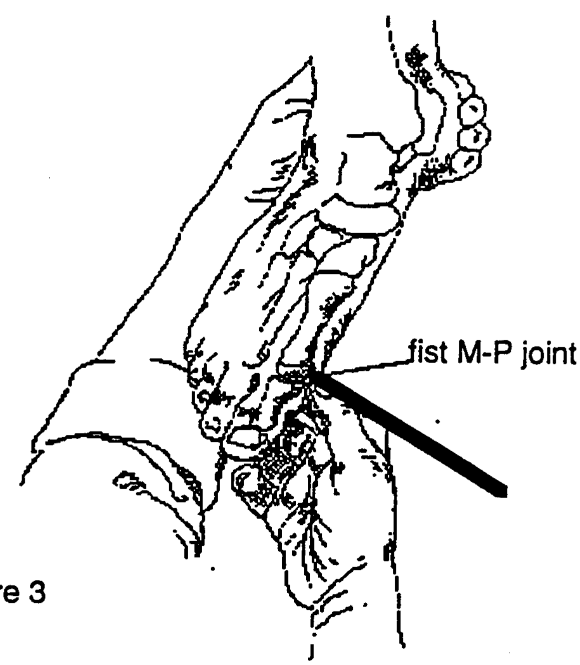


Figure 3

Figures 4 through 8 - Orientation points for locating medial knee joint space.

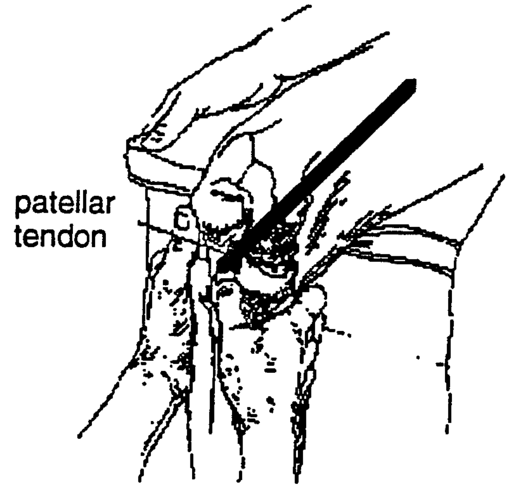


figure 4

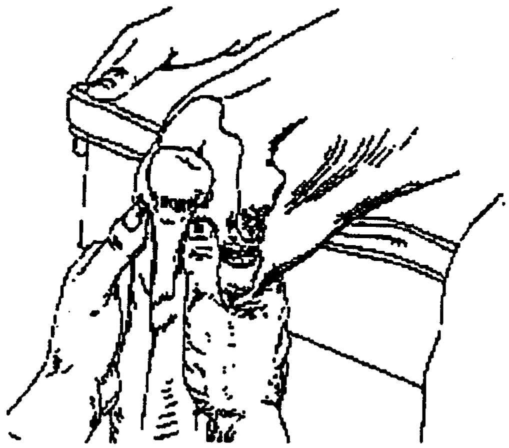


figure 5

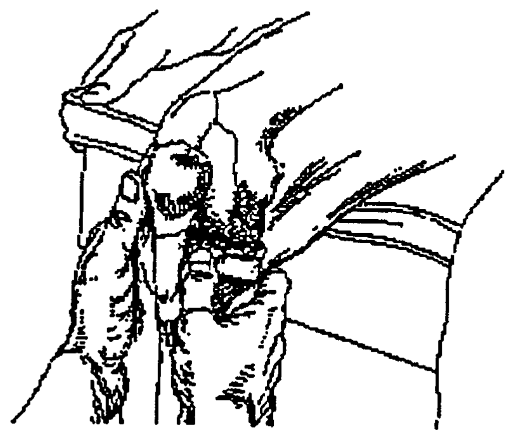


figure 6

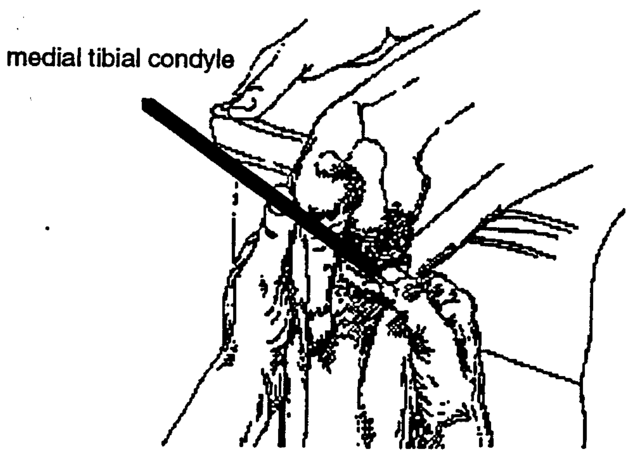


figure 7

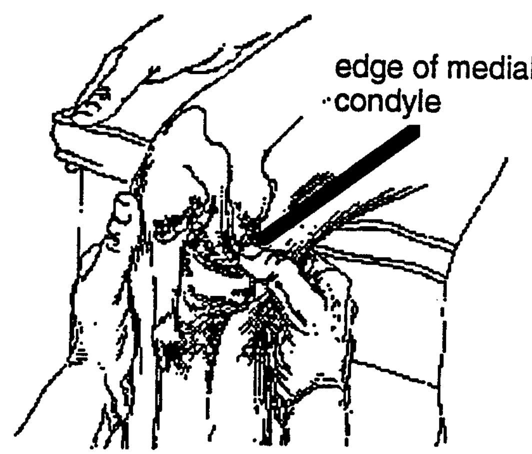


figure 8

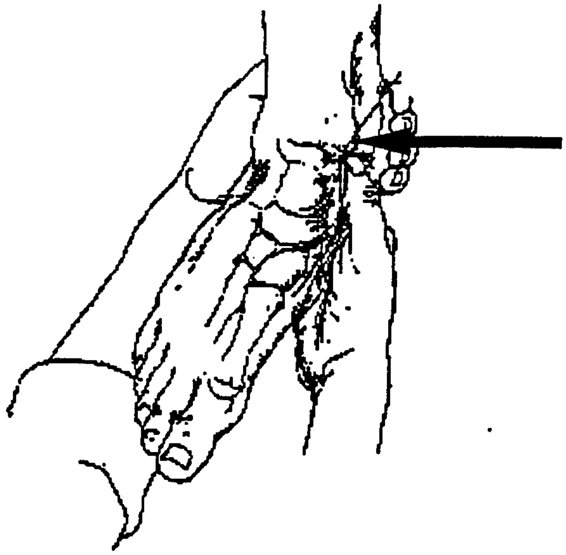
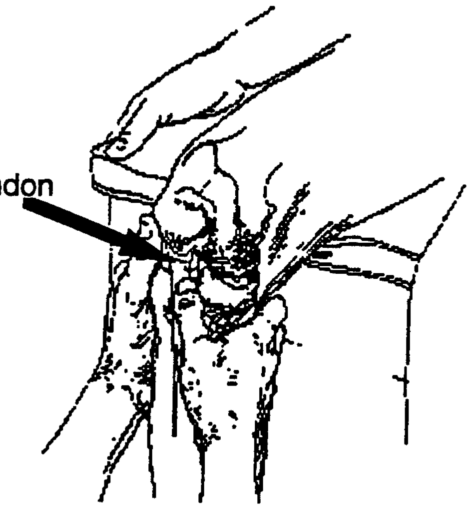


figure 9 - Locating medial malleolus.



Figures 10 through 12 - Locating and marking the tibial tubercle.

figure 10

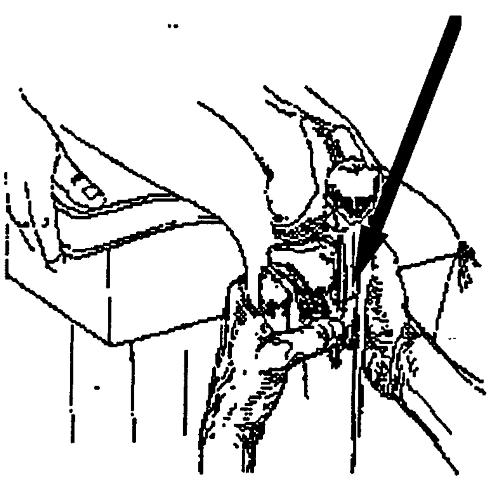


figure 11

figure 12

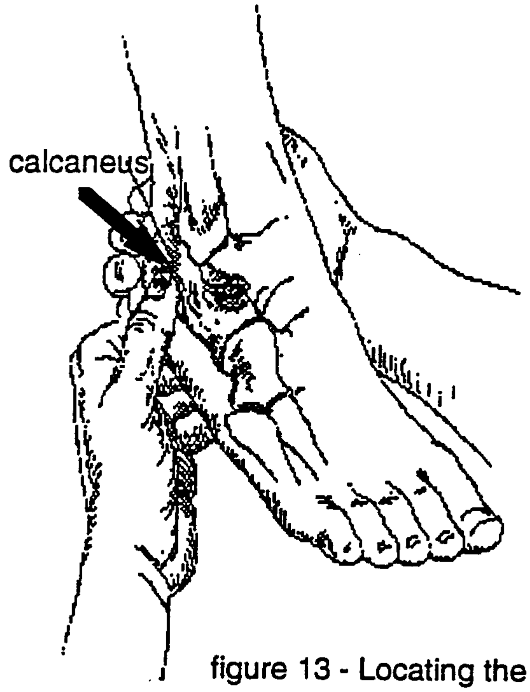


figure 13 - Locating the calcaneus.

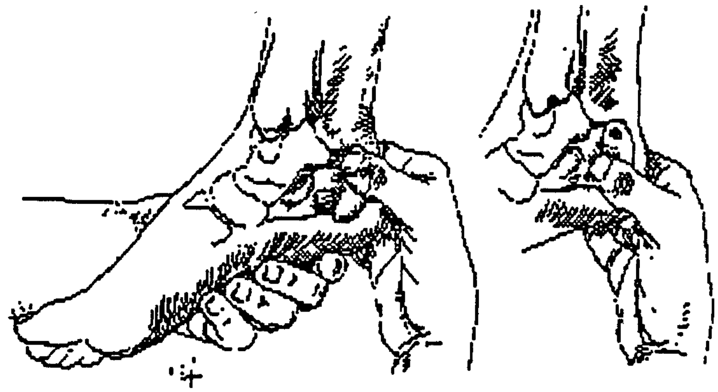


figure 14 - Delineating the calcaneus.

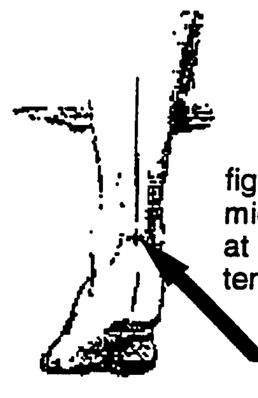


figure 15 - Skin markings: midline heel, upper heel at insertion of Achilles tendon, midline distal calf.

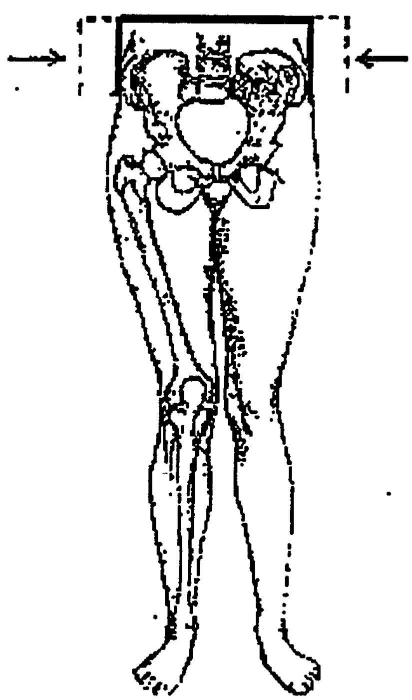


figure 16 - Pelvis width measurement at widest point on pelvic girdle.

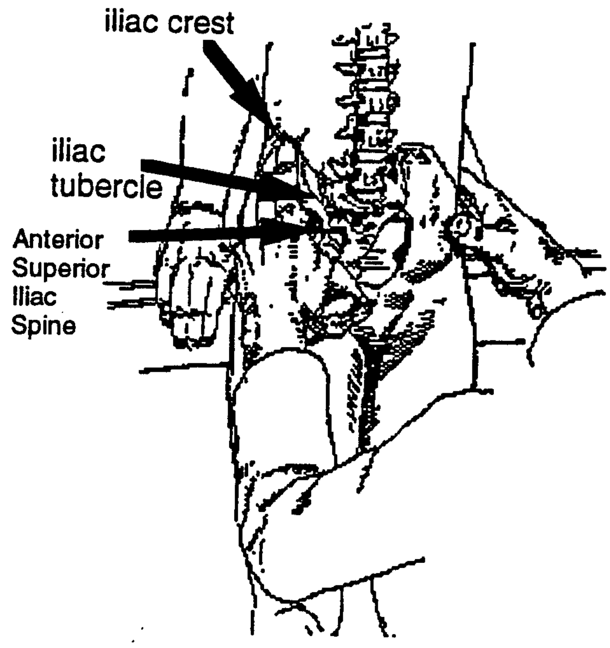


figure 17 - Orientation of pelvis for locating ASIS and iliac tubercle.

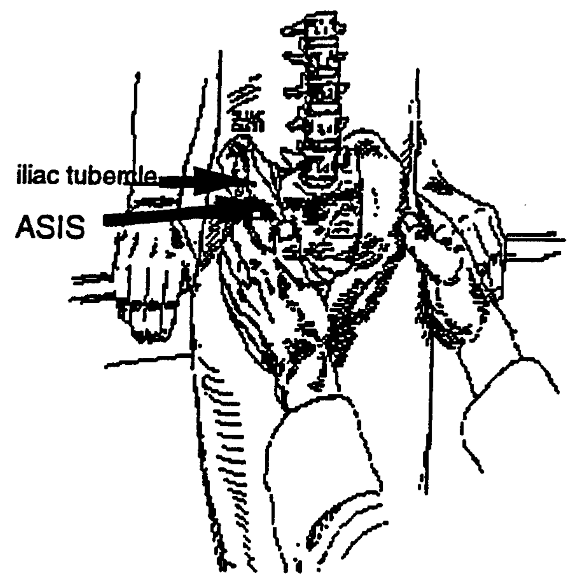


figure 8 - Orientation of pelvis for locating ASIS and iliac tubercle.

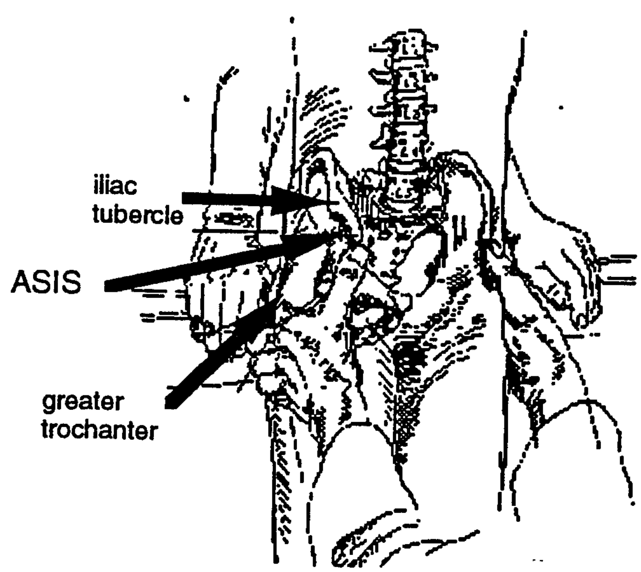


figure 19 - Locating the greater trochanters.

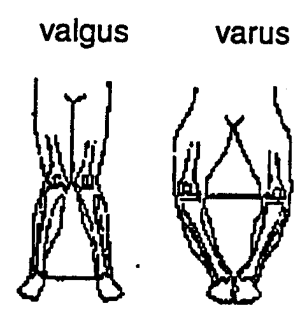


figure 20 - Knee valgus/varus measurement: distance between medial malleoli or femoral condyles.

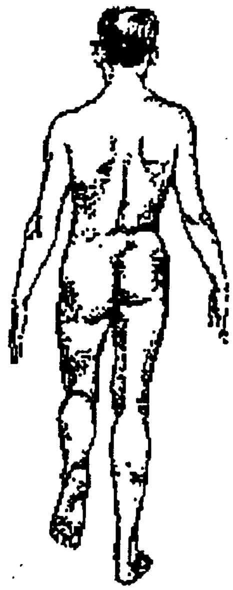


figure 21 - Positioning of subject for lower leg-heel alignment and longitudinal foot-arch measurements.

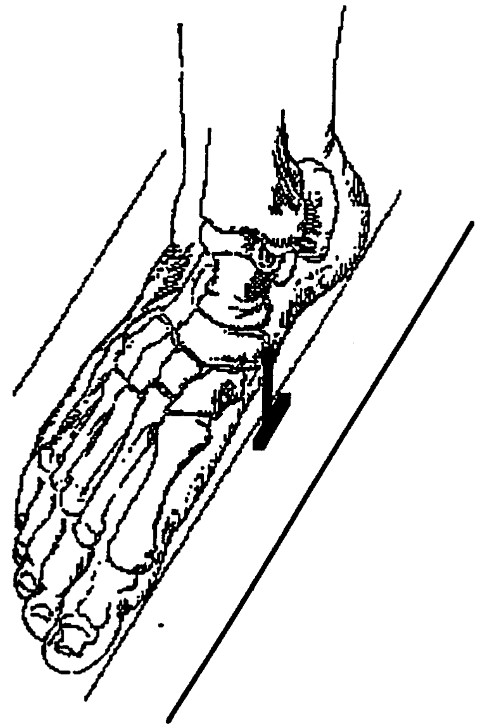


figure 22 - Height of navicular positioning and measurement (navicular-floor).

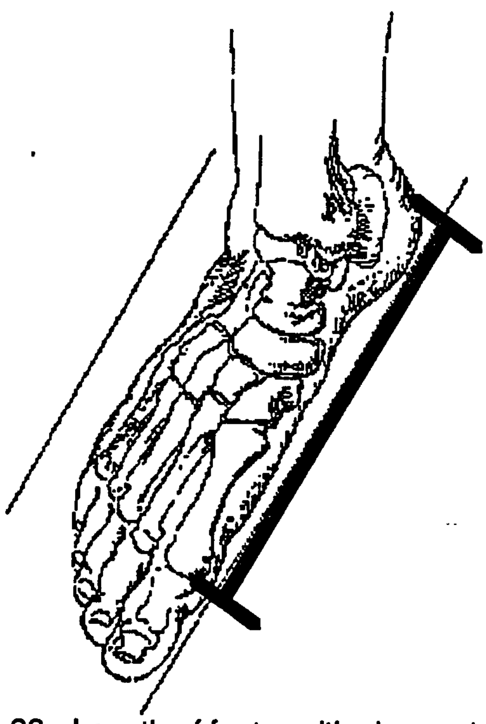


figure 23 - Length of foot positioning and measurement (tubercle calcanei-first MP joint).

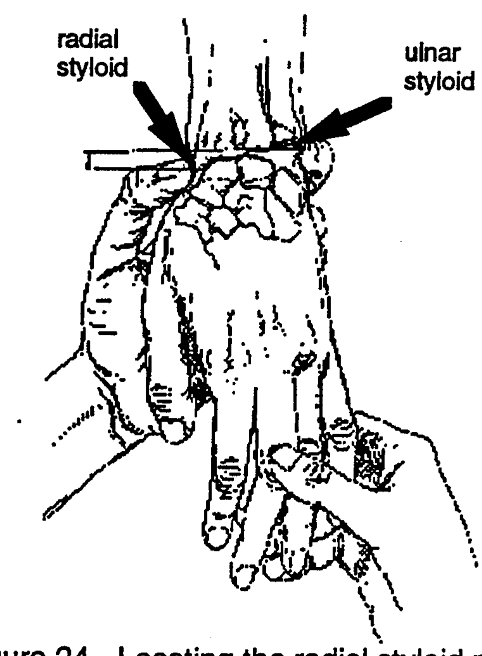


figure 24 - Locating the radial styloid process.

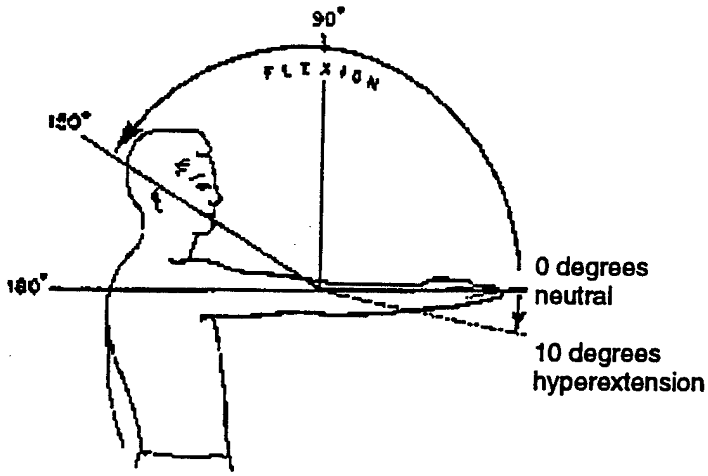


figure 25 - Measurement of elbow extension.

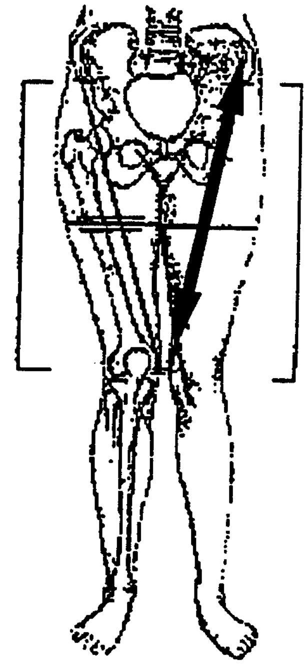


figure 26 - Upper leg length measurement and skin markings (ASIS-medial knee joint space).

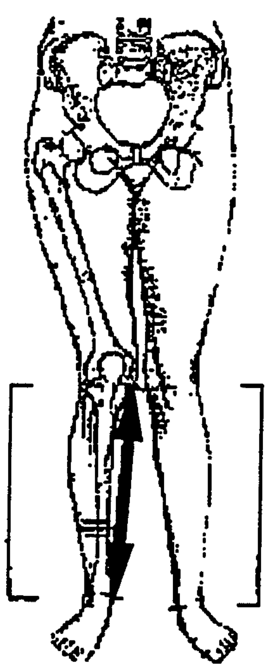


figure 27 - Tibial length measurement and skin markings (medial knee joint space-medial malleolus).

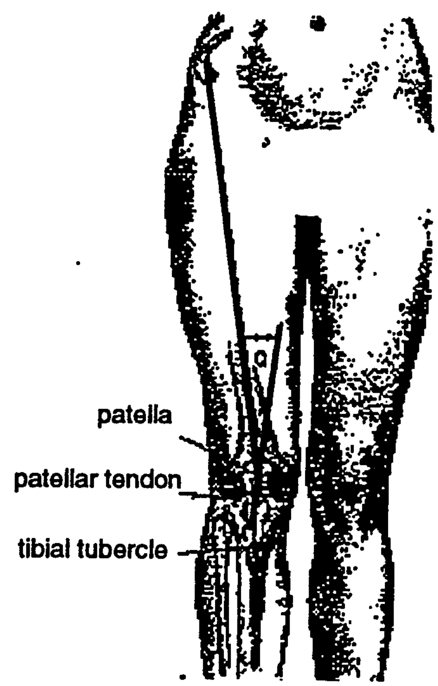


figure 28 - Q angle measurement (ASIS-central patella-tibial tubercle).

Figures 29 and 30 - Orientation points for locating lateral knee joint space.

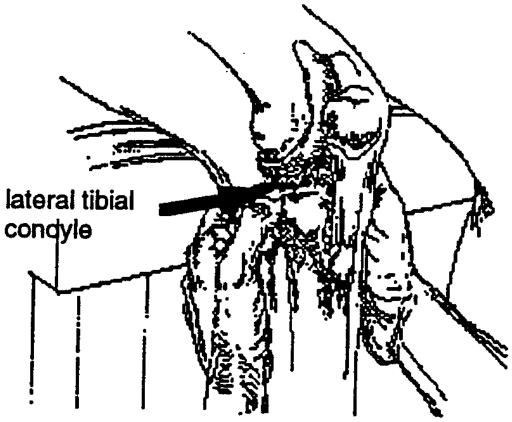


figure 29

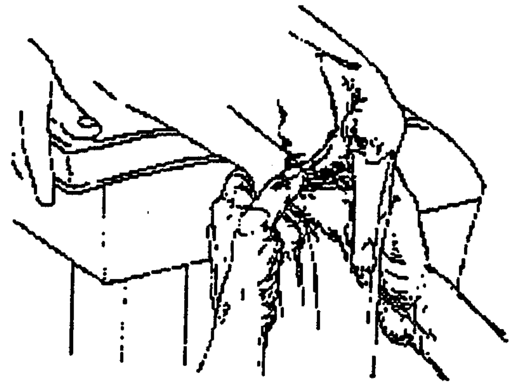


figure 30

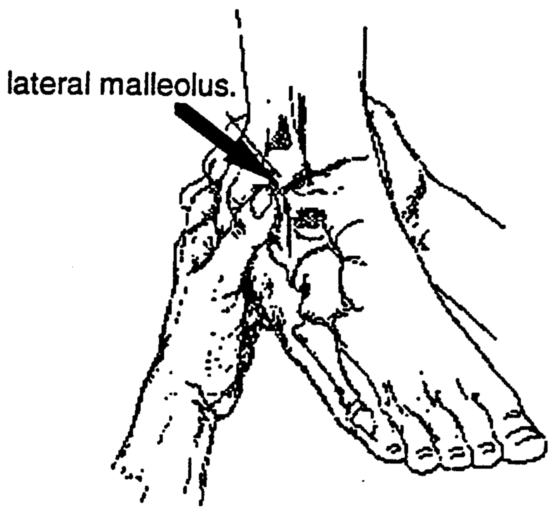


figure 31 - Locating the lateral malleolus.

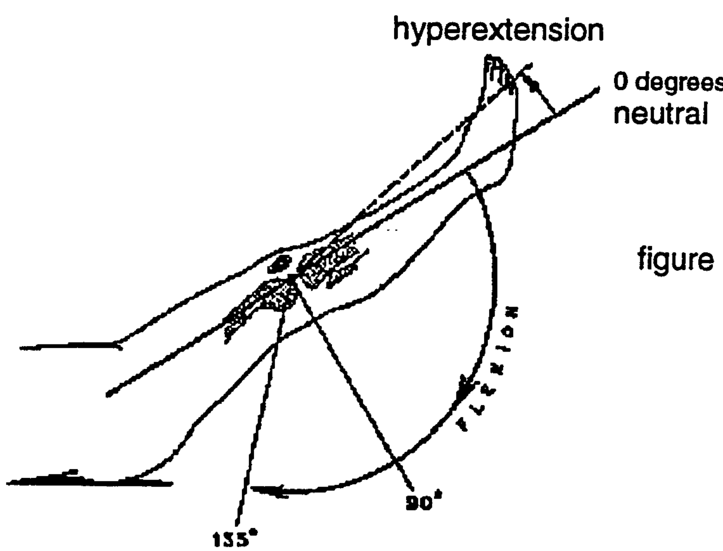


figure 32 - Measurement of knee extension and flexion.

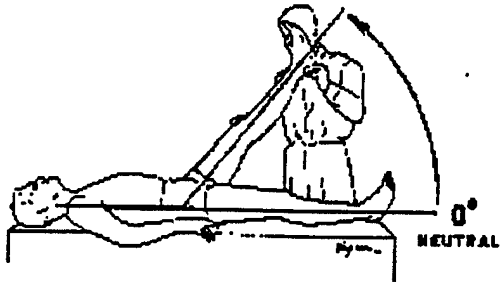


figure 33 - Measurement of straight leg raise.

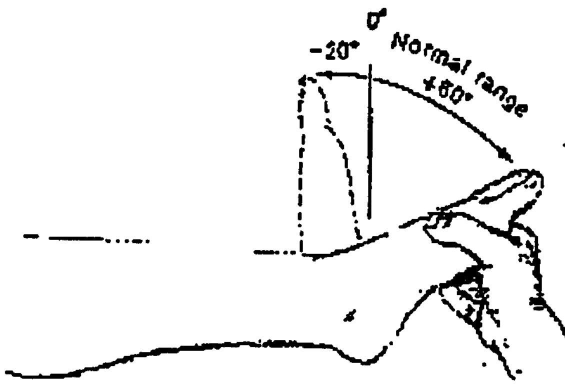


figure 34 - Ankle dorsiflexion measurement.

Figures 35 and 36 - Demonstration of the Ober Test.

figure 35

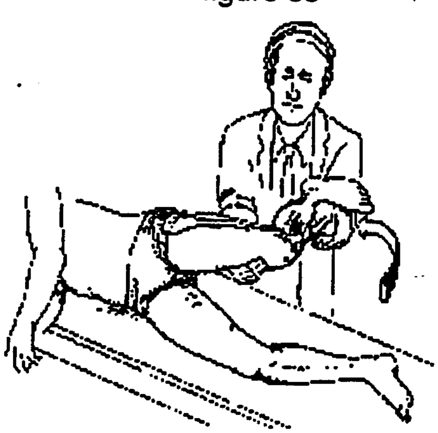
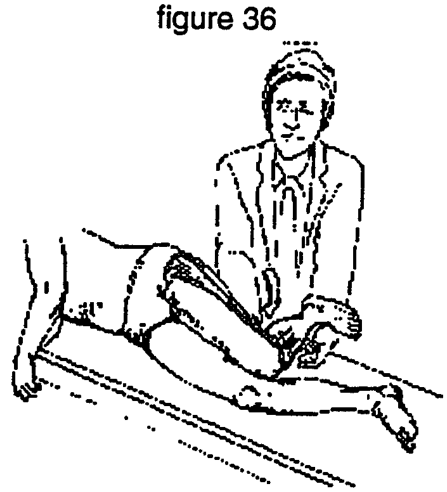


figure 36



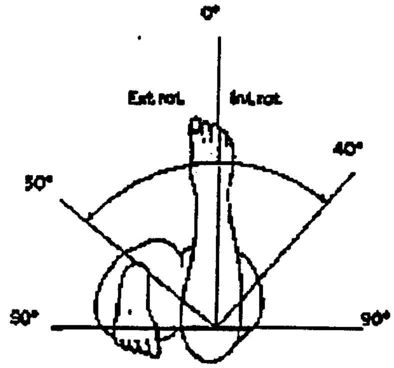


figure 37 - Positioning of subject for internal and external hip rotation measurements.

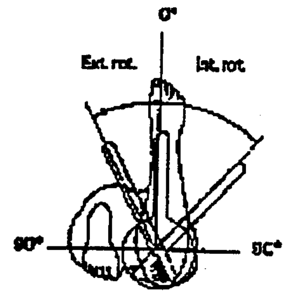


figure 38 - Aligning goniometer and axis of rotation for internal and external hip rotation measurement.

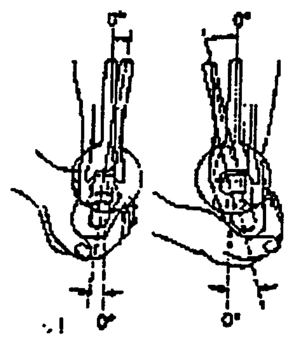


figure 39 - Aligning goniometer for hindfoot inversion and eversion measurements.

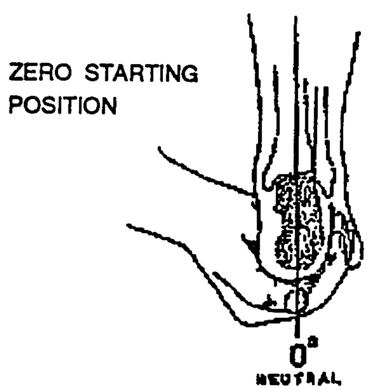


figure 40 - Neutral zero starting position for hindfoot inversion and eversion measurements.

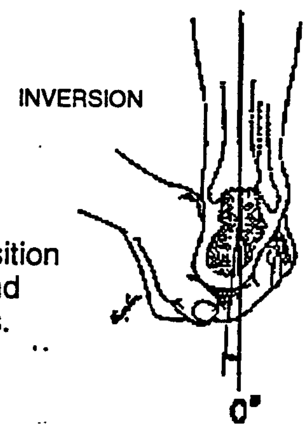


figure 41 - Passive motion of subtalar joint for hindfoot inversion measurement.

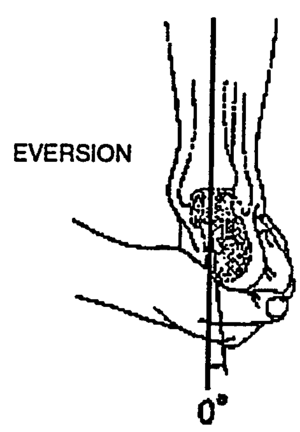


figure 42 - Passive motion of subtalar joint for hindfoot eversion measurement.

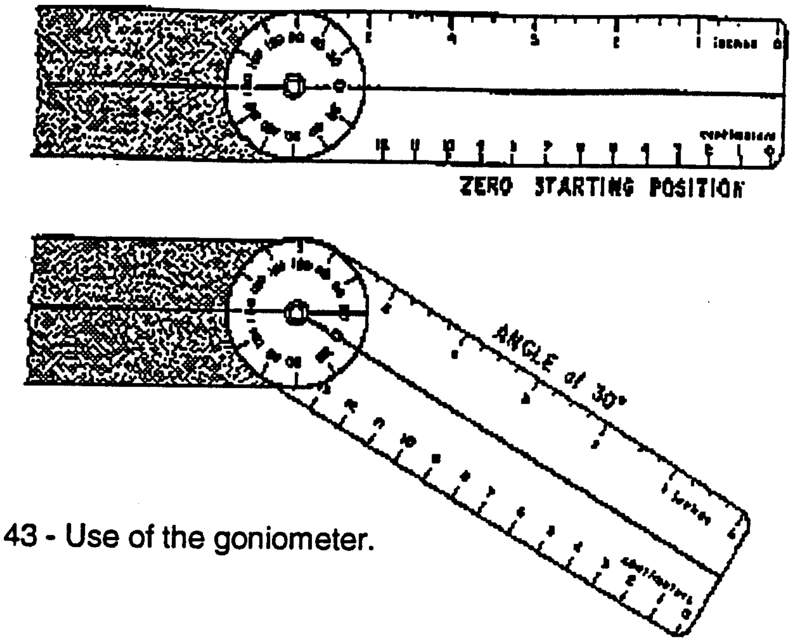


figure 43 - Use of the goniometer.

References for Anthropometric Protocol and Illustrations

American Academy of Orthopaedic Surgeons. Joint motion: Method of measuring and recording. Chicago: American Academy of Orthopaedic Surgeons, 1965.

Brody, D.M. Running Injuries. Clinical Symposia, 32(4):2-36, 1980.

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