
• PROSTHETIC PRINCIPLES • ABOVE

PROSTHETIC PRINCIPLES – ABOVE KNEE AMPUTATIONS

By

MILES H. ANDERSON, Ed.D.
Director, Prosthetics Education Project
School of Medicine
University of California
Los Angeles

JOHN J. BRAY, C.P., C.O.
Associate Research Prosthetist, Prosthetics Education Project
School of Medicine
University of California
Los Angeles

CHARLES A. HENNESSY, C.P., C.O.
Associate Director, Prosthetics Education Project
School of Medicine
University of California
Los Angeles

Edited by

RAYMOND E. SOLLARS
Associate Director, Prosthetics Education Project
School of Medicine
University of California
Los Angeles

CHARLES C THOMAS • PUBLISHER

Springfield · Illinois · U.S.A.

CHARLES C THOMAS · PUBLISHER
BANNERSTONE HOUSE
301-327 East Lawrence Avenue, Springfield, Illinois, U.S.A.

Published simultaneously in the British Commonwealth of Nations by
BLACKWELL SCIENTIFIC PUBLICATIONS, LTD., OXFORD, ENGLAND

Published simultaneously in Canada by
THE RYERSON PRESS, TORONTO

Library of Congress Catalog Card Number: 59-15595

Printed in the United States of America

FOREWORD

In the early part of 1944, a man named John E. Northrop, president of Northorp Aircraft, Incorporated, visited the Army's Birmingham General Hospital in Van Nuys, California. As a result of that visit, he became interested in the rehabilitation of amputees, and set about to improve service to amputees through the use of modern techniques, devices, and materials. In June of 1945, a Veterans Administration research and development contract was issued to Northrop Aircraft, terminating December 31, 1950.

During that period, the first five years of organized prosthetics research and development, Northrop Aircraft worked closely with the Department of Anatomy of the University of Southern California in the development of cinefluorography techniques, and collaborated with the fundamental researches when they were initiated at the University of California.

In reviewing the final report of the Northrop researches, published in 1950, we note that 56 individuals are given contributor credit by name. In a similar review of the 1947 report on the lower extremity fundamental researches at the University of California School of Engineering in Berkeley and School of Medicine in San Francisco, we note that 24 individuals receive acknowledgement as contributors. In the last decade, many other individuals have given of their thoughts and labors, adding to the contributions of the eighty pioneers mentioned above. In view of the ever-growing list of individuals who have contributed to this work, no attempt will be made in these pages to give credit by name.

This volume has as its foundation the findings of the early researches. These findings were translated into instructional materials setting forth basic principles and actual step-by-step procedures, and were then taught in the courses in "Clinical Prosthetics: Above-Knee Amputations" pre-

by the Prosthetics Education Project in the School of Medicine at the University of California, Los Angeles.

One of the most significant group contributions in the material presented in this volume was made by many of the prosthetists who not only attended the prosthetics education courses, but remained in contact with Anderson, Bray, and Hennessy through correspondence and return visits, and assisted in the constant refinement and improvement of the principles and procedures that were taught.

This book is presented as the culmination of four years of work by the staff of the Prosthetics Education Project, aimed at the production of a practical, ready-reference volume for the practicing prosthetist as well as a teaching text.

The Prosthetics Education Project is largely supported by a direct grant from the Office of Vocational Rehabilitation, Department of Health, Education, and Welfare. This support not only made possible the training of 125 prosthetists, 148 therapists, and 174 physicians and surgeons in above-knee prosthetics, but also made it possible to compile this volume.

The reader will find several references in these pages to a research study on 300 above-knee amputees. The work is now being carried on in the University of California School of Medicine, Los Angeles, under a research contract with the Prosthetic and Sensory Aids Service of the Veterans Administration. This work, titled "Clinical Study of Edema and Contracture Deformity As Amputation Sequelae", although not complete has already yielded findings which have brought about significant improvement and refinements in the above-knee prosthetics procedures.

It is the aim of this foreword to provide the reader with an understanding of the broad panoramic background of the materials presented herein, and to make him aware of the contributions of the Office of Vocational Rehabilitation and the Veterans Administration toward better service for amputees.

That worthy aim -- better service for amputees -- is the reason all of the research was done, and the reason this book was written.

PROSTHETIC PRINCIPLES

TABLE OF CONTENTS

FUNCTIONAL ANATOMY OF THE HIP, THIGH, AND KNEE

Introduction

The first step in fitting a socket is to make a complete and accurate record of all the important dimensions of the stump, and describe its characteristics in detail. This requires you to know the names and locations of all the important bones, muscles, and other landmarks involved.

Then we need to know the action of the muscles in the sound leg, in order to understand the ways in which their action is changed by amputation. That, in turn, helps us to construct the prosthesis so as to make the best possible use of the remaining musculature. We must know what has happened to the muscles, and what they are capable of before we can understand how to fit and train the amputee.

HIP AND THIGH

Bony Anatomy of the Hip and Thigh

The left and right halves of the pelvis are the innominate bones. These are seldom mentioned, as such. Their various parts are so important in body function -- and in lower extremity prosthetics -- that each part is spoken of separately.

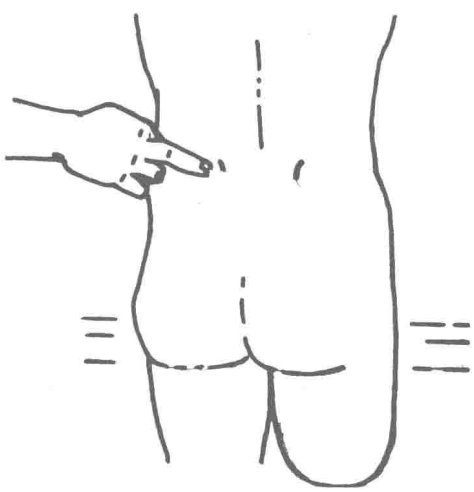
The parts of the pelvis that concern us are the ilium, the ischium, ramus, and acetabulum.

Functional Anatomy of the Hip, Thigh, and Knee

The Ilium

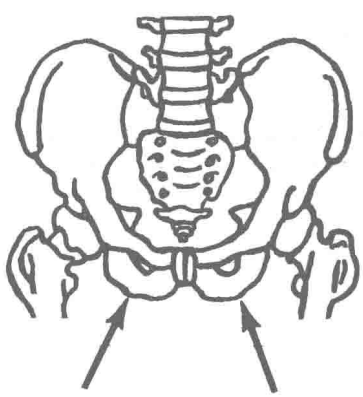
The ilium is the curving bone which begins just below the waistline in front and curves forward alongside the abdomen and down into the crease of the groin. Its top portion, the iliac crest, is clearly visible on most persons, and is an important landmark. By comparing the positions of the right and left iliac crests you can tell if the pelvis is level from side to side.

The ilium also curves to the rear and down. Another bony prominence, the posterior superior spine, is found here. This does not stick out, but its position is usually shown by a dimple in the flesh. Again, the right and left posterior spines may be compared to determine pelvic tilt.



Ischium, Ischial Tuberosity, and Gluteal Fold

The ischium is the lower posterior portion of the pelvis. Its most easily identifiable part is also the most important for suction socket fitting. The ischial tuberosity, the bone we sit on, is not only an important landmark but is the primary weight-bearing point in an A.K. suction socket prosthesis.



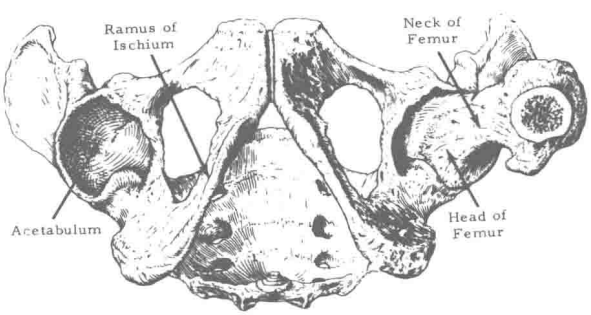
Functional Anatomy of the Hip, Thigh, and Knee

To locate the ischial tuberosity, place the palm of your hand, thumb up, on the back of the thigh -- left hand for the right thigh, right hand for left thigh. Slide the hand up the thigh till it meets the gluteal fold (the curve of the buttocks).

If your hand is pressed firmly into the fold, the forefinger will be on the tuberosity, or will be pointing at it.

Ramus of the Ischium

The ramus is the part of the ischium that curves forward and upward from the tuberosity. It is not used as a landmark in suction socket fitting; but it is of major importance because of the pain that is caused if it is called upon to bear any weight.

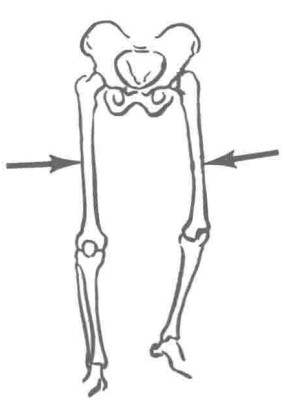


Acetabulum

The acetabulum, a hollow about 2-1/4 inches in diameter, receives the head of the femur to form the hip joint. It is the center of flexion and extension, adduction, and abduction.

Femur

The femur, or thigh bone, is the longest and strongest bone in the body. As we have already mentioned, the globular head rests in the acetabulum, forming the hip joint. The neck of the femur projects upward and inward toward the acetabulum at an angle of about 125 degrees from the shaft of the bone.



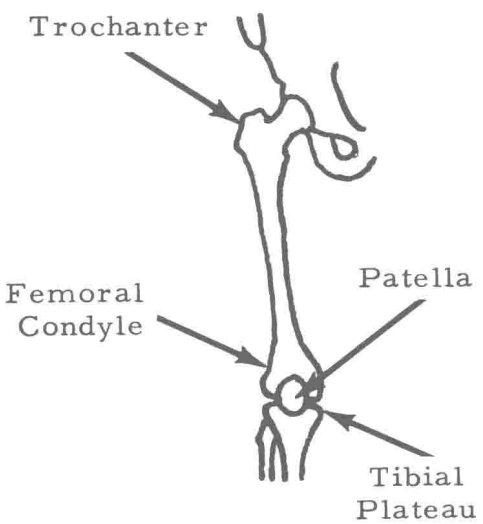
Functional Anatomy of the Hip, Thigh, and Knee

Trochanter

At the lateral (outer) end of the femoral neck is a large prominence called the greater trochanter, or simply trochanter.

Femoral Condyles

At the lower end of the femur are two bony prominences, or condyles, on the medial and lateral (inner and outer) sides. These are easily located and identified by palpation with the fingertips.

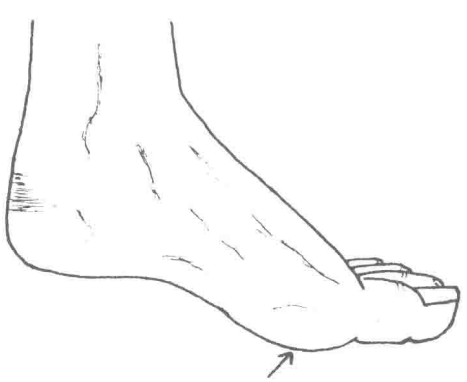


Patella (Kneecap)

The patella or kneecap is a lensshaped bone located at the front of the knee. It is actually in, and is a part of, the tendon of the quadriceps femoris muscle. In Gritti's amputation, an end-bearing stump is made by bringing the patella against the cut end of the femur.

Tibia and Tibial Plateau

The larger and inner (medial) of the two parallel bones of the lower leg (shank) is the tibia. It articulates with the femur to form the knee joint. On the left and right sides of the upper end are condyles, easily found by feel. These are regarded as defining the axis of A.K. prosthetic knee flexion. Their top surface is known as the tibial plateau, an important landmark for measurement purposes.



Medial Metatarsal Phalangeal Joint

This is the joint located on the medial side of the foot just back of the great toe. It is used as a landmark in locating the toe-break in the prosthetic foot.

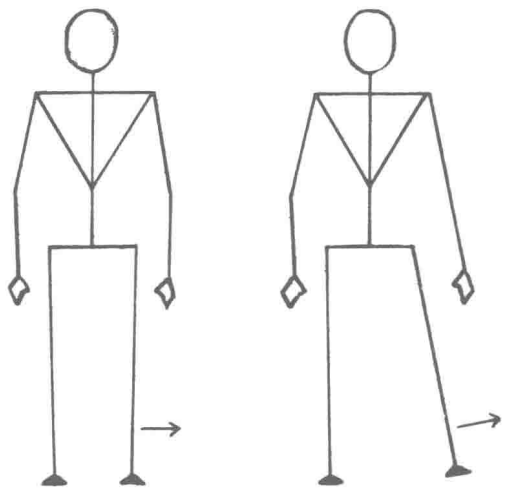
Functional Anatomy of the Hip, Thigh, and Knee

Anatomical Terms Used to Describe Body Movements

ABDUCT - To draw a limb away from a position near or parallel to the center line or median axis of the body. Standing erect with both feet together, you abduct your right leg by moving it sideways to your right.

ABDUCTION - The act of abducting a limb.

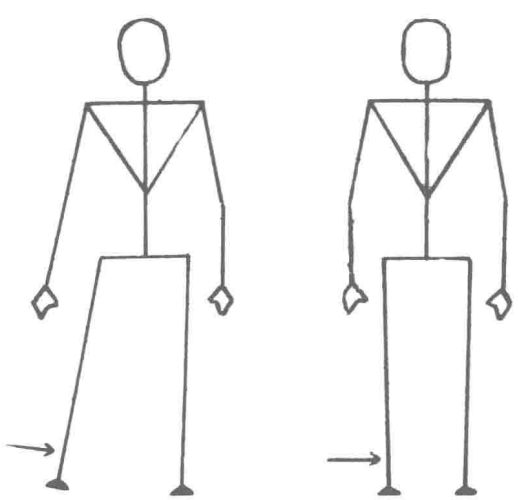
ABDUCTOR - A muscle that abducts a limb.



ADDUCT - To draw a limb toward the center line of the body. Standing erect with the feet apart, you adduct your right leg by moving it toward the left leg.

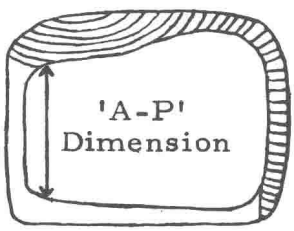
ADDUCTION - The act of adducting a limb.

ADDUCTOR - A muscle that adducts a limb.

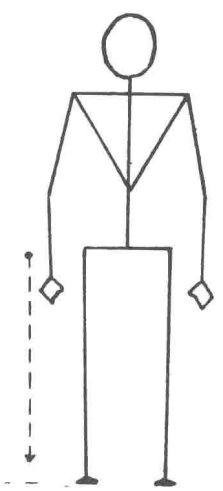


Functional Anatomy of the Hip, Thigh, and Knee

Anatomical Terms (cont'd.)



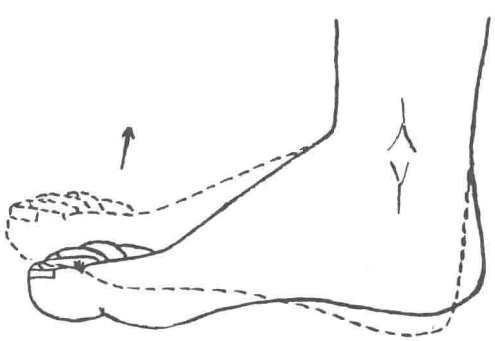
ANTEROPOSTERIOR - Extending from the front to the rear. Sometimes abbreviated 'A-P'.



DISTAL - The end of a limb farthest from the point of attachment.

DORSAL - Pertaining to the back of a body or one of its parts.

DORSUM - The back portion of a body or one of its parts.

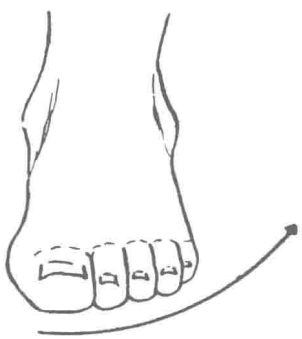


DORSIFLEXION - Flexion of a joint in a dorsal direction, or toward the back of the part.

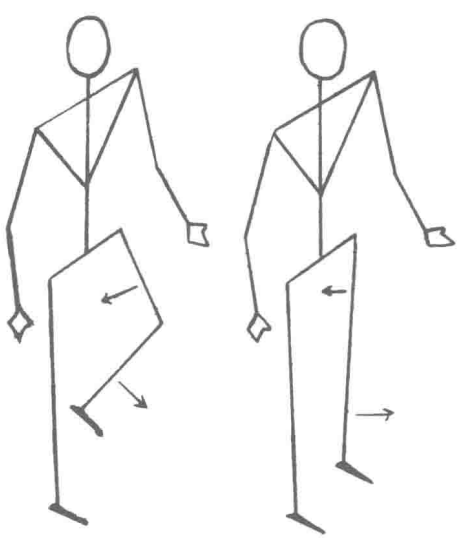
Functional Anatomy of the Hip, Thigh, and Knee

Anatomical Terms (cont'd.)

EVERSION - Turned outward.



EXTEND - To straighten a joint that has been flexed or bent. Joints can be extended or straightened, but limbs cannot. For example, in the act of rising from a kneeling position the knee (joint) and hip (joint) are extended or straightened.



EXTENSION - The motion of a joint when it is being straightened.

EXTENSOR - A muscle that acts to straighten a joint.