

Anterior Knee Pain in Children

Review of Recent Literature

Essay

Submitted for Fulfillment of
M.Sc. Degree in
Orthopedic Surgery

By

ABD ALMONEM GOMAA ABD ALMONEM

M.B., B.CH

Supervised by

Professor Dr. AHMED ABD EL- AZIZ AHMED

Professor of Orthopedic Surgery
Cairo University

**Assistant Professor DR KHALED ABD EL- SALAM
SHOHAYEB**

Assistant Professor of Orthopedic Surgery
Cairo University

Faculty of Medicine
Cairo University
2008

Abstract

causes. An awareness of certain patterns can help the physician identify the underlying cause more efficiently. Teenage girls are more likely to have patellar tracking problems such as patellar subluxation, dislocation and patellofemoral pain syndrome; where as teenage boys are more likely to have extensor mechanism problems such as Osgood Anterior knee pain in children is not a disease but is a syndrome with numerous causes. Chondromalacia patellae is a condition of the cartilage, not a disease that is never diagnosed alone. Relative muscular insufficiency, especially of knee

Key words

Disturbance – transmitted – shape - Children

Acknowledgment

I would like to express my profound gratitude and appreciation to **Prof. Dr Ahmed Abd El Aziz Ahmed**, professor of orthopedic surgery, Cairo university, under whose supervision, I had the honor to proceed with work.

I am also deeply indebted to **Prof. Dr. Khalid Abd El salam Shohyb**, professor of orthopedic surgery, Cairo university, for his constant support, valuable comments and continuous guidance in setting up and organizing the plane of this work.

The candidate

Abd AL Monem Gomaa

Contents

Acknowledgment	page 2
Introduction	page 4-5
Anatomy of the knee joint	page 6-14
Patellofemoral Biomechanics	page 15-19
Causes of anterior knee pain	page 20-21
Degenerative causes: Chondromalacia Patellae	page 22-25
Malalignment Syndromes: Patello femoral Malalignment	page 26-41
Miserable Malalignment Syndrome	page 42-44
Traumatic causes: Meniscal Injuries	page 45- 46
Congenital Discoid Meniscus	page 47-52
Patellar Dislocation	page 53- 57
Patellar Fractures	page 58-59
Bipartite Patella	page 60-61
Anterior Cruciate Ligament Injury	page 62-64
Diseases of Hoffa's Fat Pad	page 65-70
Over use syndromes: Osgood-Schlatters Disease	page 71
Sinding-Larsen-Johansson Syndrome	page 72
Jumper's Knee	page 73-75
Miscellaneous causes: Osteoid Osteoma of the Tibial Tubercle	page 76
Köhler's Disease of the Patella	page 77-79
Osteochondritis Dissecans	page 80-83
Idiopathic Anterior Knee Pain	page 84-86
Algorithm for anterior Knee Pain & summary	page 87-95
References	page 96-103
Arabic Summary	page 104

Introduction

Anterior knee pain in children is a common complaint with many possible causes. An awareness of certain patterns can help the physician identify the underlying cause more efficiently. Teenage girls are more likely to have patellar tracking problems such as patellar subluxation, dislocation and patellofemoral pain syndrome; where as teenage boys are more likely to have extensor mechanism problems such as Osgood schlatter disease and patellar tendonitis. Referred pain resulting from hip joint pathology, such as slipped capital femoral epiphysis also may cause anterior knee pain. Active patients are more likely to have ligamentous sprains and over use injuries such as pes anserine bursitis and medial plica syndrome (*Walter et al., 2003*).

Anterior knee pain in children is not a disease but is a syndrome with numerous causes. Chondromalacia patellae is a condition of the cartilage, not a disease that is never diagnosed alone. Relative muscular insufficiency, especially of knee extensors may occur in children and adolescents, as they grow rapidly the consequence is unbalance of active stabilizers and the disturbance of the tracking of the patella, particularly in the presence of dysplasia of the patellofemoral joint. The impingement syndrome pain occurs in sports children and in children overloading the patellofemoral joint (*Haspl et al., 2001*).

Other causes of anterior knee pain in children are idiopathic anterior knee pain, bipartite patella, osteochondritis dissecans, patellar fractures and bursitis (*Haspl et al., 2001*).

Musculoskeletal complaints account for 6.1% of primary pediatric clinic visits and knee pains account for 33% of these complaints. Hyper mobility of the knee joints and growth related factors unique to adolescent age group may play an important role in management of anterior knee pain. This condition is self limited and the prognosis is good (*Stathopulu et al., 2003*).

Determining the underlying cause of the knee pain can be difficult, in part because of the extensive differential diagnosis. The physician should be familiar with knee anatomy and common mechanisms of injury, and a detailed history and focused physical examination can narrow possible causes (*Walter et al., 2003*).

The diagnosis depends on the history, clinical examination, radiological finding and arthroscopy. The treatment in most cases is conservative consisting of stretching exercises and the strengthening of certain groups of femoral muscles serves to regain the balance, thus normalizing the tracking of the patella. If conservative treatment fails surgery is the alternative (*Haspl et al., 2001*).

Anatomy of the knee and patellofemoral joint

Introduction

The knee joint is the largest and probably the most complex joint within the human body. Its position between the two longest lever arms of the skeleton makes it vulnerable to injury by the tremendous moments that can be transmitted to it from loads applied at great distance to the ligaments and capsular structures that provide the structural integrity of the joint. Thus, it is not surprising that the knee joint is one of the most frequently injured joints (*Chapman, 2001*).

Because of its vital importance in support and locomotion of our bipedal existence, damage to its major components results in much discomfort and disability. An understanding of fundamental anatomy and biomechanics provides the basis for appropriate treatment of injury and disease processes involving the knee (*Chapman, 2001*).

The knee joint does not conform to any of the standard classifications of joints because it has some features of a hinge joint allowing flexion and extension and some of an arthrodial joint allowing gliding movement along its opposing plane surfaces.

The knee consists of three articulations: one between each sphere-like condyle of the femur and a corresponding but more planar condylar surface of the tibia, with interposed menisci, and a third between the patella and the trochlear groove of the femur. None of the pairs of bearing surfaces is exactly congruent, which results in a combination of rolling and gliding motions determined by the restraints of a complex network of ligaments, capsular structures and the contours of the bones themselves. This allows the knee six degrees of motion: three rotations and three translations:

a-The translations are anteroposterior (5 to 10 mm), compression–distraction (2 to 5 mm), and mediolateral (1 to 2 mm). These motions are limited by the ligaments, capsule, and to some degree the intracondylar eminences of the tibia.

b-The rotations are flexion–extension, varus–valgus, and internal–external rotation and in general they are much more extensive than the translations. Normal flexion and extension of the knee is variable, ranging from 0° to 15° of hyperextension to 130° to 150° of flexion. Internal and external rotation ranges from little or no motion in full extension to 20° to 30° with the knee flexed. Tightening of the capsular and ligamentous structures, which is greatest in full extension, accounts for this variation.

A- Osseous structures of the knee: (Fig.1)

The Patella:

The patella is a sesamoid bone in the quadriceps mechanism. As the insertion site of all muscle components of the quadriceps complex, it serves biomechanically to provide an extension moment during range of motion of the knee joint. The trochlear shape of the distal femur stabilizes the patella as it tracks through a range of motion. The hyaline cartilage of the patella is the thickest in the body (*Desio et al., 1998*).

At birth, the shape of the patella is well defined in cartilage form. Ossification begins between 3 and 6 years of age. Often there is more than one ossification center which gradually coalesce and ossification proceeds peripherally until all but the articular surface is replaced by bone. Ossification of the patella usually is complete by the beginning of the second decade (*Rockwood, 2006*).

The patella has a multifaceted dorsal surface, which articulates with the trochlear groove:

1- A median ridge divides the patella into two large facets. The lateral facet is greater in area than the medial, but sometimes they are nearly equal.

2-A less distinct vertical ridge divides the medial facet into two separate surfaces in most knees. The more medial of these two facets has a more nearly sagittal orientation and contacts the femur along the medial side of the notch only when the knee is flexed past 90°.

3-Indistinct transverse ridges divide the medial and lateral facets into roughly equal-sized superior, middle, and inferior facets.

The Distal Femoral Epiphysis:

The epiphysis of the distal femur is the first epiphysis to ossify at 39 weeks of gestation. From birth to skeletal maturity, the distal femoral physis contributes 70% of the growth of the femur and 37% of the growth of the lower extremity. The annual rate of growth is approximately 9 to 10 mm. The growth rate slows at a mean skeletal age of 13 years in girls and 15 years in boys. Physeal closure occurs between 16 to 19 years (*Anderson et al., 1963*).

Immediately above the medial border of the medial condyle, the metaphysis of the distal femur widens sharply to produce the adductor tubercle. In contrast, the metaphysis flares minimally on the lateral side to produce the lateral epicondyle. A line tangential to the distal surfaces of the two condyles(the joint line) is approximately horizontal in the upright stance. The longitudinal axis of the diaphysis of the femur inclines medially downward, with an angle of 9 degrees from vertical (the anatomical axis). The mechanical axis of the femur is formed by a line between the centers of the hip and knee joints (*Anderson et al., 1963*).

Anteriorly, the condyles of the distal femur are separated from one another by this shallow articular depression, which averages 5 to 6 mm in depth. Inferiorly and posteriorly, the trochlear surface is continuous with the intercondyloid fossa or notch. The lateral wall of the trochlear surface of the femur is more prominent than the medial and projects farther anteriorly.

The Proximal Tibial Epiphysis:

The ossific nucleus of the proximal tibial epiphysis appears by 2 months of age. It lies in the center of the cartilaginous anlage, somewhat closer to the metaphysis than to the articular surface. Occasionally, the ossification center is double. The secondary center in the tubercle appears between the 9th and 14th years. By the 15th year, the upper epiphysis unites with the tubercle and is almost completely ossified. Physeal closure occurs between 16 to 19 years (*Blanks et al., 1994*).

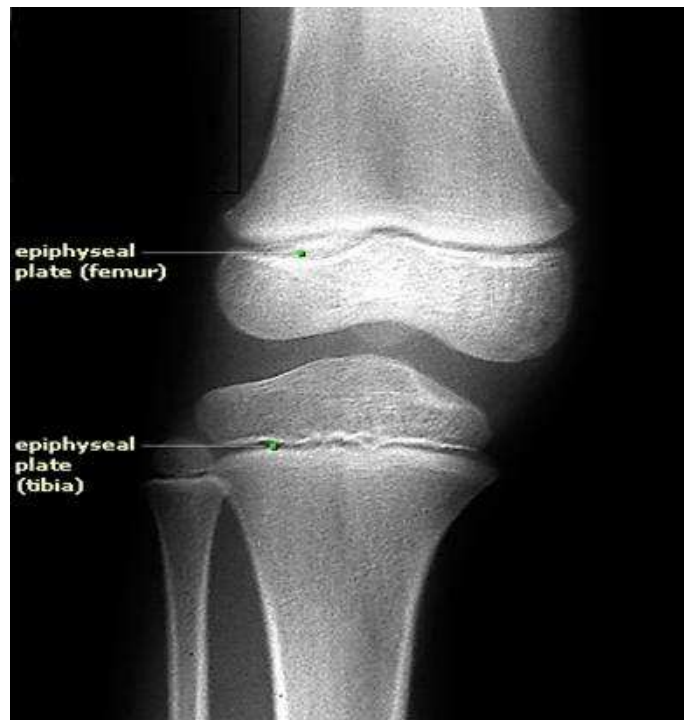
The distal surface of the epiphysis is concave to match the convex upper surface of the metaphysis. In the postero lateral corner, the physeal surface is immediately inferior to the upper tibiofibular joint. On the medial side, the physis is proximal to the insertion of the superficial MCL. In the midline anteriorly the physis dips down underneath the tibial tubercle (*Blanks et al, 1994*).

The Intercondylar Eminence:

The intercondylar eminence is that part of the tibial plateau lying between the anterior poles of the menisci forward to the anterior tibial spine. In the immature skeleton, the proximal surface of the eminence is covered entirely with cartilage. The anterior cruciate ligament attaches distally to the anterior tibial spine with separate slips anterior and lateral as well (*Lowe et al., 2002*).

The Tibial Tubercle:

The tibial tubercle is a bony prominence on the anterior aspect of the proximal tibia it lies approximately one to two finger breadths distal to the proximal articular surface of the tibia and forward of the anterior rim of proximal articular surface.



(Fig.1)Antero posterior X-ray showing the articulation of the knee joint(**Rockwood, 2006**).

B-Soft tissue covering of the knee:

The fascia lata of the thigh invests the superficial surface of the quadriceps, the patella, and the patellar tendon. Its medial and lateral extensions contribute to the patellar retinaculum along with aponeurotic fibers from the vastus medialis and lateralis. Laterally, the fascia lata thickens into the iliotibial tract and the iliopatellar band. The former inserts into the tubercle of Gerdy, and the latter inserts into the patella (**Terry et al., 1986**).

The patellofemoral ligaments are variably present. When present they range in width from 3 to 12 mm. They are thickenings of the joint capsule and pass from the epicondyles to their respective borders of the patella. Of 20 specimens dissected specifically to identify these structures, they are present laterally in seven instances, medially once, and both medially and laterally in six Specimens (**Reider et al., 1981**).

The patellar retinaculæ: (Fig.2.).

These are fibrous expansions from the tendon of the quadriceps femoris, and inserted into the edges of the patella and the ligamentum patellae and into the inferior border of the tibial condyles (*Last, 1988*).

A-The lateral retinaculum :

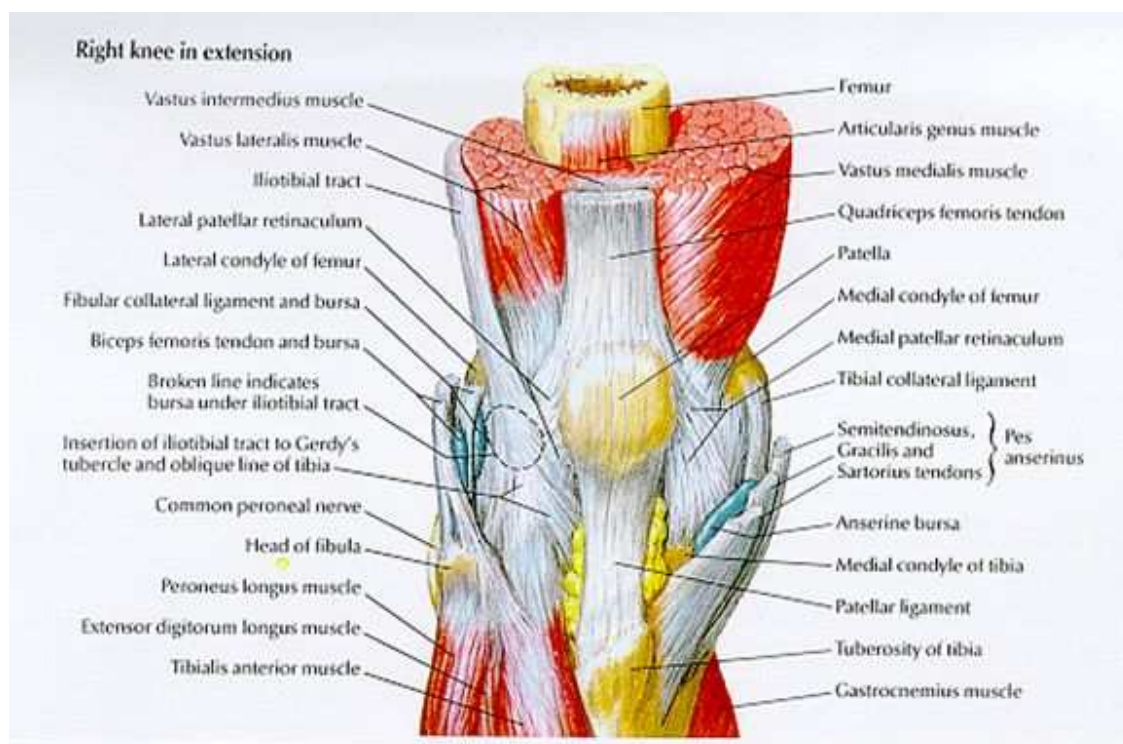
The lateral retinaculum Is composed of two layers of fibers:

- (1) The superficial layer (the superficial oblique retinaculum) is composed of oblique fibers running in a distal and inferior direction, from the anterior border of the iliotibial band to the lateral margin of the patella and the lateral aspect of the patellar tendon.
- (2) The deep layer is composed of three distinct structures:
 - a- Deep transverse retinaculum: is the midportion that runs transversely from the deep surface of the iliotibial band to the lateral border of the patella (*Fulkerson and Grossling, 1980*).
 - b- Epicondylopatellar band: which runs superior to the deep transverse retinaculum and connects the lateral epicondyle to the superolateral aspect of the patella (*Kaplan, 1962*).
 - c- The patello tibial band which runs inferior to the deep transverse retinaculum and connects the tibia to the inferolateral aspect of the patella (*Reider et al., 1981*).

B-The medial retinaculum:

The medial patellar retinaculum inserts into the upper two thirds of the medial margin of the patella. Two distinct condensations of fibers have been described:

- (1) The medial patellofemoral ligament which inserts into the medial femoral epicondyle.
- (2) The medial patellotibial ligament which inserts into the medial meniscus and tibia (*Reider et al., 1981*).



(Fig.2)The patellar retinaculæ

The four large quadriceps muscles form a tendon of insertion into the superior aspect of the patella, which has classically been described as consisting of three separate layers: A deep portion arising from the vastus intermedius, A middle layer consisting of the two vasti and a superficial layer from the rectus femoris (**Reider et al., 1981**).

The patella tendon extends from the entire inferior aspect of the patella (closer to its superficial surface than to the articular surface) to the periosteum overlying the tibial tubercle. The majority of its fibers blend into the periosteum rather than inserting directly into bone. The length of the infrapatellar tendon is variable, but it is usually approximately equal to that of the patella (**Reider et al., 1981**).

C-Intra articular structures of the knee:

The Anterior Cruciate Ligament:

The anterior cruciate ligament originates off the posterior margin of the lateral aspect of the intercondylar notch. The anterior horn of the lateral meniscus is typically attached in the region of the intercondylar eminence at the anterior cruciate ligament insertion (*Lowe et al., 2002*).

The Posterior Cruciate Ligament:

The posterior cruciate ligament originates off the medial aspect of the intercondylar notch and inserts on the posterior aspect of the proximal tibia, distal to the joint line (*Lowe et al., 2002*).

The Menisci:

The menisci become clearly defined as early as 8 weeks of embryologic development. By the week 14, they assume the normal mature anatomic relationships. At no point during their embryology are the menisci discoid in morphology. Thus, the discoid meniscus represents an anatomic variant, not a vestigial remnant (*Kaplan, 1955*).

The blood supply arises from the periphery and supplies the entire meniscus. This vascular pattern persists through birth during post partum development, the vasculature begins to recede and by the 9th month, the central third is avascular. This decrease in vasculature continues until approximately age 10, when the menisci attain their adult vascular pattern (*Clark et al., 1983*).

The medial meniscus is C shaped. The posterior horn is larger in anteroposterior width than the anterior horn. The medial meniscus covers approximately 50% of the medial tibial plateau. It is attached firmly to the medial joint capsule through the meniscotibial or coronary ligaments. The inferior surface is flat and the superior surface is concave so that the meniscus conforms to its respective tibial and femoral articulations (*Greis et al., 2002*).

The lateral meniscus is more circular in shape and covers a larger portion, approximately 70%, of the lateral tibial plateau. It is more loosely connected to the lateral joint capsule. There are no attachments in the area of the popliteus hiatus, and the fibular collateral ligament does not attach to the lateral meniscus. Accessory meniscomfemoral ligaments exist in up to 1/3 of cases. These arise from the posterior meniscus if this ligament inserts anterior to the posterior cruciate ligament, it is known as the ligament of Humphrey (*Greis et al., 2002*).

The menisci serve to increase contact area and congruency of the femoral tibial articulation. This allows the menisci to participate in load sharing and reduces the contact stresses across the knee joint it is estimated that the menisci transmit up to 50% to 70% of the load in extension and 85% of the load in 90 degrees of flexion (*Ahmed et al., 1983*).