

Structure of the Knee

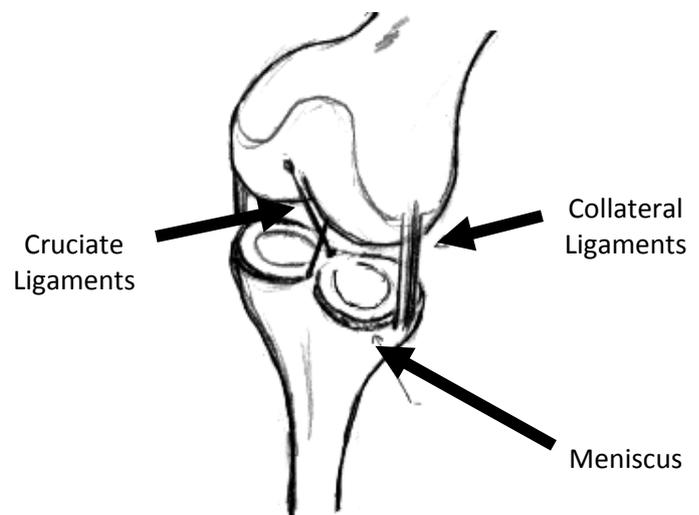
The knee is one of the most complex joints in the body. It is highly flexible and yet bears the weight of the body across its surfaces. This combination makes it susceptible to damage and strain making it one of the most common sites of sporting injuries and a potential site of yoga practice injuries.

The bones which make up the knee are the Femur (thigh), Tibia (shin) and Patellar (knee cap). Although it appears to be simple joint it is in fact made up of 2 distinct joints. These are tibiofemoral and patellofemoral joints.

Across these articulating surfaces there are structures which bind, secure and align the knee - these are the cartilages and ligaments. The 2 cartilages called meniscus sit between the bones and keep the femur and tibia running smoothly on one another and stop the bones wearing, the 2 collateral ligaments which align the joint in hinge and secure the knee when straight, and the anterior and Posterior cruciate ligaments which locate the tibia under the femur. See **Figure 1**

Within the knee there are a number of Bursa. These are small, fluid filled sacks usually located behind the attachment of a tendon to stop rubbing and potential inflammation.

Figure 1



Function of the Knee

While the knee appears to be a hinge joint (one which flexes like a door hinge) it has 3 distinct movements. These are hinge, glide and rotation.

Figure 2a, b, c, defines these movements and the structures which initiate it. The collateral ligaments

support the knee from either side and are tight when the leg is straight. As the knee bends these ligaments loosen and the cruciate ligaments which crisscross deep in the knee move the tibia back so that it remains under the femur. As the knee bends and the joint un-tensions the tibia turns inwards due to 2 of the three hamstring attachments being located on the inner knee. The knee joint becomes flexible allowing the knee to perform Virasana cycle where the heel sits outside the line of the hip. Although not easily seen, inward rotation creates a greater possibility for the medial meniscus to become squashed between the tibia and femur in poses such as janu sirsasana and padmasana. (see last page).

Figure 2



A - Hinge.

The collateral ligaments on either side Hinge the knee as it bend



B - Glide.

As the knee bends the cruciate ligaments slide the tibia back or forward to keep it under the femur



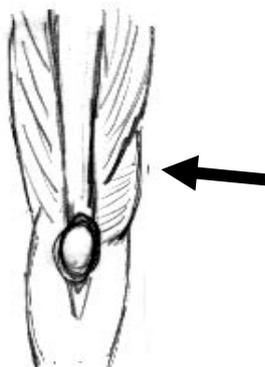
C - Rotation.

As the knee bends the tibia turns inwards as 2 of the 3 hamstrings are attached to the back of the inner knee.

While these structures mentioned above support and bind the knee it is important not to underestimate the influence of the muscles which in effect enhance the stability by keeping the joints snug. Across every joint are a set of opposing muscle groups. As one set contract the group on the opposite side must lengthen the effect of which keeps the joint surface under a constant, even pressure and distribute the weight over a greater surface. If one of the muscle groups is over developed or tight an excess of pressure is created. This often leads to a grinding sensation or a gravelly sound because of increased joint pressure.

Each time the knee bend, the meniscus, cruciates, and bones must relocate into exact positions for the joint to function smoothly, as often occurs a twist or strain produces the laxity in the joint, or following a sprained ankle loss of muscle strength, is the first stage in loss of joint integrity. Thus follows increased wear in the structure as the structures “slap” against one another. The muscles when functioning in coordination keep the joint well oiled and stable but when one set are overdeveloped or tight they create unequal pressures in the joint which when used hundreds or thousands of times a day, as we all do in walking, multiplies the stresses. One of the quadriceps group Vastus Medialis (located on the inner thigh) is often indicated in knee discomfort. Vastus Medialis **Figure 3** is only active in the last 15 degrees of straightening and if under used it atrophies and the opposing group of muscles on the outer leg create an uneven pressure on the knee. Medial (inside portion) Meniscal injuries are more prevalent in cases of under developed Vastus Medialis - this is the most common form of knee injury.

Figure 3

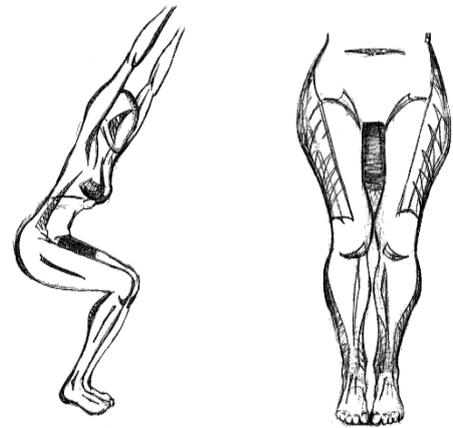


Vastus Medialis
Balances the angle of pull of the quadriceps so that the knee aligns evenly

The knee is at its most stable when straight when the knee aligns its bones and they lock into place, although it is vulnerable at this time to impact forces from the side as is often found in contact sports ie rugby league and soccer as well as sports which require fast changes of direction with body weight - squash.

It is important to remember also that the knee is not used in isolation and that it is rare if ever that we use the knee without using the hip and ankle. Can you imagine the increased forces applied to the knee if these other 2 joints were severely restricted. It is impossible to study the knee without assessing these other structures. Weakness and instability of the knee cause an increase of tension in the hip complex - non weight bearing *supta padanghusthasana* is ideal for addressing tension and loss of mobility in the area. *Utkatasana* is an asana which can be used to coordinate and define the movements of the Knee, hip and ankle. Place a block between the thighs to keep the thighs parallel and the abductors tensioned. When the knees are bent keep the weight into the heels (toes light) but importantly keep the inner ankles separated by about 2 fingers width so that as the knees bend the ankles don't swivel and avoid the work of the thighs **Figure 4**. This keeps the bent knees tracking straight ahead and coordinates the movement of these three joints altering the habitual use of the muscles and in the long term balancing their development. If *Utkatasana* is done, bending and straightening the legs slowly, with emphasis on lifting the kneecaps with thighs firm through the last portion of the movement, the *Vastus Medialis* is integrated into the movement as it is only active in the last 15 degrees of straightening. With this in mind all standing poses should be done in this way -for example: *Trikonasana* done bending and straightening like a one legged *Utkatasana* with emphasis on smooth slow straightening through the last few degrees with thigh drawn up and inner ankles lifted (weight in heels). Same for *Virabhadrasana 2*, *Parsvottanasana*, *Ardha Chandrasana*. A block can be placed under the ball of the foot to assist the active use and strengthening of the quadriceps with conscious application of the big toe mound throughout the movement.

Figure 4



Utkatasana

The ankles are kept at 2 fingers width while gripping a block.

Strength versus Stretch

If the muscles around the joint are too strong (ie short), the joint surfaces are compressed while if there is no tone in the muscles the joint becomes loose and unstable. Joint integrity is maintained by a fine balance of strength and stretch. After an injury muscle bulk depletes rapidly without weight bearing use, with significant changes in muscle size noted in as little as 3 days. Yoga is ideal for re-establishing stability to the knee joint post injury as all the movements can be done in a controlled way without jarring or impact. A trestler is ideal to assist the student in adjusting the pressures and weight across the surfaces of the knee although a chair or stool can be used in its place - using the hands to take some of the body weight.

Squatting is the most open position for the joint where the structures are stretched to the limit. Those with knee damage or sensitivity find this movement most difficult with the knee either feeling too stiff, compressed or they experience sharp pain. With this in mind, standing up from squatting should be done with caution and in cases of knee damage squatting should be avoided completely until the swelling has reduced and the joint becomes stable. Bearing this caution in mind, stretching is the most beneficial of movements to create space within the joint. Stretching the joint is done at end range of both bending and straightening. In bending a small roll or hand towel placed behind the joint presses the femur and tibia apart so that the front of the joint is stretched and the joint surfaces and meniscus are kept from compressing. This action of stretching the joint and capsule provides a greater flow of blood.

In cases of chronic knee problems the full extension of the knee joint is lost. While initially the hamstrings tighten, joint thickening and adhesion follows so that over time the joint will not straighten. In these cases *Utthita Hasta Padanghusthasana* with weights as well as *Paschimottanasana* with weights are ideal. This however should be developed with a program of strengthening, as in **Group 1** poses. Asanas which stretch the knee are included in **Group 2**.

Arthritic Knees

Due to the repetitive weight bearing use of the knee arthritic changes are not uncommon. Arthritis is of 2 main types - Rheumatoid arthritis and Osteoarthritis. In Rheumatoid arthritis the joint is attacked by the body's immune system and changes the joint capsule and running surfaces while osteoarthritis is generally associated with wear and tear over a period of time.

Regardless of the cause, which is often uncertain, arthritis presents as a gradual tightening and withering of the joint and bone surfaces. Under use of the affected area increases stiffening and withering. Apart from anti-inflammatory drugs exercise is recommended by doctors. Blood is the vehicle through which nutrition is supplied to the site as well as the removal of waste by products, so that asana practice should be undertaken regularly to mobilise and open the joint. The use of a spacer (rolled or folded hand towel) behind the knee keeps the joint surfaces apart and stretches the joint capsule. Asanas from **Group 2** show a number of movements which stretch the joint. Inversions from **Group 3** relieve weight bearing fatigue and pain.

Meniscal Damage

Damage to the meniscus (cartilages of the knee) are common with the inner (medial) meniscus more prone to injury. The meniscus sit between the femur and tibia and are attached to the synovial capsule (joint wall). They move forward and back as the knee goes from straight to stretch. Damage occurs when the meniscus becomes squashed between the femur and tibia as they straighten. This occurs on rapid, weight bearing change of direction ; examples are squash - where the foot is slammed down applying body weight to the bent knee which compresses the meniscus; then the upper body changes direction on the fixed position of the tibia. This force acts like a pestle and mortar grinding the meniscus between the bones. A cut or tear appears in the meniscus which often creates a flap that sits prominent in the joint over stretching it. Associated swelling compresses the joint. In the acute phase care should be taken as the swelling and instability can lead to further damage.

Although healing of the tear depends largely on the location and extent of the tear (as the meniscus has only limited blood supply) supporting the back of the joint with a roll will maintain space in the joint and relieve pain. Janu Sirsasana presents a challenge as the joint is at full stretch and the twist of the tibia exerts more pressure on the meniscus. Asanas from **Group 1** are indicated.

Caution

Following a knee injury there is always swelling - whether impact, strain, or internal damage. The area affected swells and becomes hot and sensitive. This may last anything from a few days up to weeks or even months in some cases of meniscal tear. There should be no attempt to manipulate the area until this acute phase passes or a clear diagnosis is confirmed.

Asanas

The following 3 groups of Asanas are useful for :

Group 1. Strength and Alignment.

No jumping into or out of standing asana. Emphasis should be given to alignment of hip, knee and ankle.

- Virabhadrasana 2 *
- Utkatasana
- Trikonasana *
- Ardha Chandrasana *
- Parsvottanasana. *
- Prasaritta Padottanasana
- Chatush Padasana. (feet on floor)

Note - Standing poses marked with an asterisk can be done with front foot supported on a wedge as in photo 1.



Foot position on wedge



Elasticated belt may be used to increase resistance



Hand to inner heel



Ardha Chandrasana



Parsvottanasana



Uttkatasana



Uttkatasana (block support)

Group 2. Knee Stretches

Movements which stretch and open the knee joint must create space between the internal surfaces of the knee and in this case a support behind the knee is common.

- Half Bhekasana - standing (close to wall) with towel or roll behind knee.
- Virasana with buttocks lifted and ropes behind to draw the knee crease well in.
- Eka pada Bhekasana. (lying with rope traction behind knee to crease the knee).
- Baddha Konasana (with rope traction behind knee).
- Uthita Hasta Padanghusthasana - to front and side. Weight can be used where past injury has developed adhesions and limited range of movement.
- Paschimottanasana with belt around shins and or block between thighs where femur and tibia are misaligned.



Utthita hasta
padangusthasana 1



Adho mukha Svanasana on
chair

Utthita hasta
padangusthasana 2



Virasana cycle. Arm variations
can be included in the cycle

Utthita hasta
padangusthasana 2



Virasana using blocks to
manage the range of
movement



Triang mukhaikapada
paschimottasana with
roll¹



Janu sirsasana rope²



Baddha konasana with belts



Eka pada
bhekasana

Group 3. Inversions

non weight bearing pressure changes and strengtheners for the knee.

- Sirsasana - with block between thighs and belt around.
- Sarvangasana - with block between thighs and belt around.
- Hanging Sarvangasana - with knees bent over trestler.
- Urdhva Prasarita Padasana.
- Supta Padanghusthasana.
- Viparita Karni.
- Ardha Halasana (with chair or box)
- Chair support to the knee whilst lying in Savasana.



Salamba Sirsasana 1



Salamba Sarvangasana 1



Salamba Sarvangasana 1
with trestle support



Ardha halasana

¹ Use of roll or bandage spaces the bones of the joint to remove pressure on the meniscus

² A belt is used to 'crease the knee'. The hamstring tendons are pacified so as to maintain the space in the joint and emphasise the stretch on the frontal fibres of quadriceps and patellar.



Viparita karani



Sputa padangusthasana
cycle



Sputa padangusthasana
cycle



Sputa padangusthasana
cycle



Bent leg savasana

Group 4. Asanas which may cause difficulty or irritation

Janu Sirsasana. (see diagram below)

Pasasana. (full squat)

Virabhadrasana , Parivrtta Trikonasana and Parsvakonasana. All twisting standing poses may place twisting pressure through the back leg and knee. A block or wedge under the heel will lessen the torque on the back knee. Padmasana. And all padmasana type movements where stretch and rotation is present.



In both Janu Sirsasana and all padmasana the femur should roll out as the tibia turns forward so as to keep space in the joint. A rope behind the knee pulling forward (to crease the knee) clears the meniscus and elongates the hamstring attachments to maintain the space in the joint.