



Prevention of progression of osteoarthritis knee. Is it possible?

D Prabodh Kumar*, L Sarella, B Srinivasrao & D Bhaswanth
Rangaraya Medical College, Kakinada-533 001, Andhra Pradesh, India

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Knee joint is an organ made up of joining of two long bones and supported by joint capsule, ligaments and menisci which is moved by muscles. It helps in locomotion. As many physicians thought osteoarthritis of knee is not a degenerative disease but failed attempt of the joint to repair the mechanically induced damage caused by abnormal intraarticular stress. Normalization of this stress is shown to result in structural and symptomatic improvement. Progression of osteoarthritis can be prevented by strengthening of bone and muscles and also by correcting the altered mechanical axis. Strength of bone and muscles is the strength of joint.

Keywords: Knee joint, Mechanical axis, Osteoarthritis, Osteotomy

Osteoarthritis of knee is a chronic disease and a leading cause of disability, which can deteriorate a patient's quality of life and currently affecting about 10% of the population older than 60 years worldwide. People belong to rural areas are being affected more due to over usage of knees as a part of their lifestyle. Affected people of osteoarthritis of knees, suffers from, joint pain, stiffness, crepitus, swelling, limitation of movement leading to significant disability, loss of working capability, and impaired quality of life.

Unfortunately, many physicians and patients still consider osteoarthritis as a degenerative joint disease due to aging. *But osteoarthritis is not a degenerative joint disease.* Osteoarthritis is often viewed incorrectly as a condition that once osteoarthritis becomes symptomatic it progresses and makes the patient disabled.

While several studies suggest that a moderate level of physical activity does not cause permanent joint damage or a predisposition to osteoarthritis, but any abnormal joint stress can increase the progression of osteoarthritis.

In our study, we found all cases of osteoarthritis knee are due fundamentally to abnormal intraarticular stress. It has been suggested that the mechanical environment of the knee can influence both the health and breakdown of all supporters of the knee including articular cartilage during walking.

The knee joint is the unique organ that is load-bearing and weight-bearing formed by the articulation of two long bones that is the distal end of the femur and the proximal end of the tibia which receives both ground reaction force and body reaction force and it is subjected to more stress during all regular physical activities when compared to the hip joint above and ankle joint below.

The mechanical axis extends from the centre of the head of the femur, across the centre of the knee to the centre of the ankle joint. Any deviation of the mechanical axis can produce abnormal stresses across the knee (Fig. 1).

Materials and Methods

For our study we screened the people from rural areas both male and female aged above fifty years, complaining of knee joint pains. Most of them work in fields, work in building construction, walk on uneven surfaces without proper foot wear, carry lot of weights on their back, often sitting in squatting position for prolonged period, stand or walk for hours together as a part of profession. In all these activities the knees will be overused and the supporting structures become weak and intra articular stress of the knees will be increased.

Knee stabilization

The most important factors of knee stability include:

Ligaments of the knee the knee is stabilized by four main ligaments
Anterior cruciate ligament (ACL)

*Correspondence:

Phone: +91-9491418893 (Mob)

E-mail: Prabodh.ortho@gmail.com

Posterior cruciate ligament (PCL)
 Medial collateral ligament (MCL)
 Lateral collateral ligament (LCL)
 Menisci

Joint capsule (especially posterior knee capsule)
 Muscle Quadriceps femoris muscle (vastus medialis obliques stabilizes patella)

The normal knee joint can support a life time of repetitive load generally without the development of mechanical changes. Any change in above structures can alter the bio mechanics of knee thus initiates osteoarthritis. The knee joint can withstand all these forces and stresses as long as the bone mineral density, strength of the muscles and other supporters (stabilizers) of the knee joint are normal (Fig. 2).

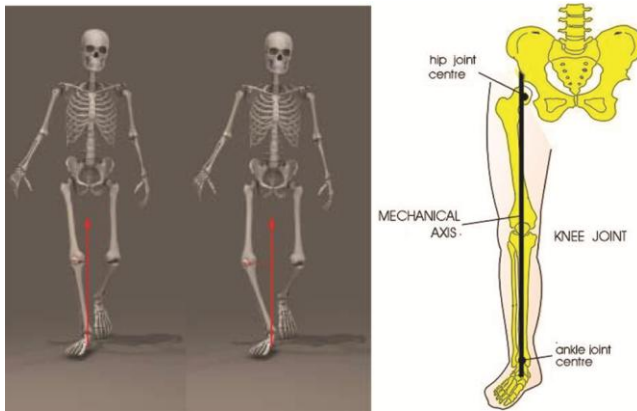


Fig. 1 — Mechanical axis

Knee Joint Ligaments

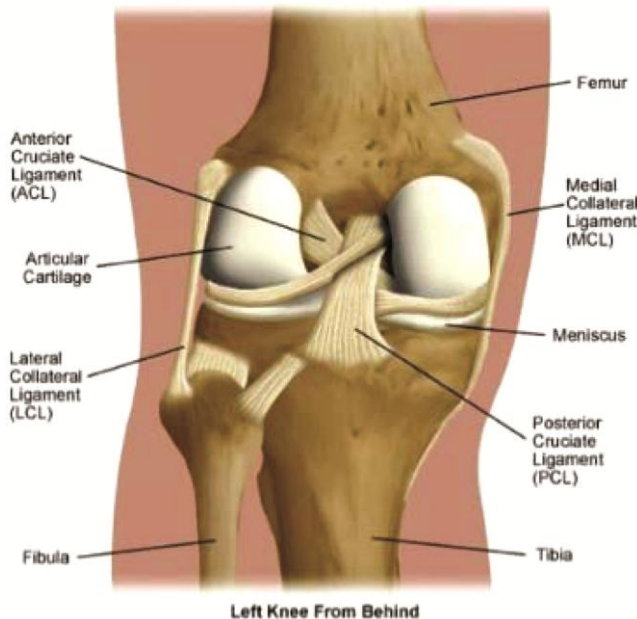


Fig. 2 — Knee stabilizers

As the tone of antigravity muscles reduced due to sarcopenia (the loss of skeletal muscle mass), and osteoporosis, pressure falling on knee joints will be increased. The porotic bones cannot withstand the forces falling on knees, leads to collapse of trabeculae of condylar part of tibia (cancellous part), more in medial condyle in turn leads to genu varus deformity. *Varus thrust i.e., rapid lateral bowing of the knee during ambulation was associated with a four-fold increase in the likely hood of progression of medial tibiofemoral compartment osteoarthritis.*

The ligaments of the knee also become lax and the knee become unstable, further causes articular damage. The hyaline cartilage, is subjected to degrade due to raised pressures in the knee joint and altered biomechanics.

- Most of the times, varus at knee in older people is not due to medial joint compartment narrowing, but it is due to collapse of sub chondral cancellous bone due to osteoporosis more on medial condyle of tibia.
- Which further increases the load on medial compartment of knee leads to more pressure on articular cartilage and makes it thin.

Excessive loading of a joint especially RIL-(repetitive impulsive loading) will lead to a fracture of the subchondral bone before it produces obvious damage to articular cartilage (Fig. 3).

Softening of underlying subchondral bone and healing trabecular micro fractures followed by progressive damage to the articular cartilage.

Osteoporosis indirectly weakens the joint integrity, which in turn influences the muscle action force leading to muscle atrophy. Sarcopenia and osteoporosis decreases the weight bearing and load bearing capacity of the knee and make it vulnerable for progression of osteoarthritis (Fig. 4). Most of the shock absorption is provided by the subchondral metaphyseal and diaphyseal bone and the periarticular soft tissues

Clearly showing trabecular collapse at medial condyle of Tibia

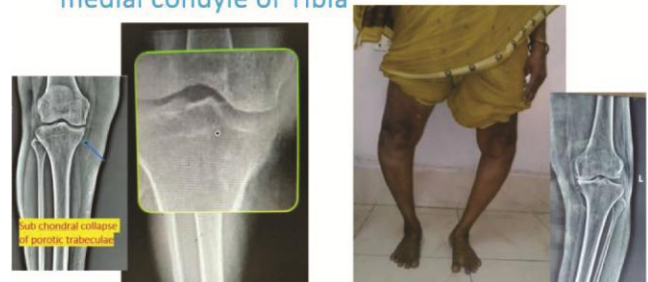


Fig. 3 — Sub chondral bone collapse leading to varus

SARCOPENIA AND OSTEOPOROSIS

• REVERSED MILE STONES THEORY

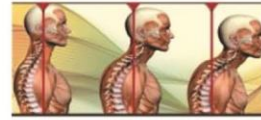
- As infant grows
- At 3 Months Head holding



- At 6 Months Sitting



- At 12 Months Standing and walking



Difficulty in head holding



difficulty in holding the back



Difficulty in standing erect

Fig. 4 — Sarcopenia and osteoporosis changes weight bearing axis



Fig. 5 — Gross wasting of quadriceps muscle on right side

especially muscles. Progressive quadriceps wasting can make almost all daily activities more difficult (Fig. 5).

Hypothesis of present study

The present study is designed to study about the various preventive aspects of progression of osteoarthritis of knees in rural population.

Objectives

- 1 To assess various causes of osteoarthritis of knees in rural population, and to study the various preventive methods of progression of osteoarthritis.
- 2 To make the rural population more aware about osteoarthritis of knees, so they can work for more years efficiently, without any disability due to osteoarthritis of knee.

Analysis and statistical methods

- 1 In the rural population, people above 50 years, are assessed about their knees, in relation with their daily activities and profession.

- 2 Their musculoskeletal balance will be assessed by assessing the antigravity muscle tone and quality of bone.

Hand grip strength alone has also been advocated as a clinical marker of sarcopenia that is simple and cost effective and has good predictive power, although it does not provide comprehensive information.

3. Bones....assessment of bone quality is done by assessing BMD (bone mineral density) X-Rays, MRI.
 - Most of the times, varus at knee in older people is not due to medial joint compartment narrowing.
 - But varus is due to collapse of sub chondral cancellous bone due to osteoporosis more on medial condyle of tibia.
 - Collapse of sub chondral bone by micro fractures of thinned out trabeculae due to osteoporosis, gives pain and patient complains pain of knee which may be mistaken for OA knee pain (Fig. 6).

How to prevent the progression of osteoarthritis?

The health of the knee joint is based on the strength of the muscles and strength of the bones and stabilizing structures i.e., ligaments and supportive tissues like meniscus, cartilage, synovium, and joint capsule.

Osteoarthritis knee is a chronic and progressive disease, an early diagnosis is essential to establish adequate therapy to counter the progression of the disease. Indeed, untreated osteoarthritis can easily evolve into symptomatic late-stage osteoarthritis, eventually leading to the complete loss of articular function and subsequently to the need for TJA (Total Joint Arthroplasty).



Fig. 6 — Collapse of thinned out (osteoporotic) sub chondral trabeculae due to micro fractures

Exercise program

Exercise is effective, economical, and safe. But exercises are prescribed much less often than drugs. Non-pharmacologic measures are the cornerstone of the management of the patient with symptomatic osteoarthritis. The exercise program should focus on joint protection strategies. Regular physical activity is important for patients with knee osteoarthritis.

In the presence of knee osteoarthritis, quadriceps strength may be diminished by as much as 60%. Exercise programs aimed at strengthening the knee extensors (isometric quadriceps exercises) mainly vastus medialis obliquus muscle, can result in a significant gain in strength of quadriceps, reduction of joint pain and improvement in gait.

Peri articular muscles are of major importance in attenuating shock to the joint. periarticular muscle weakness may result in the progression of structural damage to the joint in osteoarthritis. Exercise regimes that strengthen lower extremity muscles decrease joint pain and slow down the progression of joint damage in patients with knee osteoarthritis.

Apart from the quadriceps, the other antigravity muscles above the knee – the gluteus maximus, erector spinae, and other muscles of the back and neck are also may become weak due to sarcopenia and are indirectly responsible for the increased load over the knee while standing and walking.

Strengthening of muscles and strengthening of bones is crucial in the prevention of progression of osteoarthritis knee.

Foot Orthotics

Altering foot mechanics has been shown to affect forces at the knee and indirectly reduce knee load and pain associated with OA during everyday activity. Most literature suggests a 5° lateral wedge throughout the entire length of the shoe insert can help relieve medial knee osteoarthritis pain by lightening some of the load



Fig. 7 — Laterally wedged footwear

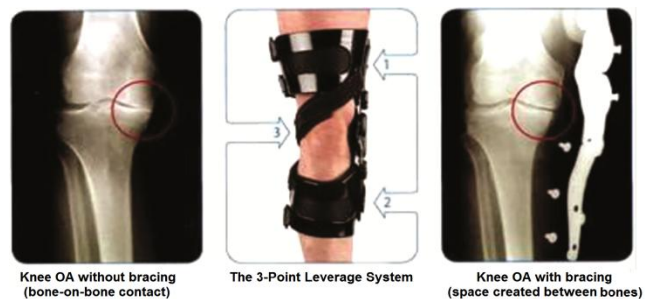


Fig. 8 — Knee brace

on that part of the knee. *The use of laterally wedged orthosis for more than a year resulted in a significant and persistent decrease in PAM (peak adduction movement).* Perfect footwear with well-cushioned soles reduced mechanical stress across the knee.

External adductor movement of the knee appears to be important in the progression of medial compartment osteoarthritis. Lateral heel and sole wedges are effective in the treatment of the medial compartment of knee osteoarthritis even in patients with complete loss of joints space in the knee X-ray and a significant decrease in NSAID consumption. Several studies suggest that patients tolerate foot orthotics well.

The use of laterally wedged orthosis for more than a year resulted in a significant and persistent decrease in PAM (Fig. 7).

Functional knee braces

Osteoarthritis knee with varus, functional knee braces (valgus braces) may decrease joint pain and improve function and quality of life. By producing valgus thrust, they unload the medial tibiofemoral compartment and strain on the lateral collateral ligament.

Prevention of progression of osteoarthritis knee in many patients can be achieved with encouragement, reassurance, advice about exercise, a recommendation of measures to unload the arthritic joint such as a cane, knee brace (Fig. 8) and proper footwear.

Diathermy

Application of moist heat to knee joint with osteoarthritis is more effective than dry heat. Deep heat is also useful. Application of deep heat before stretching exercises will enhance the efficacy of the exercises. Deep heat can be employed by ultrasound in which high-frequency sound waves are converted to heat.

Short Wave Diathermy (SWD) is a treatment that uses electromagnetic energy to produce deep heating in joints and soft tissues. Thus SWD can effectively relieve joint pain, improve soft tissue healing, and decrease the symptoms of osteoarthritis.

Ultrasound

It penetrates more deeply than either shortwave or microwave diathermy. It can raise the intraarticular temperature. Joint pain in osteoarthritis knee can be significantly reduced by ultra or shortwave diathermy. Therapeutic ultrasound is often used to reduce pain, increase circulation, and increase the mobility of soft tissues. Additionally, the application of ultrasound can be helpful in the reduction of inflammation, reducing pain (Fig. 9).

Few suggestions to protect the knee from joint stress and prevent progression of osteoarthritis

- Perfect footwear with well-cushioned soles
- Sit on a high stool rather than stand
- Avoid squatting or kneeling
- Swimming will place much less stress on the knees than jogging
- Use ramps or elevators instead of steps
- Cane in the opposite hand will reduce knee loading by 46% (Fig. 10)

Imageology

X-ray

Radiography has been the most widely used for the diagnosis and management of the progression of knee osteoarthritis. More than 80% of everyone over the



Fig. 9 — Ultrasound

age of 55 years has X-ray evidence of osteoarthritis but 10 – 20 % are symptomatic (Fig. 11).

X-ray AP view of knee with osteoarthritis shows sub chondral sclerosis, sub chondral cysts, sub chondral trabecular collapse, and marginal osteophytes. Medial trabecular micro fractures leads to sub chondral bone collapse which in turn leads to loss of support to articular cartilage results in depression and cupping. Full-length hip to ankle alignment radiograph to assess mechanical axis to know about malalignment (Fig. 12). Radiologically by plain x-ray with Rosenberg view and MRI, osteoporosis, trabeculae collapse, deviation of mechanical axis, joint laxity can be assessed (Fig. 13).



Fig. 10 — Walking stick in opposite hand reduces load on knee

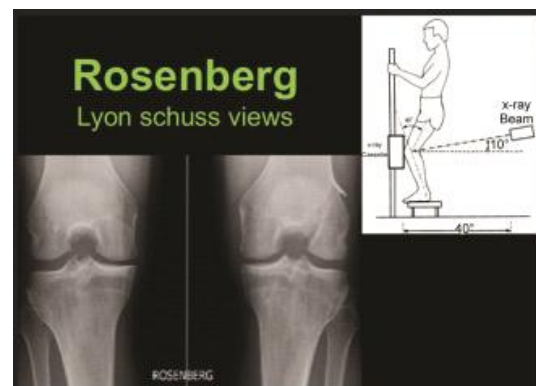


Fig. 11 — X-ray knee

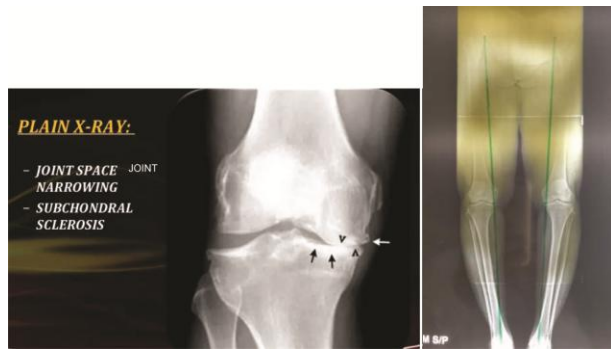


Fig. 12 — Mechanical axis is deviated due to varus



Fig. 13 — X-ray shows sub chondral collapse

MRI

Crucial in the diagnosis of osteoarthritis knee (Fig. 14):

- To evaluate articular cartilage
- To identify meniscus and ligamentous pathology
- To assess the involvement of subchondral bone

These technical diagnosis findings must be correlated with clinical symptoms

1. Improve bone strength by physical activity, high protein diet, rich calcium nutrition supplements, bisphosphonates and. Daily injections of teriparatide stimulates new bone formation leading to increased bone mineral density.

2. Increase muscle strength. The tone of the muscles can be increased by physical exercises and life style modification. Regular resistance exercise, and consumption of a high-protein diet plays a vital role. Protein intake and physical activity are important stimuli for muscle protein synthesis. A number of expert groups have proposed an increase in dietary protein recommendations for older age groups to 1.0-1.2 g/kg body weight per day. Key nutrient supplementation in older adults is of interest in the prevention of sarcopenia and frailty, since it is a



TREATMENT

• **Goals**

1. improve bone strength..... Inj.Teriparatide and Bisphosphonates
2. increase muscle strength Physiotherapy
3. correct the mechanical axis deviation.... by Osteotomy
4. curette the sub chondral sclerosed bone
5. fill the sub chondral space with cancellous bone graft (Subchondral trabecular bone has bone marrow houses mesenchymal stem cells (MSCs) with chondrogenic potential).

Fig. 14 — MRI knee



Fig. 15 — Open wedge osteotomy of medial tibial condyle

simple, low-cost treatment approach without major side effects.

Amino acid therapy may be helpful for regenerating damaged or atrophied muscle tissue. In severe cases of muscular atrophy, the use of an anabolic steroid such as methandrostenolone may be administered to patients as a potential treatment. One important rehabilitation tool for muscle atrophy includes the use of functional electrical stimulation to stimulate the muscles. By strengthening, bones and muscles, the joint can be strengthened.

Surgery

Collapsed medial condyle of tibia can be reconstructed by open wedge osteotomy, curetting sclerosed sub chondral bone (Fig. 15) and filled with



Fig. 16 — Sub chondral space filled with bone graft and varus corrected

cancellous bone graft, osteotomy closed by tricortical graft. Peri articular tissues can be released, osteophytes can be excised (Fig. 16).

Post operatively we immobilise the knee for eight weeks, meanwhile we advise static exercises to strengthen the limb muscles, injection Teriparatide and calcium supplementations to strengthen the bones. After eight weeks, no weight bearing exercises for two weeks. Weight bearing will be started after a satisfactory check x-ray (ten weeks).

Conclusion

Prevention of progression of osteoarthritis knee can be achieved by life style modification, by using orthotics and by strengthening of bones and muscles. When mechanical axis is altered, it should be corrected by surgery.

Once the weight bearing axis is corrected, intraarticular mechanical stress get reduced and

promotes the healing and it gives relief of joint pain and improvement of function.

If loading of the unstable limb is markedly restricted by immobilization immediately after instability is created, osteoarthritis will not progress. Immobilization effectively reduces instability and intraarticular stress.

Knee joints can be saved from osteoarthritis, by prevention of its progression, by strengthening the antigravity muscles and by improving quality of bone.

This study recommends, to increase awareness and promote better screening of osteoarthritis, initiation of early treatment, and prevent progression of the osteoarthritis of knees.

Acknowledgement

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Conflict of interest

All authors declare no conflict of interest.

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