SciMedCentral

Annals of Orthopedics & Rheumatology

Review Article

An Overlooked Mechanism Protecting the Knee from Degenerative Arthritis

Leung Ping Chung*

Department of Orthopedics and Traumatology, the Chinese University of Hong Kong, Hong Kong

***Corresponding author**
Leung Ping Chung, Department of Orthopedics and Traumatology, The Chinese University of Hong Kong, 5/F, School of Public Health Building, Prince of Wales Hospital, Shatin, N. T., Hong Kong, Tel: 852 22528868; Fax: 852 2632-5441; Email: pingcleung@cuhk.edu.hk

Submitted: 08 January 2020

Accepted: 17 January 2020

Published: 20 January 2020

Keywords
• Osteoarthritis; Knee; Proprioceptive training

Abstract

Introduction: Knee pain is one of the commonest disabling diseases of the elderly people. It has been taken for granted that it is a degenerative problem related to curtilage thinning, and the pathology does not involve much inflammatory process. Osteoarthritis is therefore the most popular term used.

Causes of osteoarthritis of the knee: Apart from in-born structural varieties that affects the function of the knee joint, many other causes have been described: "cartilage derived", "ligament derived", "meniscal derived", "bone derived" and "synovial derived" pathologies, all basing on structural changes involved.

There is an important dynamic mechanism that maintains a balanced functional position between the medial and lateral compartments of the knee joint irrespective of existing structural imperfections: the proprioceptive afferent receptor -cerebral autonomous output circuit. Proprioceptive receptors in the muscles, tendons, and joint capsules are detecting all the time the detail positions of the joint components in relation to the standing posture of the individual. They send messages up to the brain so that outputs of muscular adjustments are sent down to initiate chain reactions to maintain the joint in balanced harmony irrespective of structural imperfections.

Evidences of the proprioceptive protection of joints through an autonomous neurological circuit have been proven anatomically, clinically, and also through studies on other joints e.g. the trapezio-metacarpal joint of the thumb.

Discussion: It is therefore appropriate to introduce training activities to boost up the balancing dynamics around the knee joint, particularly for the early clinical presentations of osteoarthritis to prevent deterioration; and also before and after appropriate structural corrections, in order to maintain its functional integrity.

ABBREVIATIONS

OA: Degenerative Arthritis; ABT: Autonomous Balance Training

INTRODUCTION

Knee pain that follows ageing is often interpreted as 'degenerative arthritis' (OA), or sometimes, to stress the minimal inflammation involved, 'Osteoarthritis'. Data around the world do illustrate that although OA does not lead to disability in all those who have clinical signs of joint damage; its impact on activities of daily living is enormous. The risk of disability attributable to knee OA in the elderly is as great as that attributable to cardiovascular disease and other medical conditions [1-3].

Apart from the degenerative cause, knee arthritis in the elderlies has been labeled as a cartilage disease. Undoubtedly, in all such cases, plain radiography always shows thinning down of the articular facet as the first stage of degeneration, to be followed by appearances of osteophytes and displacements [4].

Is cartilage degeneration or degradation the only cause of osteoarthritis? Or the result of some derangement within the joint? [5].

The fact is: most osteoarthritis of the knee first present with medial condylar involvement, suggesting that unequal stress between the lateral and medial side of the knee (more on the medial side) could be the main cause [7-9].

Structural Variations-Common Deformity: Genu Varum

Babies born with bow legs or genu varum worry the parents only if the deformity is severe and obvious. Under such situations, surgeons' advice could be close observation until walking starts to allow the decision of surgical correction or continuation of observation [10]. The mild cases are allowed to grow normally without special care.

While reaching adulthood many individuals might have different degrees of varum deformity of their knees which escape special attention. There must be hereditary, familial and racial differences affecting the alignment of the leg so that the angle between the femur and tibia could be valgus or varus [10].

Other causes of Osteoarthritis

For the adult suffering from knee pain, depending on the symptomatology and radiographic details, the arthritis has been interpreted as "cartilage derived" [11,12]; "ligament derived" [4,13]; "Meniscal-derived" [14,15]; "Bone-derived" [16,17] and "Synovial derived" [18,19].

These interpretations are all based on the analyses of specific cases. The simple interpretation takes care of the anatomical and pathological picture, without consideration of other functional processes that might have led to the outcome.

In the clinical situation, osteoarthritis of the knee commonly presents with early medial compartmental involvement coupled with different degrees of varum alignment. The stress imbalance resulting from the different structural forms of the medial and lateral compartments could be the cause of more cartilage wearing on the medical side. Yet, why do many other cases with similar structural differences do not develop arthritis clinically? It could be true that varum knees are more prone to medial meniscal injuries in sports activities [20] which however, are not always the prerequisite of knee arthritis.

Balancing Mechanisms Maintaining Knee Joint Stabilities have an important role

Structural morphology does affect joint stability which is constantly under the vertical gravitational pull. However, apart from the gravitational force, muscles responsible for the different motions of the joint are at the same time activated to counteract harmful influences of the natural gravitation, so that the two compartments of the knee are kept at balance.

This sophisticated balancing influence is activated via an effective proprioceptive afferent receptor-cerebral autonomous output circuit [21].

The proprioceptive receptors detect the detail positions of the joint relevant to the stance of the individual and are responsible to send messages up to the brain so that orders of muscular adjustments are sent down the spinal cord to allow a coordinated response from the muscles responsible for the smooth function of the joint. With this effective adjustments of muscular pulls, the joint stays in balanced harmony although structurally it might not be in the best position to do so because of in-born compartmental differences or chronic stress damages.

If the medial articular surfaces are thinner than its lateral counterparts, a stronger compressing pull on the lateral side and a simultaneous decompressing lift on the medical side would satisfy the need of keeping the medial and lateral inter-articular spaces at a better balance [21,22].

Most proprioceptive receptors are contained at the ends of the muscle insertions, joint capsules and both ends of ligaments. They regularly send up messages to the brain which actively arranges equalizing muscular pulls. Disuse of joints and aging result in a deterioration of proprioceptive activities which fail to keep a dynamic balance of the joint, thus failing to protect it from developing degenerative arthritis [23- 25].

Other evidences of proprioceptive protection of joints through an autonomous neurological circuit.

In contrast to the free nerve endings of sensory or motor function, the role of the proprioceptive sensors is to provide information of our actual motor performance (the afferent copy of our movements) compared to the efferent motor program, which is activated by our will to move. These include proprioceptors in the skin (e.g., Meissner corpuscles), muscles (annulospiral and flower-spray endings of the muscle spindles), Golgi tendon organs, and Ruffini end organs and Pacinian corpuscles in the superficial and deep layers of the joint capsule. Elderly people may have slow reflexes, lax joints, joint incongruity, and loss of muscle power; obesity, alcohol and medicinal use: all affecting the proprioceptive responses. Degenerative arthritis is therefore the result of the poor capacity for repair and remodeling of the musculoskeletal tissues [26].

A clinical study on 2243 subjects suffering from early knee osteoarthritis from baseline to 30 months' follow up was completed in 2009, looking at the relationship between proprioceptive acuity of the subjects with pain and functional limitations. Results showed that at baseline, proprioceptive acuity was associated with less pain and functional limitations. Longitudinally, proprioceptive acuity was related only modestly to changes in pain and function. These effects were not associated with X-ray changes over time. 30 months follow-up was not too long, however, the effects of proprioceptive acuity on osteoarthritis were shown [27].

With regard to joints other than the knee, the trapezio-metacarpal joint of the thumb has been intensely studied to explain why it is frequently affected with osteoarthritis. Its frequent, multidirectional movements must be the major cause. On top of this, copious proprioceptive receptors are found in the ligaments, capsules, synovia and artilages related to this joint, which is also affected by relaxin receptors to circulating relaxin. Unbalanced proprioceptive responses therefore, could be contributing towards the arthritis of this joint [28].

Practical Training to boost up balancing activities around the knee joint.

Since proprioceptive responses on the knee joint could be important for the progress of osteoarthritis, attention should be focused on practical means of boosting up proprioceptive sensitivities so that joint stability could be better maintained. At least two systems of training are commonly practiced. First, training to prevent fall among the elderly people. And second, stance training with semi-flexed knees practiced by oriental (Chinese and Japanese) martial art practitioners [29,30]. Fall prevention training advocates stance with semi-flexed Knees and Tandem walking both of which actively stimulate the proprioceptive receptors around the knee (Figure 1). Martial art practitioners also stress the importance of semi-flexion of the knees so that their stance could be more stable when preparing to act or getting ready for unexpected pushes (Figure 2).

DISCUSSION

When the Autonomous Balance Mechanisms around the knee are comprehensively considered, the orthopedic surgeon might extend his vision in the overall planning for the care of his patients suffering from osteoarthritis.

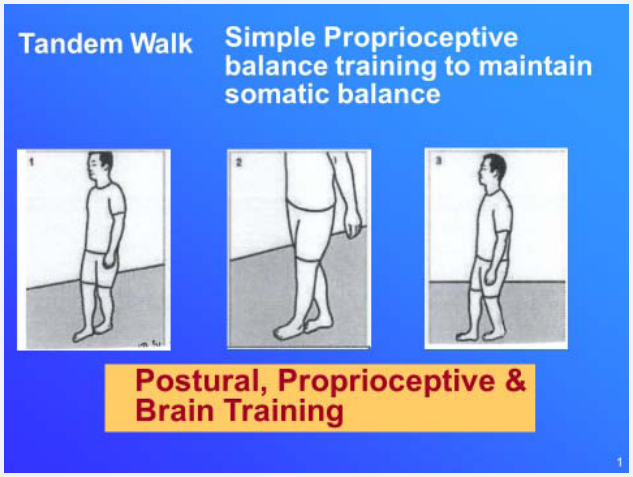

Figure 1 Tandem Walk: Simple proprioceptive training to maintain balance.

Figure 2 Posture and stretchings that provide Autonomous-Somatic balance.

In the severe cases of genu varum deformities in the children, early structural correction needs to be considered since the morphological defect would not be able to resist continuous gravitational insults.

CONCLUSION

In the early presentation of knee pain among the elderlies before involvement of both medial and lateral sides, the inter-articular spaces between the femoral and tibial condyles of the medial and lateral compartments should be carefully analyzed, and managed accordingly: -

(i) Very mild narrowing of the medial compartment - active autonomous balance training (ABT) should be coupled with observations.

(ii) Moderate narrowing of medial compartment - ABT could be followed with fibular shortening to release medial stress [31].

(iii) Severe narrowings- Proper balancing supra patellar tendon tibial osteotomy could be considered [32].

It should be clear that most age related osteoarthritis is not a primary cartilage disorder. Instead, it actually results from the imbalance between the lateral and medial condylar interspaces. Effective proprioceptive training could create a state of auto-adjustment and better balance, thus preventing further deterioration.

In the current popular consideration of stem cell transplant to reconstruct the collapsed cartilage, total success would be doubtful since the damaged cartilage is not the primary cause but the result of unbalanced stress. Repaired cartilage is deemed to collapse again as long as the cause remains. As long as the causative mechanical stress persists, artificial cartilage regeneration will tend to be short lived [33].

REFERENCES

1. Anderson AS, Loeser RF. Why is Osteoarthritis an age-related disease? Best Pract Res Clin Rheumatol. 2010; 24: 15-26.
2. Guccione AA, Felson DT, Anderson JJ, Anthony JM, Zhang Y, Wilson PW, et al. The effects of specific medical condition on the functional limitation of elderlies in the Framingham Study. Ann J Public Health. 1994; 84: 351-358.
3. Sharma L, Cahue S, Song J, Hayes K, Pai YC, Dunlop D. Physical functioning over three years in Knee Osteoarthritis. Arthritis Rheu. 2003; 48: 3359-3370.
4. McGonagle D, Tan AL, Carey J, Benjamin M. The anatomical basis for a novel classification of Osteoarthritis and allied disorders. J Anat. 2010; 216: 279-291.
5. Buckwalter JA, Mankin HJ, Grodzinsky. Articular cartilage and osteoarthritis. Instr Course Lect. 2005; 53: 465-480.
6. Brandt KD, Radin EL, Dieppe PA, L van de Putte. Yet more evidence that Osteoarthritis is not a cartilage disease. Ann Rheum Dis. 2006; 65: 1261-1264.
7. Pearson OM, Lieberman DE. The aging of Wolff's law: ontogeny and responses to mechanical loading in cortical bone. Am J Phys Anthropol. 2004; 39: 63-99.
8. Wang J, Chen W, Zhang YZ. Law of dynamic deformation of bone. Chin Med J (Engl). 2019; 132: 2636-2637.
9. Adams JG, Mc Alindon T, Dimasi M. Contribution of meniscal extrusion and cartilage loss to joint space narrowing in osteoarthritis. Clin Radiol. 1999; 54: 502-506.
10. Brandt KD, Dieppe P, Radin EL. Workshop on etiopathogenesis of osteoarthritis of knee. Rheum Dis Clin North Am. 2008; 34: 531-559.
11. Recnik G, Kralj-Iglic V, Iglic A. The role of obesity, biomechanical constitution of the pelvis and contact joint stress in progression of osteoarthritis. Osteoarth Cartil 2009; 17: 879-882.
12. Wardle EN. Osteotomy of the tibia & fibula. Surg Gynecol Obstet. 1962: 115: 61-64.
13. Quasnichka HL, Anderson-Mackenzie JM, Tarlton JF. Cruxiate ligament laxity and femoral inter-condylar notch arrowing in early stage knee osteoarthritis. Arthritis Rheum. 2005; 52: 3100-3109.
14. Mesner K, Gao J. The menisci of the knee joint, Anatomical and functional characteristics. J Anat. 1998; 193: 161-178.
15. Lanzer WL, Komenda G. Changes in articular cartilage after meniscectomy. Clin Orthop Relat Res. 1990; 41-48.

16. Franchi A, Bullough PG. Secondary avascular neurosis in cox-arthrosis. J Rheumatol. 1992; 19: 1263-1268.

17. Clark JM. The Structure of vascular channels in the subchondral plate. J Anat. 1990; 171: 105-115.

18. Vlychou M, Koutroumpas A. Ultrasonographic evidence of inflammation is frequent in erosive osteoarthritis. Osteoarthritis Cartilage. 2009; 17: 1283-1287.

19. Reginato AJ. Calcium pyrophosphate dehydrate gout and osteoarthritis. Curr Opin Rheumatol. 1991; 3: 676-683.

20. Louboutin H, Debarge R, Richou J. Osteoarthritis in patients with anterior cruxiate ligament rupture: a review of risk factors. Knee. 2009; 16: 239-244.

21. Sharma L. The role of Proprioceptive Deficits, ligamentous laxity and malalignment in Development and Progression of knee Osteoarthritis. J Rheumatol Suppl. 2004; 87-92.

22. Brandt KD, Dieppe, Radin E. Etiophathogenosis of Osteoarthritis. Med Clin North Am. 2009; 93: 1-24.

23. Hurley WV, Scott DL, Rees J. Sensorimotor changes and functional performances in patients with knee osteoarthritis. Ann Rhum Dis 1997; 56: 641-648.

24. O'connor BL, Palmoski MJ, Brandt KD. Neurogenic acceleration of degenerative joint lesions. JB Joint Surg Am.1985; 67: 562-72.

25. Skinner HB, Barrack RL, Cook SB. Age related decline in proprioception. Clin Orthop Relat Res. 1984; 184: 208-211.

26. Konttinen Y, Tiainen V, Barrena E. Innovation of the Joint and Role of Neuropeptides. Ann NY Acad Sci. 2006; 1069: 149-154.

27. Felson D, Gross KD, Nevitt MC, Hurley V. The effects of impaired joint position sense on the development and progression of pain and structural damage in knee osteoarthritis. Arthritis Rheum. 2009: 61: 1070-1076.

28. Clifton KB, Rodner C, Walf J. Detection of relaxin receptor in the dorsoradial ligament, synovium and articular cartilage of the trapeziometacarpal joint. J Orthop Res. 2014; 32: 1061-1067.

29. Center for Disease. Preventing Falls: A guide to implementing effective community-based Fall Prevention Program. National Centre for Injury Prevention and control, USA. 2015.

30. National Centre for Qi Gong Training. Practice of Qi Gong (in Chinese). Peoples Physical Training Publisher. 2003.

31. Liu B, Chen W, Zhang YZ. Proximal fibular Osteotomy to treat medial compartment knee osteoarthritis. PLoS One. 2018; 13: e0197980.

32. Coventry MB. Osteotomy of the upper portion of the fibia for degenerative arthritis of the knee. JBJS. 1965; 47A: 948-990.

33. Mc Gonagle D, De Bari C, Arnold P. Lessons from Musculoskeletal Stem cell research: the key to successful regenerative medicine development. Arthritis Rheum. 2007; 56: 714-721.

Cite this article

Chung LP (2020) An Overlooked Mechanism Protecting the Knee from Degenerative Arthritis. Ann Orthop Rheumatol 7(1): 1087.