Journal of the Anatomical Society of India 66 (2017) 105–108

Contents lists available at ScienceDirect

Journal of the Anatomical Society of India

journal homepage: www.elsevier.com/locate/jasi

Original Article

Analysis of relationship between radiological morphometric measurements of knee joint and symptomatology of osteoarthritis – A pilot study

Shilpi Gupta Dixit[a,*], Vertika Kesarwani[a], Abhay Elhence[b], Surajit Ghatak[a]

[a] Department of Anatomy, All India Institute of Medical Sciences, Jodhpur, Rajasthan, India
[b] Department of Orthopaedics, All India Institute of Medical Sciences, Jodhpur, Rajasthan, India

ARTICLE INFO

Article history:
Received 7 January 2016
Accepted 27 November 2017
Available online 1 December 2017

Keywords:
Arthritis
Knee
Morphometry

ABSTRACT

Introduction: Osteoarthritis (OA) is commonly viewed as a pathological outcome of a range of disorders resulting in structural degradation and functional failure of synovial joints. Osteoarthritis is the leading cause of pain and disability in the elderly affecting about 21 million people across the world out of which knee osteoarthritis occupies a major fraction. Despite this, osteoarthritis remains a condition that is poorly understood and for which very few therapeutic options are available.
Methods: The present cross sectional study comprised of 30 subjects suffering from osteoarthritis attending orthopaedics OPD and morphometric measurements (average joint space width, tibial anatomical axis, medial and lateral tibiofemoral joint space and articulate angle) were taken on X-Ray images.
Results: In our study, these measurements in patients of knee OA were significantly reduced when compared to controls but their correlation to pain symptoms was found to be non-significant may be because the study was on a very small scale.
Discussion: Further studies need to be done with inclusion of more factors or symptoms relating to morphometric measurements. Nevertheless the measurements done were relatively simple therefore easily reproducible and also independent of any observational error. This study assumes significance as few studies are available in North Indian population.

1. Introduction

Arthritis is a type of joint disorder featuring inflammation of joints. It may involve one or more joints depending upon which it can be classified as (a) monoarticular-involving one joint; (b) oligoarticular- involving a few joints or; (c)polyarticular- involving many joints. Inflammation is characterized by joint stiffness which may lead to either loss of function or limited function of the affected joints. The four characteristics of inflammation namely rubour (redness), calor(temperature), dolour (pain) and tumor (swelling) are found on examination. Inflammation is accompanied by joint pain which is commonly called as arthralgia. The pain is constant and localized in character. However, the pain pattern may differ depending on the type of arthritis and the location of pathology. Arthritis is of many types. Over 100 s of types have been identified by now and the number is still growing. It can be classified into various types depending on the criteria of classification.

Arthritis is a multifactorial disorder having causes which may include injury as in osteoarthritis, metabolic abnormalities as in gout and psuedogout, it may also be a result of direct or indirect effect of infection or overactive immune system as in rheumatoid arthritis. It may also be a result of genes inherited from ancestors which is one of the major causes of arthritis.

Osteoarthritis is a group of mechanical abnormalities involving degradation of joints including articular cartilage and subchondral bone. Varied sources of mechanical stress, which may include misalignment of bones caused by congenital or pathogenic causes, mechanical injury, overweight and loss of strength in muscles supporting the joint. Osteoblast cells from the exposed subchondral bone migrate into the joint capsule around the margins leading to development of bony projections called “spur” or “osteophytes” within the joint capsule. It is one of the major causes

* Corresponding author at: Department of Anatomy, All India Institute of Medical Sciences (AIIMS), Jodhpur, Rajasthan, 342005, India.
E-mail address: shilpidr@gmail.com (S.G. Dixit).

https://doi.org/10.1016/j.jasi.2017.11.005
0003-2778/

of disability affecting about 27 million people in USA. It begins in the cartilage and eventually causes the opposing bones to erode each other exposing the underlying bone surface. It starts with minor pain initially which occurs only during activities but soon the pain may become continuous and even occur in state of rest. The pain can be debilitating and prevent one from doing routine activities which eventually leads to disability and handicap of lower extremity.[1–4]Other symptoms may include pain in the associated muscles and tendons, inflammation of the joint capsule, development of hard bony enlargement, accumulation of fluid in joints etc. A characteristic feature of osteoarthritis distinguishing it from rheumatoid arthritis is that it feels better with gentle use but worsens with prolonged use. Also, contrary to rheumatoid arthritis which is a disease of the young and children and affects mainly small joints such as fingers, wrist, elbow etc., OA is a disease of the elderly and mainly affects larger joints including hand, feet, back, hip and knee.[5] Age, obesity, injury and genetic factors predispose to OA and are its major risk factors. Warning signs may include soreness after periods of overuse and inactivity, morning stiffness, pain due to muscle weakening and worsening of pain in the morning. Diagnosis can be made using X-Ray radiographs, MRI or CT scans. Radiological findings in the X-Ray may show narrow joint space, osteophytes, osteosclerosis and subchondral cyst.[6] For this project we preferred X-Ray studies over MRI accounting to its cost effectiveness and accuracy in measurements. We did some morphometric measurements on X-ray films of knee joint and correlated with severity of symptoms of the patients. We restricted our study to the osteoarthritis of knee joint because according to statistics the number of hip and knee replacements due to severe OA has increased rapidly over the past decade.

2. Methods

The cross sectional study comprised of 30 subjects suffering from osteoarthritis attending orthopaedics OPD of the Institute. Knee joint roentgenograms (both AP and lateral views) (Figs. 1–3) of these patients and 30 age and sex matched subjects attending the OPD for other ailments to serve as controls were taken.

Fig. 2. Representative Lateral view of Knee joint of controls.
B- Articulate angle—Angle between femoral joint surface and tibial joint surface

Exclusion criteria – All patients who had hip or ankle joint involvement or other diseases of bone(like hemiplegia, gout etc.) that effect lower limb functions were excluded from the study.

Written informed consent for participation was obtained from each subject before enrolling them for the study.

A detailed history was obtained from the patients which included age, socioeconomic and educational status, duration of symptoms and treatment modalities, if any, used by them. A Questionnaire about pain was included in our study. The patients were asked to grade pain from 0–4 in:

- Squatting
- Getting up from sitting position
- Sitting cross-legged

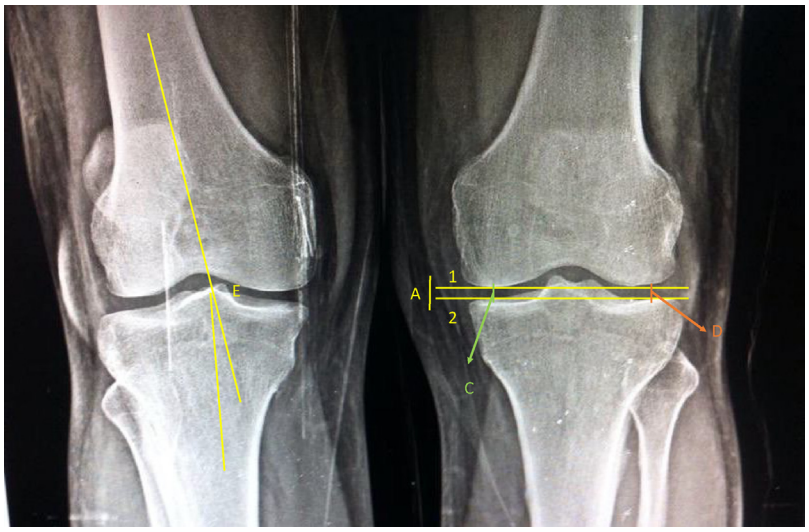

Fig. 1. Representative AP view of Knee joint of controls.
A- Average joint space width—distance between tangent drawn to the lowest curvature of medial and lateral femoral condyles (1) and the tangent drawn to medial and lateral tibial plateau (2)
C- Medial tibiofemoral space—minimum joint space height between medial tibial and femoral condyles
D- Lateral tibiofemoral space—minimum joint space height between lateral tibial and femoral condyles
E- Tibial anatomical axis—Varus or valgus in the knee was estimated

Fig. 3. Representative AP view of Knee joint of Osteoarthritic Cases.

0—indicating no discomfort or pain, to 4—indicating most severe discomfort or pain

Radiography: To avoid joint laxity and minimize the effect of synovial fluid, weight bearing position was used for taking X-Ray images of all patients. All radiographic images were in DICOM (Digital Imaging and Communications in Medicine) format.

Radiological measurements taken included:

- Average joint space width—distance between tangent drawn to the lowest curvature of medial and lateral femoral condyles and the tangent drawn to medial and lateral tibial plateau (Fig. 1)
- Articulate angle – angle between femoral joint surface and tibial joint surface (Fig. 2)
- Medial tibiofemoral space—minimum joint space height between medial tibial and femoral condyles (Fig. 1)
- Lateral tibiofemoral space—minimum joint space height between lateral tibial and femoral condyles (Fig. 1)
- Tibial anatomical axis—varus or valgus in the knee was estimated (Fig. 1)
- Patellofemoral joint space– this could not be estimated in all X-Rays so was not considered for results

Size of any loose bodies in joint space was measured.

The findings of control and study groups were compared and statistically analysed by SPSS 17. Correlation coefficients were calculated between average joint space width, tibial anatomical axis, medial and lateral tibiofemoral joint space and articulate angle and stiffness as well as pain in squatting, sitting cross-legged, getting up from sitting position.

Experiment was carried out after obtaining clearance from the Institutional human ethics committee.

Table 1
Showing measurements (Mean ± SD).

	Controls	Cases
aJSW (mm)	6.93 ± 0.29	4.88 ± 0.19***
mtfj (mm)	6.44 ± 0.98	5.03 ± 0.15***
ltfj (mm)	5.99 ± 0.11	4.91 ± 0.13***
taa (degree)	175.48 ± 2.34	176.24 ± 2.2

aJSW- average joint space width; mtfj- medial tibio-femoral joint space; ltfj- lateral tibio-femoral joint space; taa- tibial anatomical axis.
***$p < 0.001$.

3. Results

Table 1 is showing the mean and standard deviations of all the measurements taken. The values of average joint space width, and medial and lateral tibio-femoral joint space was found to be significant in patients with Osteoarthritis when compared to controls.

Table 2 is showing the correlation coefficients between the measurements and pain on squatting, sitting cross legged and getting up from sitting position in patients of osteoarthritis. the correlation was non-significant for each of the parameters.

Loose bodies were not seen in any of the X Rays.

4. Discussion

Osteoarthritis is commonly viewed as a pathological outcome of a range of disorders resulting in structural degradation and functional failure of synovial joints. In an apparently healthy human being, there exists a dynamic equilibrium between breakdown and repair of joint tissues but in conditions when the mechanical load applied exceeds that which can be borne by joint tissues, this equilibrium is disturbed leading to structural and functional degradation of the affected joint. Osteoarthritis is the leading cause of pain and disability in the elderly affecting about 21 million people across the world out of which knee osteoarthritis

Table 2
Showing correlation between symptoms and measurements.

	aJSW	mtfj	ltfj	taa
Stiffness				
Correlation	−0.17	0.21	−0.06	−0.16
Significance	0.55	0.44	0.84	0.56
Pain on squatting				
Correlation	−0.45	-0.21	-0.25	0.06
Significance	0.93	0.46	0.36	0.84
Pain in getting up				
Correlation	0.07	0.26	−0.50	0.42
Significance	0.79	0.34	0.06	0.12
Pain in sitting cross legged				
Correlation	−0.09	0.01	−0.03	0.03
Significance	0.76	0.97	0.92	0.92

aJSW- average joint space width; mtfj- medial tibio-femoral joint space; ltfj- lateral tibio-femoral joint space; taa- tibial anatomical axis.

occupies a major fraction. Despite this, osteoarthritis remains a condition that is poorly understood and for which very few therapeutic options are available. Drug development in osteoarthritis is now focussed on modification of structural progression. However, therapeutic development is constrained by its heterogeneous clinical manifestations, the unclear relation between structural progression and clinical end points and the need for long term follow up to observe changes in structure. Therefore, accurate and highly reproducible measurement of rate of progression in individual is a prerequisite for assessing structural change both for clinical trials and subsequently for patients in clinical practice. Osteoarthritis is characterised by cartilage loss resulting in reduction of cartilage thickness which is inferred from a reduction in the joint space. Quantification of this joint space narrowing and comparison with degree of disability is the purpose of our study.

In our study, the radiological measurements in osteoarthritis patients were significantly reduced when compared to controls which was a consistent finding. Various studies have reported that X-Ray radiography can be used not only for diagnosis of the disease but also for the judgement of severity of osteoarthritis. But all pathological findings on radiography may not match clinical symptoms[11–13] Neogi et al in their study suggested that few radiological manifestations in OA patients were related to knee pain.[14] Chen et al also deduced from their study that average joint space width correlated with most of the symptoms of knee pain and knee functions such as squatting, kneeling and sitting crosslegged on the floor.[15] 43% of the patients had knee symptoms, 28% had radiographic knee OA while 16% and 8% had symptomatic knee OA and severe radiographic changes respectively in a study by Jordan et al.[16] Comas et al concluded in their study that prevalence was higher when using radiological evidence alone followed by symptomatic criteria and combination of both.[17] Ding et al reported a significant association between age and loss of cartilage volume.[18] Emrani et al and Felson et al considered joint space width as a reliable variable for assessment of progression of knee OA.[19,20] In our study, the morphometric measurements in patients of knee OA were significantly reduced when compared to controls but their correlation to pain symptoms was found to be non significant may be because the study was on a very small scale. Further studies need to be done with inclusion of more factors or symptoms relating to morphometric measurements. Nevertheless the measurements done were relatively simple therefore easily reproducible and also independent of any observational error. This study assumes significance as few studies are available in North Indian population.

5. Conclusion

In our study, the morphometric measurements (average joint space width, tibial anatomical axis, medial and lateral tibiofemoral joint space and articulate angle) in patients of knee OA were significantly reduced when compared to controls but their correlation to pain symptoms was found to be non significant may be because the study was on a very small scale. Further studies need to be done with inclusion of more factors or symptoms relating to morphometric measurements. Nevertheless the measurements done were relatively simple therefore easily reproducible and also independent of any observational error.

Conflict of Interest

There is no Conflict of Interest to be declared by the authors.

Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at https://doi.org/10.1016/j.jasi.2017.11.005.

References

1. Manek NJ, Lane NE. Osteoarthritis: current concepts in diagnosis and management. *Am Fam Phys.* 2000;61:1795–1804.
2. Sharma L, Kapoor D, Issa S. Epidemiology of osteoarthritis: an update. *Curr Opin Rheumatol.* 2006;18:427–441.
3. Lawrence RC, Helmick CG, Arnett FC, Deyo RA, Felson DT, Giannini EH, et al. Estimates of the prevalence of arthritis and selected musculoskeletal disorders in the United States. *Arthritis Rheum.* 1998;41:778–799.
4. Lawrence RC, Hochberg MC, Kelsey JL, McDuffie FC, Medsger Jr. TAJr., Felts WR, et al. Estimates of the prevalence of selected arthritic and musculoskeletal diseases in the United States. *J Rheumatol.* 1989;16:427–441.
5. Zeng QY, Zang CH, Li XF, Dong HY, Zhang AL, Lin L. Associated risk factors of knee osteoarthritis: a population survey in Taiyuan, China. *Chin Med J.* 2006;119:1522–1527.
6. Marijnissen AC, Vincken KL, Vos PA, Saris DB, Viergever MA, Bijlsma JW, et al. Knee Images Digital Analysis (KIDA): a novel method to quantify individual radiographic features of knee osteoarthritis in detail. *Osteoarthritis Cartil.* 2008;16:234–243.
11. Hochberg MC, Lawrence RC, Everett DF, Cornoni-Huntley J. Epidemiologic associations of pain in osteoarthritis of the knee: data from the National Health and Nutrition Examination Survey and the National Health and Nutrition Examination-I Epidemiologic Follow-up Survey. *Semin Arthritis Rheum.* 1989;18(4 Suppl. 2):4–9.
12. Creamer P, Lethbridge-Cejku M, Hochberg MC. Determinants of pain severity in knee osteoarthritis: effect of demographic and psychosocial variables using 3 pain measures. *J Rheumatol.* 1999;26:1785–1792.
13. Salaffi F, Cavalieri F, Nolli M, Ferraccioli G. Analysis of disability in knee osteoarthritis: relationship with age and psychological variables but not with radiographic score. *J Rheumatol.* 1991;18:1581–1586.
14. Neogi T, Felson D, Niu J, Nevitt M, Lewis CE, Aliabadi P, et al. Association between radiographic features of knee osteoarthritis and pain: results from two cohort studies. *BMJ.* 2009;339:b2844.
15. An B, Fang K, Wang Y, Zeng Y, Dai K. New variables for measuring joint space width to evaluate knee osteoarthritis. *Chin Med J.* 2011;124(23):3886–3890.
16. Jordan JM, Helmick CG, Renner JB, Luta G, Dragomir AD, et al. Prevalence of knee symptoms and radiographic and symptomatic knee osteoarthritis in African Americans and Caucasians: the Johnston County Osteoarthritis Project. *J Rheumatol.* 2007;34(January (1)):172–180.
17. Comas MA, Sala MA, Román RA, Hoffmeister LA, Castells XA. Variations in the estimation of the prevalence of knee osteoarthritis as the diagnostic criteria used in population studies. *Impact of the distinct diagnostic criteria used in population-based studies on estimation of the Prevalence of knee osteoarthritis.* 2010;24(January 1).
18. Ding C, Cicuttini F, Blizzard L, Scott F, Jones G. A longitudinal study of the effect of sex and age on rate of change in knee cartilage volume in adults. *Rheumatology (Oxford).* 2007;46:273–279.
19. Emrani PS, Katz JN, Kessler CL, Reichmann WM, Wright EA, McAlindon TE, et al. Joint space narrowing and Kellgren Lawrence progression in knee osteoarthritis: an analytic literature synthesis. *Osteoarthritis Cartil.* 2008;16:873–882.
20. Felson DT, Nevitt MC, Yang M, Clancy M, Niu J, Torner JC, et al. A new approach yields high rates of radiographic progression in knee osteoarthritis. *J Rheumatol.* 2008;35:2047–2054.

Futher reading

7. Hunter DJ, Marie-Pierre H, Graverand L, Eckstein F. Radiologic markers of osteoarthritis progression. *Curr Opin Rheumatol.* 2009;21:(2)110-117.
8. Altman R, Asch E, Bloch D, Bole G, Borenstein D, Brandt K, et al. Development of criteria for the classification and reporting of osteoarthritis: classification of osteoarthritis of knee. Diagnostic and Therapeutic Criteria Committee of the American Rheumatism Association. *Arthritis Rheum.* 1986;29:1039-1049.
9. Duryea J, Neumann G, Niu J, Totterman S, Tamez J, Dabrowski C. Comparison of radiographic joint space width to MRI cartilage morphometry: analysis of longitudinal data from the Osteoarthritis Initiative (OAI). *Arthritis Care Res (Hoboken).* 2010;62:(July (7)):932-937.
10. Hunter DJ, M.-P.H. Le Graverand , F. Eckstein. Radiologic markers of osteoarthritis progression. *Curr Opin Rheumatol.* 2009;21:110-117.
21. Brazier J, Migaud H, Gougeon F, Cotton A, Fontaine C, Duquennoy A. Evaluation of methods for radiographic measurement of the tibial slope. A study of 83 healthy knees. *Rev Chir Orthop Reparatrice Appar Mot.* 1996;82:(3)195-200.