Journal of Electronics and Informatics (2021)
Vol.03/ No.03
Pages: 167-177
https://www.irojournals.com/iroei/
DOI: https://doi.org/10.36548/jei.2021.3.002

Quantitative Analysis of Knee Radiography

R. Kanthavel[1], R. Dhaya[2]

[1]Department of Computer Engineering, King Khalid University, Abha, Saudi Arabia
[2]Department of Computer Science, King Khalid University-Sarat Abidha Campus, Abha, Saudi Arabia

E-mail: [1]kanthavel2005@gmail.com, [2]dhayavel2005@gmail.com

Abstract

The most common orthopedic illness in the worldwide, osteoarthritis (OA), affects mainly hand, hip, and knee joints. OA invariably leads to surgical intervention, which is a huge burden on both the individual and the society. There are numerous risk factors that contribute to OA, although the pathogenesis of OA and the molecular basis of through such are unknown at this time. OA is presently identified with an analyses were used to examine and, if required, corroborated through imaging - a radiography study. These traditional methods, on the other hand, are not susceptible to sense the beginning phases of OA, making the creation of precautionary interventions for specific disease problematic. As a result, other approaches which might permit for the timely identification of OA are needed. As a result, computerized perception algorithms give measurable indicators that may be used to determine the severity of OA from photographs in an automated and systematic manner. The study of Knee radiography and its quantitative analysis is analyzed in this paper.

1. Introduction

Osteoarthritis (OA) is the world's for the most part prevalent musculoskeletal syndrome affecting. OA is a condition that distresses the entire joints, and it is defined by destruction and loss of chondrocytes, as well as other abnormalities. The cause of OA is unknown, and there is no disorder therapeutic option. Total surgical procedure performed is the sole treatment option for OA patients. Many tissues, such as the wrist and vertebrae, are affected by OA [1]. Hip and

ISSN: 2582-3825 (online)
Submitted: 20.07.2021
Revised: 01.09.2021
Accepted: 18.09.2021
Published: 30.09.2021

Journal of Electronics and Informatics (2021)
Vol.03/ No.03
Pages: 167-177
https://www.irojournals.com/iroei/
DOI: https://doi.org/10.36548/jei.2021.3.002

knee OA, on the other hand, are by far the most frequent types. They are the 11th most leading cause of disability and impose a significant cost to society [2]. Knee OA strikes millions of individuals around the world; it's predicted that ten percentages of men and eighteen percentages of women over 60 are impacted, with 250 million people suffering from the condition [3, 4] .The knee is a complicated combined made up of several skeletons and tissues. The tibia, femur, patella, and fibula are the osseous components of the knee. Articular cartilage covers the first three bones at this position. The ligaments and menisci, in addition to the cartilage, are important components of the joint. Figure 1 shows a schematic representation of this.

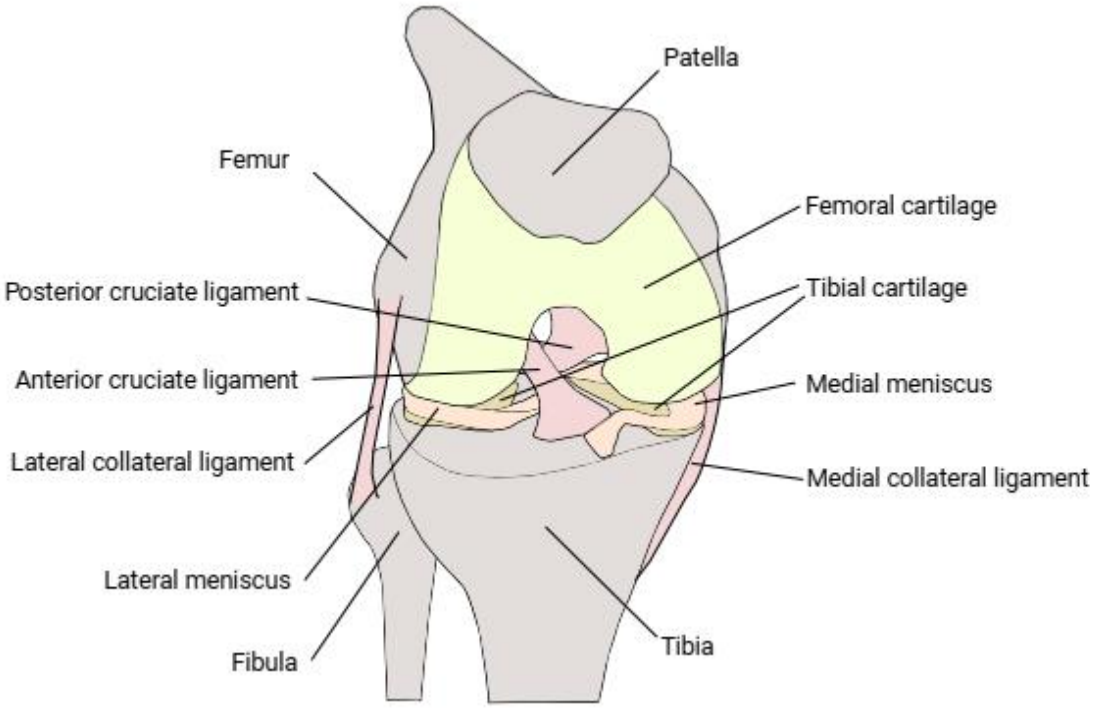

Figure 1. Diagram design of the knee joint

Articular cartilage (AC) is a medullary membrane with different and narrow qualities that allow for low-friction joint articulate and is nourished by lubricating and extracellular secretions [5, 6]. The material qualities of cartilage enable for flawless load distribution to the

ISSN: 2582-3825 (online)
Submitted: 20.07.2021
Revised: 01.09.2021
Accepted: 18.09.2021
Published: 30.09.2021

Journal of Electronics and Informatics (2021)
Vol.03/ No.03
Pages: 167-177
https://www.irojournals.com/iroei/
DOI: https://doi.org/10.36548/jei.2021.3.002

surrounding bone (SB), which is a layer of skeleton just underneath the membrane. Osteoarthritis (OA) was once thought to be a chondro degenerative brain disease; nonetheless, it is now recognized as whole and illness affecting many components inside this knee. Knee OA is caused by a variety of reasons, but leading to the decrease of bone cells and decreasing muscle activity, age is a main risk factor [7]. In all significant knees, the occurrence of OA rises with age. Weight and female species are both acknowledged to be significant predictors for knee OA. Additional risk variables include heredity, job stress, regular exercise, diet, and past injury, among others.

2. Literature Review

This portion of the paper shows the studies that concentrate with statistical knee radiography analysis. Saleem M et al (2020) introduced an object recognition approach that could help radiologists diagnose osteoarthritis by assessing radiological abnormalities in knee x-rays. To enhance the performance of knee radiography, various image processing methods were used. Using image enhancement, the knee portion was instantly deleted. The radiographs were categorized using the computed knee joint space width and a compared to the normally distributed knee joint space width. R. Altman et al. (2007) created osteoarthritis (OA) radiography matrix that can be used as a framework and reference for assessing radiographs of osteoarthritic pathologies of the wrist, thigh, and knees. As a response, an improved compendium of radiographic pictures was created to aid doctors and clinical testing participants in rating individual radiographic elements of the palm, thigh, and knee. J. Dacre et al. (1991) used digital photo analysis to assess joint development size in a group of highly radioactive normal people. Anteroposterior knee pictures were examined in 685 patients who presented to Emergency with mysterious knee discomfort or after damage, but no diagnostic or radiographic indication.

Duncan, S.T., et al. (2015) conducted a metaanalysis to gauge the level of analytical excellence for determining the high specificity of certain variables computed tomography

ISSN: 2582-3825 (online)
Submitted: 20.07.2021
Revised: 01.09.2021
Accepted: 18.09.2021
Published: 30.09.2021

Journal of Electronics and Informatics (2021)
Vol.03/ No.03
Pages: 167-177
https://www.irojournals.com/iroei/
DOI: https://doi.org/10.36548/jei.2021.3.002

viewpoints in sensing knee osteoarthritis, as well as the consequences of specific summative assessments on the designed to sense knee osteoarthritis. A survey of current advancements and advances in image features identification was presented by Li, Y., et al. (2015). To begin, they explored the relationships between borders, vertices, and lumps from a psychological point of view. Second, the techniques for identifying corners, vertices, and lumps were divided into several groups, with get everything supplied for typical recent algorithms. L. Shamir et al. (2015) presented a system for detecting radiographic osteoarthritis (OA) in knees X-ray photographs automatically. The Kellgren–Lawrence (KL) diagnostic grades, which correlate to the various phases of OA harshness, are used to detect the disease. The classifiers was created employing X-rays that had been manually ranked and represented the first four KL categories. First, a set of picture values that underpin and picture modifications that are useful for the identification of OA in X-rays are identified, and weighting are assigned to these feature representation by means of Friedman scoring.

A unique translucent machine assessment procedure according on the Deeply Siamese CNN, a constantly graded Kellgren-Lawrence grading method was used to dynamically evaluate knee OA severity. is described by Tiulpin, A. et al (2018). The technique was developed purely on data from the Cohort study Osteoarthritis Investigation, and it was verified on 3,000 participants (5,960 knees) from the Osteoarthritis Initiatives collection. When comparing to the comments provided by a committee of doctors and specialists, our technique had a polynomial Kappa coefficient .They also reported a 0.93 auc value for radiographic OA diagnosis. It is observed from the review of the literature that the existing papers talked about concentrate with statistical knee radiography analysis.

3. Concept, Pathology, and Factors Associated Of Osteoarthritis

Osteoarthritis (OA) was once thought to be a cartilage debilitating condition; nonetheless, this is now recognized as whole and illness affecting many components inside this knee [8]. Although AC degeneration is the most common symptom of OA, SB reconfiguration

ISSN: 2582-3825 (online)
Submitted: 20.07.2021
Revised: 01.09.2021
Accepted: 18.09.2021
Published: 30.09.2021

Journal of Electronics and Informatics (2021)
Vol.03/ No.03
Pages: 167-177
https://www.irojournals.com/iroei/
DOI: https://doi.org/10.36548/jei.2021.3.002

and joint inflammation (infection of the joint capsule) frequently occur before cartilage loss. Additionally, OA is defined as a " a progression based on age reactivity behavior of a joints in answer to shock or damage," implying that OA is a bone dysfunction. From a scientific perspective, the makeup of AC in OA varies, and the ECM loses its coherence [9] . The biomechanics capabilities of cartilage have been found to be altered by OA. Furthermore, the radical changes begin with degradations of the cartilage's surface. As a result, OA causes more deep cracks in AC, calcified collagen growth, and tidemark replication. This mechanism is also followed by the modifications in SB discussed before. Knee OA is caused by a variety of reasons, but as a result of bone turnover structure and decreasing muscle contraction, age is considered a significant known risk. In all primary joints, the frequency of OA rises with age. Overweight and female gender is both recognized to be significant predictors for knee OA [10].

4. Diagnostic and Prognotic Information

OA is generally recognized through pathological evaluation and, when appropriate, radiographic evaluation. A physical diagnosis consists of a review of indications as well as a quick medical examination of the joint. Scanning should only be utilized in circumstances where a prognosis needs clarification, according to the current remarks on the application of neuro-imaging in OA diagnosis [11]. Plain radiography (X-ray imaging) is the imagery in the first instance method that should be used in this instance. Radiography does not provide exact location of chondro, tendons, menisci, synovial membrane, and other key components impacted by OA, despite its widespread use. Although magnetic resonance imaging (MRI) can be used to scan these regions, it is expensive and not commonly employed in medical observation [12]. As a result, X-ray imaging is still the most common screening modality used in the diagnosis of OA. It is now difficult to estimate a prognosis, particularly the path of pain and appropriate result. The heterogeneity of OA and the possibility of distinct morphologies can elucidate this. Several studies were conducted too far with the goal of assessing the biomechanical and pain evolution of OA. Despite a decade of research, neither the molecular

ISSN: 2582-3825 (online)
Submitted: 20.07.2021
Revised: 01.09.2021
Accepted: 18.09.2021
Published: 30.09.2021

Journal of Electronics and Informatics (2021)
Vol.03/ No.03
Pages: 167-177
https://www.irojournals.com/iroei/
DOI: https://doi.org/10.36548/jei.2021.3.002

mechanisms OA progression nor therapeutically relevant and accurate biomarkers have been identified [13].

5. Knee Osteoarthritis Radiographic Imaging

Conventional radiographic is widely used to imaging OA, which is undertaken in primary care as required. Nonetheless, specialist detection methods like as MRI and ultrasonic can also be utilized to image OA. In the remedied plank position, a knees X-ray is routinely taken [14]. Radiography loses repeatability when data processing parameters are unregulated, such as when the trajectory of the X-ray stream changes or the knee locations are not constant – that is, the look with same patient's knee may change across scanning session. This could have a major effect on human vision, specifically when it comes to assessing joint space shortening (JSN), the most frequent radiograph quantification diagnostic indicator that's often used as a proxy for femoral and quadriceps AC thinning. The use of a locating platform is one option for overcoming the repeatability limits of plain radiographs.

6. Kellgren-Lawrence Grading

The Kellgren-Lawrence (KL) grading system is the global customary approach for determining knee OA intensity using radiographic. The KL system divides OA intensity into five categories: no OA (KL-0), questionable OA (KL-1), early OA (KL-2), moderate OA (KL-3), and severe OA (KL-4) (KL-4). Shows the example of a knee radiographs for each of the categories.

The preceding are the prerequisites for each of the KL grade levels: KL-0 indicates that there are no obvious alterations (JSN or osteopenia). JSN or osteophytes may be observed, according to KL-1. The development of obvious osteophytes and a probable JSN is indicated by KL-2. KL-2 establishes the threshold for having radiography OA [15].

ISSN: 2582-3825 (online)
Submitted: 20.07.2021
Revised: 01.09.2021
Accepted: 18.09.2021
Published: 30.09.2021

Journal of Electronics and Informatics (2021)
Vol.03/ No.03
Pages: 167-177
https://www.irojournals.com/iroei/
DOI: https://doi.org/10.36548/jei.2021.3.002

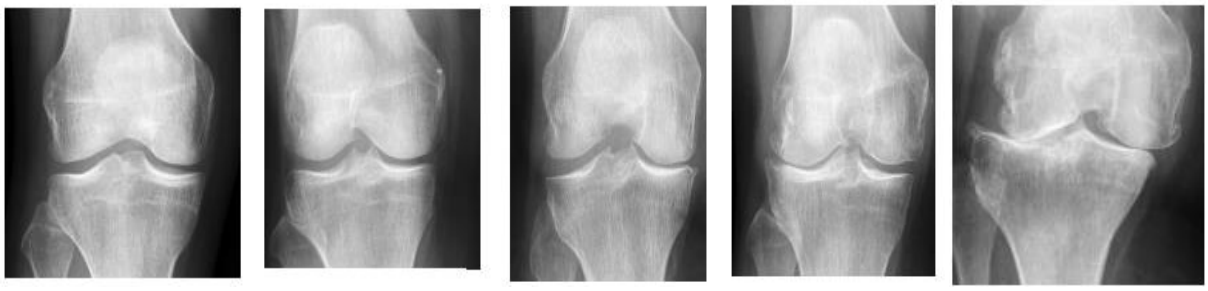

Figure 2. Examples of X-ray scans for each phase of osteoarthritis (OA) - (KL-0, KL-1, KL-2, KL-3, KL-4)

Substantial osteophytes, obvious JSN, partial bone degeneration, and likely skeletal deformation are all defined by KL-3. Ultimately, KL-4 suggests clear bone deformities, extensive osteophytes, severe fibrosis, and a pronounced JSN. Due to its simple structure, the KL grading scale has one significant flaw: the viewer's judgment.. Furthermore, because the KL method is category and non-sensitive, it does not enable for perfectly alright evaluations of OA characteristics that can be a barrier to detecting early signs and symptoms of OA [16].

7. Computer-Aided Methods in Osteoarthritis

Since 1989, researchers have been looking into bone texture features in the OA domain. Lynch et al. recently invited FSA in 1991, and it is still utilized for various applications today [17]. FSA, in instance, has been proven to have the ability to not only detect but also predict the course of radiological OA. Other subset, such as local features or grayscale level co-occurrence lattice variables, has also been found to be beneficial in the detection of OA [18]. One putative description of OA-induced alterations is bone and cartilage modifications that can be recorded by a texture features. Some other method for detecting OA automatically is to use contour assessment. Furthermore, a composite of color and size has been demonstrated to be more effective in diagnosing radiographs OA [19]. JSW measures can be regarded a simplification of deformations. JSW assessments of any joint, in general, are quantifiable and easily decipherable for clinicians, although they are night before going to bed to perform mechanically.

ISSN: 2582-3825 (online)
Submitted: 20.07.2021
Revised: 01.09.2021
Accepted: 18.09.2021
Published: 30.09.2021

Journal of Electronics and Informatics (2021)
Vol.03/ No.03
Pages: 167-177
https://www.irojournals.com/iroei/
DOI: https://doi.org/10.36548/jei.2021.3.002

8. Conclusion

OA, a devastating condition that affects billions of individuals across the world, was covered extensively in this research. OA of important parts, including the knee and ankle, has been one of the leading causes of disability worldwide. Behavioral intervention, hospice pharmaceutical therapy, and TKR towards the end course of the illness are now the only effective treatments for OA. Because the path physiology of OA is uncertain, making a diagnosis for Patients is challenging. Although OA is now diagnosed in general practice, the key diagnostic techniques are restricted in their ability to detect early OA alterations. While radiography is not required by present OA diagnosis recommendations, it could be used to identify and quantify the first abnormalities in the knee. In addition, radiographic imaging of the knee joint was provided in this work. Two classification systems for knee radiographic were discussed, as well as their advantages and disadvantages. The standardization of data collecting has been identified as being significant in the study of radiographic. The photos' subjective assessment suffered from inter-rater variance.

Funding Details: King Khalid University, Abha, Kingdom of Saudi Arabia, supported this research project by funding it through a General Research Project with award number RGP/119/42.

References

[1] Saleem, M., Farid, M.S., Saleem, S. et al. X-ray image analysis for automated knee osteoarthritis detection. SIViP 14, 1079–1087 (2020). https://doi.org/10.1007/s11760-020-01645-z

[2] Adam, Edriss Eisa Babikir. "Survey on Medical Imaging of Electrical Impedance Tomography (EIT) by Variable Current Pattern Methods." Journal of ISMAC 3, no. 02 (2021): 82-95.

ISSN: 2582-3825 (online)
Submitted: 20.07.2021
Revised: 01.09.2021
Accepted: 18.09.2021
Published: 30.09.2021

Journal of Electronics and Informatics (2021)
Vol.03/ No.03
Pages: 167-177
https://www.irojournals.com/iroei/
DOI: https://doi.org/10.36548/jei.2021.3.002

[3] Altman, R., Gold, G.: Atlas of individual radiographic features in osteoarthritis, revised. Osteoarthr. Cartil. 15, A1–A56 (2007)

[4] Balasubramaniam, Vivekanadam. "Artificial Intelligence Algorithm with SVM Classification using Dermascopic Images for Melanoma Diagnosis." Journal of Artificial Intelligence and Capsule Networks 3, no. 1: 34-42.

[5] Dacre, J., Scott, D., Da Silva, J., Welsh, G., Huskisson, E.: Joint space in radiologically normal knees. Rheumatology 30(6), 426–428 (1991)

[6] Sungheetha, Akey, and Rajesh Sharma. "Design an Early Detection and Classification for Diabetic Retinopathy by Deep Feature Extraction based Convolution Neural Network." Journal of Trends in Computer Science and Smart technology (TCSST) 3, no. 02 (2021): 81-94.

[7] Duncan, S.T., et al.: Sensitivity of standing radiographs to detect knee arthritis: a systematic review of level i studies. Arthroscopy 31(2), 321–328 (2015)

[8] Li, Y., Wang, S., Tian, Q., Ding, X.: A survey of recent advances in visual feature detection. Neurocomputing 149, 736–751 (2015)

[9] Shamir, L., Ling, S., et al.: Knee x-ray image analysis method for automated detection of osteoarthritis. IEEE Trans. Biomed. Eng. 56(2), 407–415 (2009)

[10] Tiulpin, A., Thevenot, J., et al.: Automatic knee osteoarthritis diagnosis from plain radiographs: a deep learning-based approach. Sci. Rep. 8(1), 1727 (2018)

[11] You, X., Du, L., Cheung, Y., Chen, Q.: A blind watermarking scheme using new nontensor product wavelet filter banks. IEEE Trans. Image Process. 19(12), 3271–3284 (2010)

[12] Zheng, J., Ji, Z., Yu, K., An, Q., Guo, Z., Wu, Z.: A feature-based solution for 3d registration of ct and mri images of human knee. Signal Image Video Process. 9(8), 1815–1824 (2015)

[13] ElTantawy, A., Shehata, M.S. Local null space pursuit for real-time moving object detection in aerial surveillance. SIViP 14, 87–95 (2020). https://doi.org/10.1007/s11760-019-01528-y

ISSN: 2582-3825 (online)
Submitted: 20.07.2021
Revised: 01.09.2021
Accepted: 18.09.2021
Published: 30.09.2021

Journal of Electronics and Informatics (2021)
Vol.03/ No.03
Pages: 167-177
https://www.irojournals.com/iroei/
DOI: https://doi.org/10.36548/jei.2021.3.002

[14] R. T. Wahyuningrum, L. Anifah, I. K. Eddy Purnama and M. Hery Purnomo, "A New Approach to Classify Knee Osteoarthritis Severity from Radiographic Images based on CNN-LSTM Method," *2019 IEEE 10th International Conference on Awareness Science and Technology (iCAST)*, 2019, pp. 1-6, doi: 10.1109/ICAwST.2019.8923284.

[15] J. Antony, K. McGuinness, N. E. O'Connor and K. Moran, "Quantifying radiographic knee osteoarthritis severity using deep convolutional neural networks," 2016 23rd International Conference on Pattern Recognition (ICPR), 2016, pp. 1195-1200, doi: 10.1109/ICPR.2016.7899799.

[16] Y. Du, J. Shan, R. Almajalid and M. Zhang, "Knee Osteoarthritis Severity Level Classification Using Whole Knee Cartilage Damage Index and ANN," 2018 IEEE/ACM International Conference on Connected Health: Applications, Systems and Engineering Technologies (CHASE), 2018, pp. 19-21, doi: 10.1145/3278576.3278585.

[17] P. P. Kawathekar and K. J. Karande, "Severity analysis of Osteoarthritis of knee joint from X-ray images: A Literature review," 2014 International Conference on Signal Propagation and Computer Technology (ICSPCT 2014), 2014, pp. 648-652, doi: 10.1109/ICSPCT.2014.6885008.

[18] Y. Dalia, A. Bharath, V. Mayya and S. Sowmya Kamath, "DeepOA: Clinical Decision Support System for Early Detection and Severity Grading of Knee Osteoarthritis," 2021 5th International Conference on Computer, Communication and Signal Processing (ICCCSP), 2021, pp. 250-255, doi: 10.1109/ICCCSP52374.2021.9465522.

[19] J. Antony, K. McGuinness, K. Moran and N.E. O'Connor, "Automatic detection of knee joints and quantification of knee osteoarthritis severity using convolutional neural networks" in Machine Learning and Data Mining in Pattern Recognition, Cham:Springer International Publishing, pp. 376-390, 2017.

Author's biography

R. Kanthavel is a Professor in the Department of Computer Engineering at King Khalid University, Abha, Saudi Arabia. His research is mainly focused on the emerging smart

ISSN: 2582-3825 (online)
Submitted: 20.07.2021
Revised: 01.09.2021
Accepted: 18.09.2021
Published: 30.09.2021

Journal of Electronics and Informatics (2021)
Vol.03/ No.03
Pages: 167-177
https://www.irojournals.com/iroei/
DOI: https://doi.org/10.36548/jei.2021.3.002

computing technologies that includes Distributed Computing, quantum computers, Computer Graphics, Computer Networks, and Web Technologies.

R. Dhaya is currently a Professor in the Department of Computer science and Engineering at King Khalid University-Sarat Abidha Campus, Saudi Arabia. Her major area of research includes Image and Video Processing Algorithms, Computer Vision, Motion Analysis, Stereo Vision, Object Recognition, computer graphics, photo interpretation, image retrieval, Embedded Image Processing and Real-time image and video processing applications.

ISSN: 2582-3825 (online)
Submitted: 20.07.2021
Revised: 01.09.2021
Accepted: 18.09.2021
Published: 30.09.2021