Can a computer sense the symptoms of osteoarthritis from a radiograph? Initial findings from a pilot, AI approach to osteoarthritis assessment

Abstract

Introduction

Osteoarthritis is the most common joint disease and is associated with substantial morbidity for the affected individual and a significant financial burden for the health system at large. There is a marked discrepancy between the extent of osteoarthritis observed via plain radiography and the magnitude of clinical symptoms. For this reason we aimed to investigate whether, using an artificial intelligence approach, we could train an algorithm to diagnose osteoarthritis and if we were able to find correlations between clinical symptoms and radiographic images.

Methods

Anterior-posterior and lateral radiographic images of the knees and hips were ascertained from members of the Hertfordshire Cohort Study (HCS, a group of community-dwelling older adults in the UK) and were merged with anterior-posterior knee X-rays obtained from Mendeley (a repository of open-access images). The HCS contributed 1445 images, which were equally split into training and testing sets, and the Mendeley cohort provided 2889 training and 828 testing radiographs. The radiographic images were passed through a detection network in order to identify the region of interest (the knee or hip joint), thereby streamlining the necessary information in the image. Next, a classification network was trained with the goal of differentiating the Kellgren and Lawrence (KL) grade for each joint. Finally, the clinical symptoms and X-rays gradings were subject to pairwise correlation, using Spearman rank-order correlation.

Results

The HCS sample included 222 males and 221 females with a mean age of 76 years (SD 2.6). In terms of detection of the join, an average accuracy of 99% was achieved. The classification task utilised alternative evaluation metrics, with the best network achieving 58% accuracy, 63% average precision and 61% average recall in the KL grading task. Superior results were obtained with knee joints than hips. However, when using the dichotomous outcomes of ‘osteoarthritis’ (defined by a KL≥2) or ‘no osteoarthritis’, the results significantly improved, obtaining an accuracy of 81.2%. Significant correlations were observed

between the majority of pain symptoms and the radiograph images, with the strongest correlations seen at the knees with; pain going up or down stairs (rho 0.30), pain standing upright (rho 0.30), pain walking on hard surface (rho 0.28), pain walking on uneven surface (rho 0.31) and pain standing from chair (rho -0.30).

Conclusions

To conclude, in this pilot study, we have trained an algorithm, to diagnose osteoarthritis of the knees and hips with limited accuracy. We have also demonstrated moderate correlations with some specific pain symptoms. It will be interesting to see whether these initial findings are replicated as we expand this project into other cohorts.