Pose estimation using smartphone camera and prediction of osteoporosis in the elderlies

Takahisa Ogawa[1,2], Yoshiyuki Suehara[3,4], Nguyen Thi Bao Uyen[5], Le Anh Tuan[5], Nguyen Van Son[5]
[1] Department of Orthopedics, Saku General Hospital, Nagano, Japan
[2] Department of Health Policy and Informatics, Tokyo Medical and Dental University, Tokyo, Japan
[3] Department of Orthopedics, Kamonomiya Orthopedic, Saitama, Japan
[4] Department of Orthopedics, Juntendo University, Tokyo, Japan
[5] Asilla Vietnam Inc, Hanoi, Vietnam
Email of Presenting Author: takahisa.o@gmail.com

INTRODUCTION:
Osteoporosis, a widespread bone condition, is marked by weakened bone integrity, making individuals more susceptible to fractures and thus early detection and appropriate prevention is important [1]. Although several screening techniques for osteoporosis, such as dual-energy X-ray absorptiometry (DEXA) have been introduced, these techniques are efficient, they necessitate specific machinery and can be expensive. As a physical examination, patient standing posture is useful identify the presence of osteoporosis [2]. Considering the widespread use of mobile devices and the progress in data science, images captured by mobile phone cameras, particularly lateral views, could provide valuable information on upright posture, potentially indicating osteoporosis[3]. The purpose of this study is to explore the feasibility of diagnosing osteoporosis using machine learning-based posture estimation. By measuring spinal alignment from smartphone images of patients taken from the lateral side, we aim to use the derived angles to predict the presence of osteoporosis.

METHODS: (1) Using the AsillaPose estimation model, a model of 2D human posture estimation was created from over 2000 images of around 50 people with different posture and different clothes. After estimating human pose, UpperBack angles at 2 different circumstances (standing straight and leaning against the wall) are calculated. (2) The osteoporosis detection model based on the Support Vector Machine (SVM) algorithm is used to evaluate the possibility of a person suffering from osteoporosis. We measured bone mineral density (BMD) at the hip joint using DEXA and we classify that the examined patient has osteoporosis if BMD level is below 70. Then, we use the osteoporosis information with upper back angles along with age information as training data to train the osteoporosis detection model.

RESULTS: The optimized pose estimation accuracy was measured in mAP (mean Average Precision) and we achieved 95.2% of mAP on a test dataset. This result shows a high accuracy of posture estimation for osteoporosis detection. The accuracy of osteoporosis detection based on SVM was 82%. The test dataset are static side view images of people collected using a smartphone.

DISCUSSION: In our study titled "AI Posture Analysis: Detecting Osteoporosis from Smartphone Images," we observed two significant findings. Firstly, the pose estimation demonstrated a notable accuracy, with a mean average precision (mAP) result of 95.2% on the testing dataset. Secondly, when adjusting for a patient's age, the accuracy of osteoporosis detection was 82% using the support vector machine and 63% with logistic regression. These findings will be further elaborated upon in the subsequent sections. In this study we used posture estimation to predict osteoporosis. Estimation with test data sets is sufficient, and validation with more patient data is needed in the future. Furthermore, the accuracy of the prediction was improved this time by estimating age separately from posture. In the future, it will be possible to estimate osteoporosis from patient photographs alone by also estimating age from posture. This approach seeks to provide a novel, non-invasive, and accessible method for early osteoporosis detection, bridging the gap between advanced medical diagnostics and everyday technology.

SIGNIFICANCE/CLINICAL RELEVANCE: Posture estimation is feasible from a patient's standing posture photo using a smartphone. In the future, posture estimation using smartphones will be possible for elderly patients as well, which will enable screening of patients with osteoporosis and other high-risk fractures without using medical devices such as x-rays or DEXA.

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