Abstract Title: IMAGE BASED MEASUREMENTS FOR EVALUATION OF PELVIC ORGAN PROLAPSE

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Abstract Body:
Objective: The main objective of this research is to design an MRI-based pelvimetry floor measurement model for automated diagnosis of POP.

Background
Pelvic organ prolapse (POP) is a major health problem that affects women. POP is a herniation of the female pelvic floor organs (bladder, uterus, small bowel, and rectum) into the vagina, which can have a significant impact on women’s quality of life causing problems such as urinary and fecal incontinence, bothersome vaginal bulge, incomplete bowel and bladder emptying, and pain/discomfort. Unfortunately, POP treatment procedures are associated with high failure rates, with approximately 30% of women who undergo surgical operation requiring additional surgery due to recurring symptoms, which are generally nonspecific. Dynamic magnetic resonance imaging (MRI) of the pelvic floor has become an increasingly popular tool to assess POP and may provide additional information that is helpful for the diagnosis and/or management of pelvic organ prolapse given the limitations of clinical examination. However, MRI measurements are currently performed manually and can be inconsistent and time-consuming.

Methods:
Pelvimetry floor measurements on MRI begin with the identification of reference points. These reference points are located on three areas: pubic bone, sacral promontory, and coccyx. Points located on the pubic bone can be found through segmentation of the pubis. On the other hand, points located on the sacral promontory and coccyx can be defined as intersecting points, and can be found by applying a corner detection algorithm. After all the points of interest are identified, the points can be linked to each other through lines to perform pelvimetry floor measurements. The proposed method to identify the reference points and lines semi-automatically on the pubic bone is divided into three main stages: pre-segmentation, segmentation, and point identification. The first stage
starts with manual segmentation pubic bone for data training, and statistical mean shape generation. In the second stage, feature extraction is done using intensity and texture features. Sequential forward selection is performed for subset feature selection. Then, pixel blocks are classified as image blocks and background blocks using support vector machines (SVM) followed by first phase morphological operations to have the initial segmented image. Segmentation is further improved by incorporating prior shape information to the initial segmented image. The final step is the identification of the points by applying morphological skeleton operation. Skeleton operation removes pixels on the boundaries of the pubic bone but does not allow objects to break apart. The remaining pixels make up the image skeleton. Points in the region of sacral promontory and coccyx are defined as a corner points for which there are two dominant and different edge directions on the local neighborhood of the point. For this reason, these points are detected using corner detection algorithms. In our experiments, we adapted the Harris corner detection algorithm to detect the bony joints.

Results:
The anonymized midsagittal MR images of 18 subjects were analyzed in this study. The experiments on the MRI images show that the automatically identified reference points were faster and consistent with the points identified manually by an expert. Moreover, the points and lines generated were consistent throughout the trials on the same image. The percentage of pixel-based distance between the points that were identified manually and automatically over images of 512x512 pixels were between 0.29% and 4.03%.

Conclusion:
The presented method aims to overcome the current limitations of manually identifying points, lines, and measurements on MRI and enable the analysis of larger image samples. The automation of the pelvimetry floor measurements on radiologic studies will allow the use of imaging in predicting the development of POP in patients. In the future, we will design a technique for the fully automated identification of other points of interest to enable the analysis of measurements between different subjects and among groups.