REGIONAL VARIATION IN COMPRESSIVE STRENGTH IN FEMUR IMAGES AS ASSESSED USING STATISTICAL PARAMETERS AND PRINCIPAL COMPONENT ANALYSIS

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INTRODUCTION

Assessment of mechanical strength of bone remains a central issue in estimation of fracture and bone loss such as in osteoporosis. The strength of the bone such as in femurs is primarily of compressive in nature and this region is highly inhomogeneous in nature. Although there are several 2D and 3D imaging methods to analyze this strength, conventional planar radiographs are capable of providing reliable inference. In this work, regional compressive strength of femur trabecular bone in planar radiographs are assessed using statistical parameters and principal component analysis.

METHODS

Digitized pelvis images recorded in anteroposterior view using a clinical X-ray unit were considered for the study. The compressive strength region in the binarized images were delineated as proposed by Singh et al [1]. The images were subjected to first and second order texture analysis to derive statistical parameters such as mean, skewness, kurtosis, uniformity and entropy. The mean intensity is an indirect measure of apparent mineralization. Skewness measures the asymmetry of the probability distribution of a random variable and kurtosis describes the peakedness. The uniformity and the entropy are the measures of maximum gray level and the coarseness of the image respectively [2]. These values were used for Principal component analysis (PCA) [3].

RESULTS AND DISCUSSION

Figure 1(a) shows the contribution of each variable in terms of magnitude and direction in case of normals whereas the same is shown for the abnormals is shown in figure 1(b). It is observed that contributions of skewness, uniformity and entropy in both the normals and abnormals are distinctly different than the other parameters. The magnitude and directions of eigen vectors of kurtosis and mean are different in normal than in abnormal. The results thus suggest that the variations of primary compressive strength in normals and abnormals are not distinctly different as been reported earlier [2]. Further the changes in magnitude and direction of these parameters could be attributed to local anisotropic variations in primary compressive region.

The percentage variance for the first three principal components for both normal and abnormal is shown in table 1. It is seen that the value of variance in first PC is high in abnormal indicating that the derived parameters correlate well in these images. Also, more than 90% of the variance is observed in the first two PCs itself in abnormals and it implies that all the parameters are significant in analyzing the variations of compressive strength in femur images. Although it is not possible to differentiate the degree of severity in abnormals, these studies could be used to reduce the number of parameters required for classification algorithms such as neural networks.

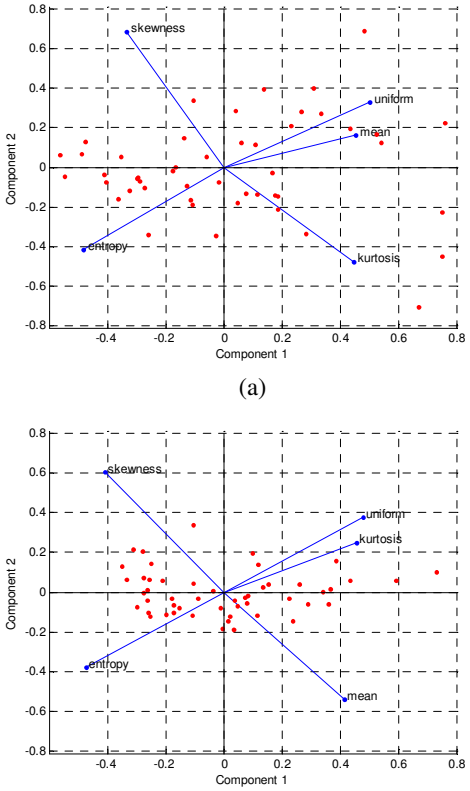

Figure 1: Scattergram showing the variation of PCA derived magnitude and direction of vectors in Normal (a) and Abnormal (b).

Table 1: The Percentage variance observed in normals and abnormals for the first five principal components.

PC	NORMAL	ABNORMAL
PC1	62.9937	76.3440
PC2	26.1496	14.2758
PC3	8.3459	7.2563
PC4	2.0774	1.9237
PC5	0.4334	0.2001

PC- Principal Component

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