AN ALGORITHM TO QUANTIFY SEGMENTAL LESIONS IN NECROTIC FEMORAL HEADS

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INTRODUCTION

Approximately 25,000 new cases of femoral head osteonecrosis (ON) present each year in the U.S. We have recently developed a method of creating segmental lesions (Reed et al.) in the emu, a large biped which progresses to femoral head collapse (Conzemius et al.). Quantification of lesion morphology is important in assessing our ability to create reproducible segmental lesions. Osteonecrosis is characterized by the presence of dead osteocytes in histological sections of the affected bone. An automated osteocyte identification and quantification algorithm has now been developed to aid in this process.

METHODS

Viable osteocytes can readily be identified in haematoxylin and eosin-stained slides by their nuclei, which show up as dark purple spots within a bright local field. Dead osteocytes present as empty lacunae — a small light-colored hole with no nucleus present — in the trabeculae (Figure 1).

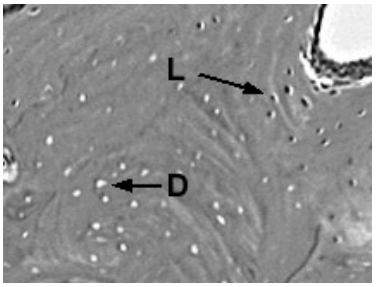

Figure 1 Stained bone showing live (L) and dead (D) osteocytes

An automatic detection algorithm was written to take advantage of these morphological features and track the quantity and location of both live and dead osteocytes. The algorithm, written in PV-Wave (VNI, Houston, TX), reads in eight-bit grayscale images and scans them for features signaturing osteocytes or empty lacunae. Its output is a list of osteocyte-center locations (pairs of x and y coordinates) and a binary value that indicates the osteocyte s status (1=alive, 0=dead)

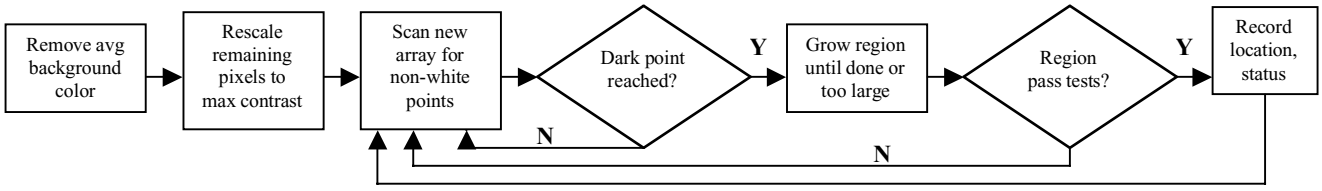

Figure 2 Flowchart describing the basic algorithm design

PERFORMANCE AND VALIDATION

Four representative sections of a femoral head slice were chosen for validation purposes. A pathologist (R.A.R.) manually identified all of the live and dead osteocytes in each section, and their locations and status were recorded. The algorithm then performed the same operation, and the pairs of lists were compared for all four sections. The results, summarized in Table 1, show very good agreement between total percentage of viable osteocytes in each section. These are, however, preliminary data, and further validation studies are being conducted.

Section #	% alive (H)	% alive (A)	Rel. Discrepency
1	31.41	28.26	0.100
2	96.36	93.08	0.034
3	51.60	50.56	0.020
4	50.51	51.90	-0.027

Table 1 Summary of validation results, human reader (H), vs. algorithm (A)

CONCLUSION

Until now, assessing the shape and size of segmental osteonecrotic lesions has been entirely qualitative. However, for the purposes of further developing the emu as a model for osteonecrosis, quantification of lesions now emerges as an important tool in assessing the extent of tissue damage.

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REFERENCES: Conzemius et al. *Trans, 46th ORS p. 206, 2000*, Reed et al., *Trans, 25th ASB, 2001*