

COMPARISON OF THIRD METACARPAL CONDYLE DENSITY PATTERNS AND SHAPE TO HISTOLOGIC CHARACTERISTICS OF THE OSTEOCHONDRAL TISSUES



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Introduction:

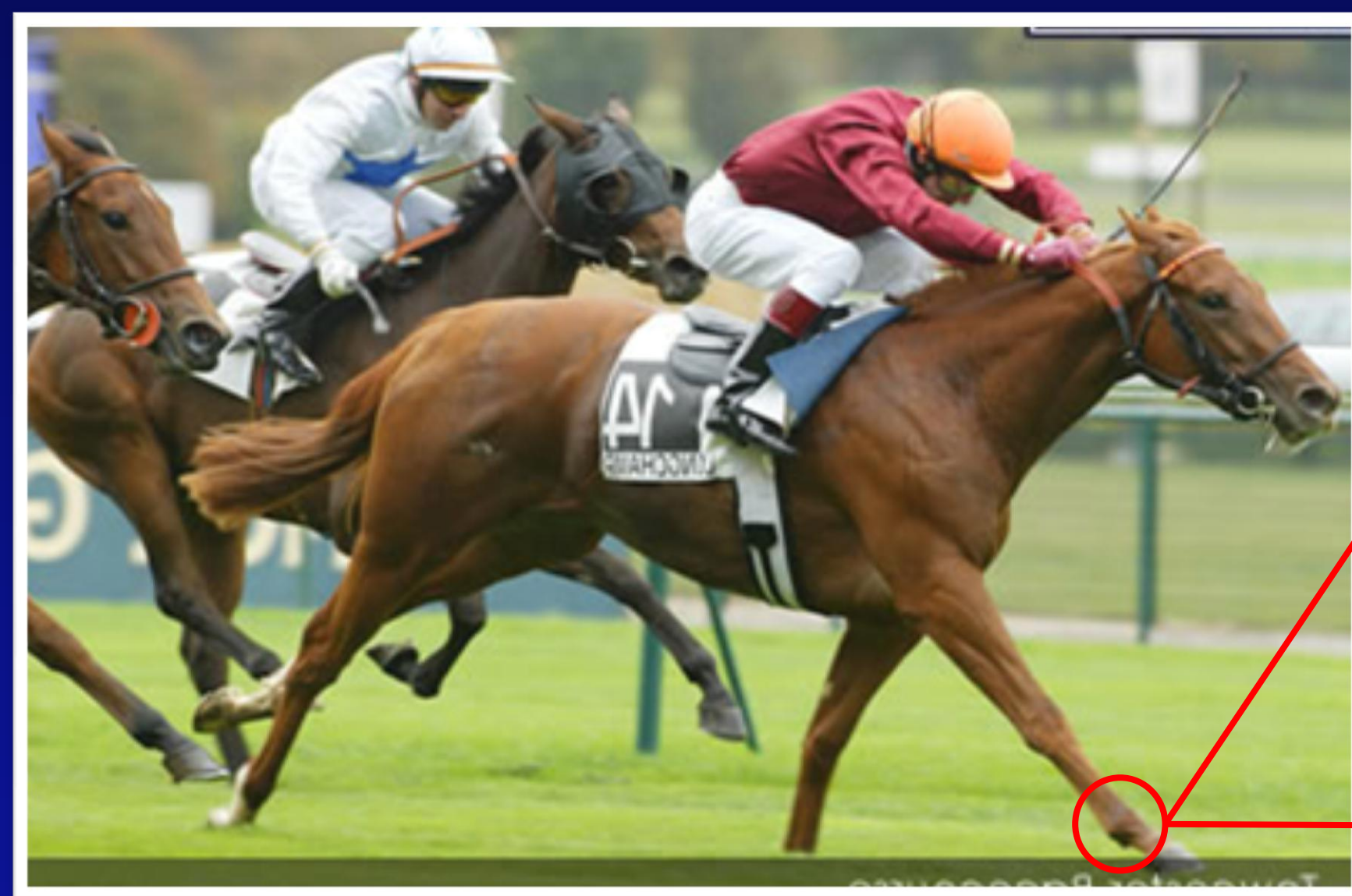


Fig. 1 Catastrophic racehorse injury in which condylar fracture held a key role.



The distal third metacarpal bone (MC3) in racehorses is prone to osteochondral disease, including catastrophic fracture often necessitating euthanasia (Figs. 1 & 2). New evidence suggests that bone density pattern and bone shape, as characterized using Computed Tomography (CT), may be determinants of fracture. This led to the hypothesis that those MC3 bones with higher grade of bone density gradient and abnormal shape have histologic characteristics of abnormal osteochondral remodeling.



Fig. 2 Gross condylar fracture (left) and gross articular cartilage loss (right).



Materials & Methods:

CT images of the metacarpophalangeal joints of twelve 18-month-old horses were exported to a 3-D software platform, analyzed in the palmar 30 degree plane, and graded using two different density gradient scales, both 0-3 (Fig. 3). Histological sections of the same area were stained with Basic Fuchsin and histologic characteristics of abnormal osteochondral remodeling were graded on individual scales (Fig. 4).

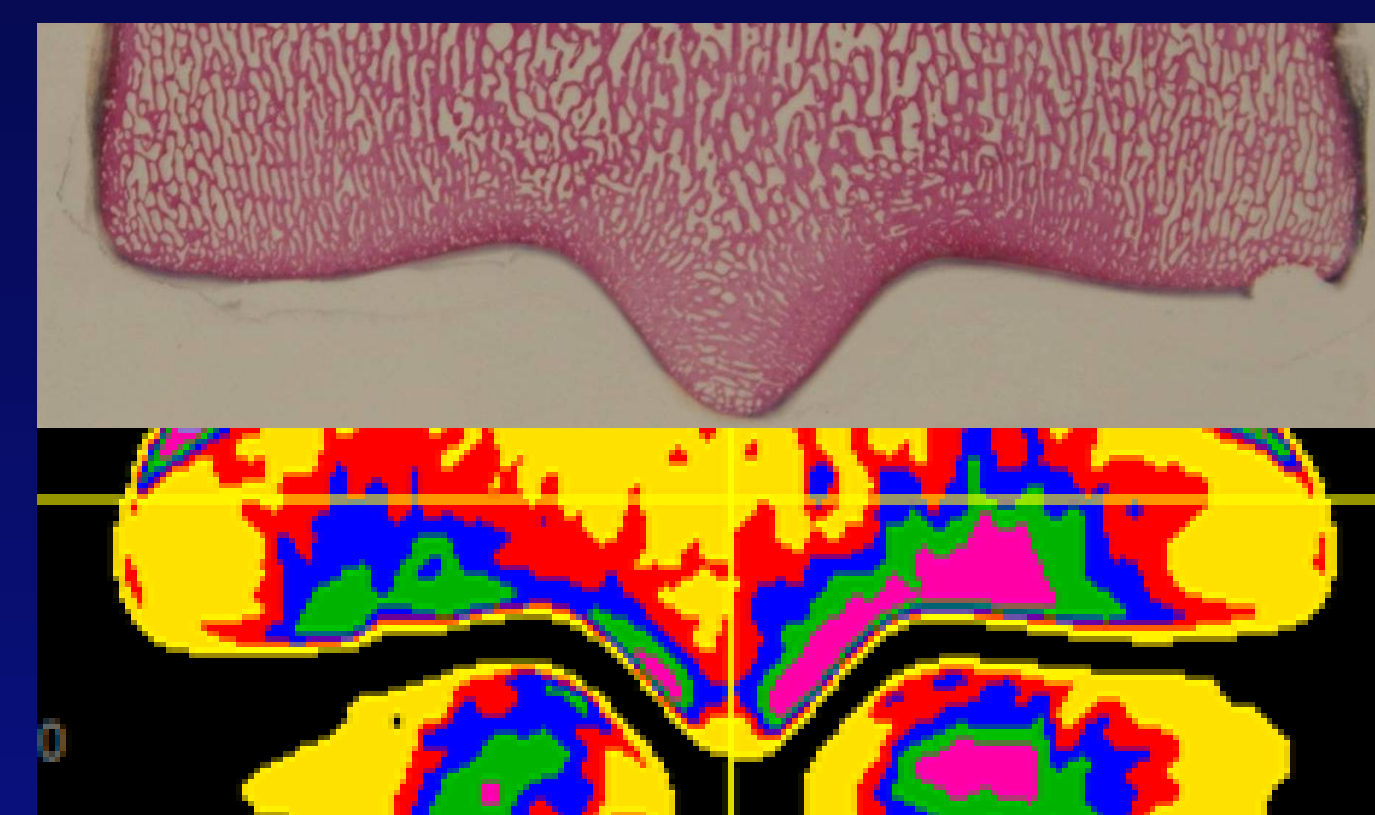


Fig. 3 Histologic section of MC3 (top) and corresponding CT image (bottom).

Characteristics included:

- Sclerosis
- Horizontally oriented trabeculae
- Stacking of horizontal trabeculae
- Stress shielding
- Calcified cartilage (CC) extension
- Bone retention
- Articular cartilage retention
- Vascularization of CC

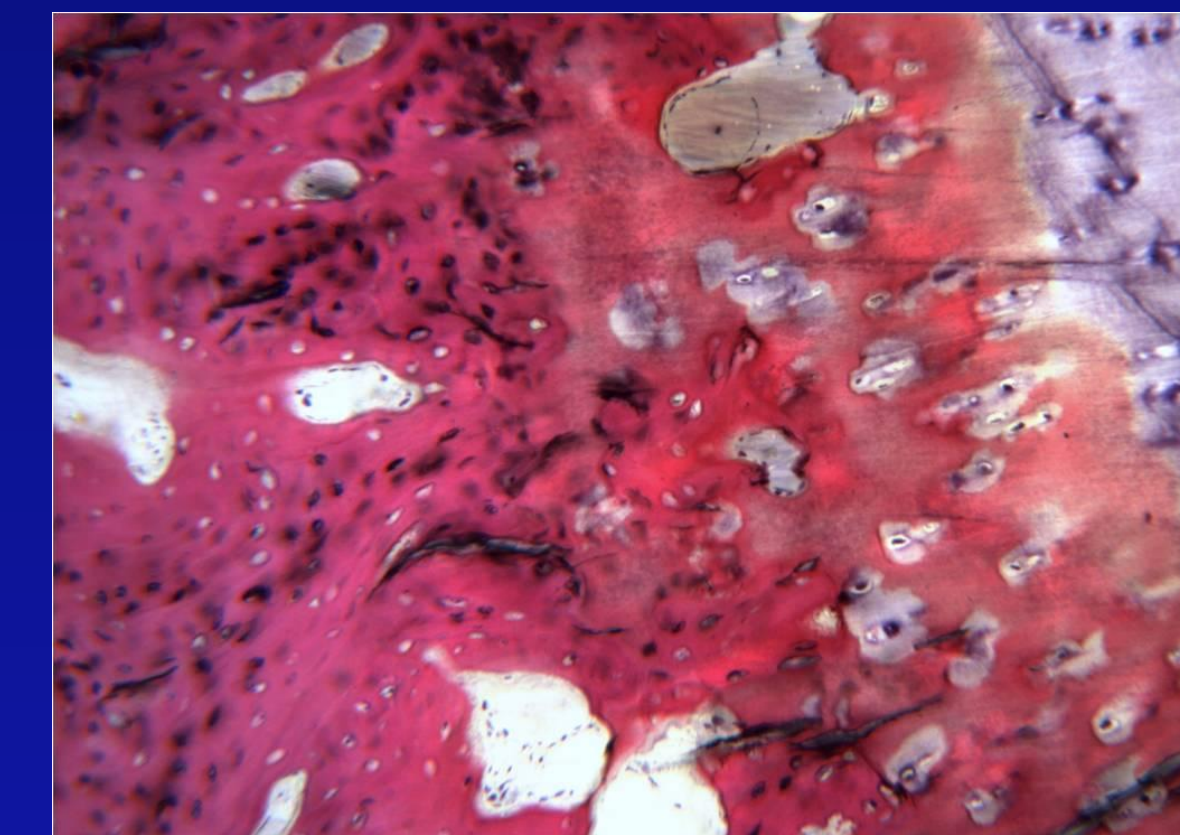


Fig. 4 Bone and Articular cartilage retention in the CC layer indicative of abnormal bone remodeling.

The shape of each condyle was also graded based on flatness of the condylar surface. Histologic results were compared between density gradient and shape groups using a mixed model ANOVA (SAS 9.2, Cary, NC).

Results:

- Lateral condyles had higher grade of horizontally oriented and stacked trabeculae than medial condyles. Those with gradual condylar slopes had higher grades of horizontal trabeculae compared to flat lateral condyles.
- Medial condyles had higher stress shielding. Those with hill type condylar slopes had higher grades of horizontally-oriented trabeculae than those with gradual configuration.
- Condyles with higher grade of bone density gradient had higher grade of horizontally-oriented trabeculae and bone retention.
- Grade 1 CT densities had significantly higher histologic bone volume than grades 2 and 3. Condyles with grade 2 CT density had significantly lower stress shielding than those with grades 1 and 3. Medial condyles with grade 3 density on CT had higher vascularity than those with grade 1 density.

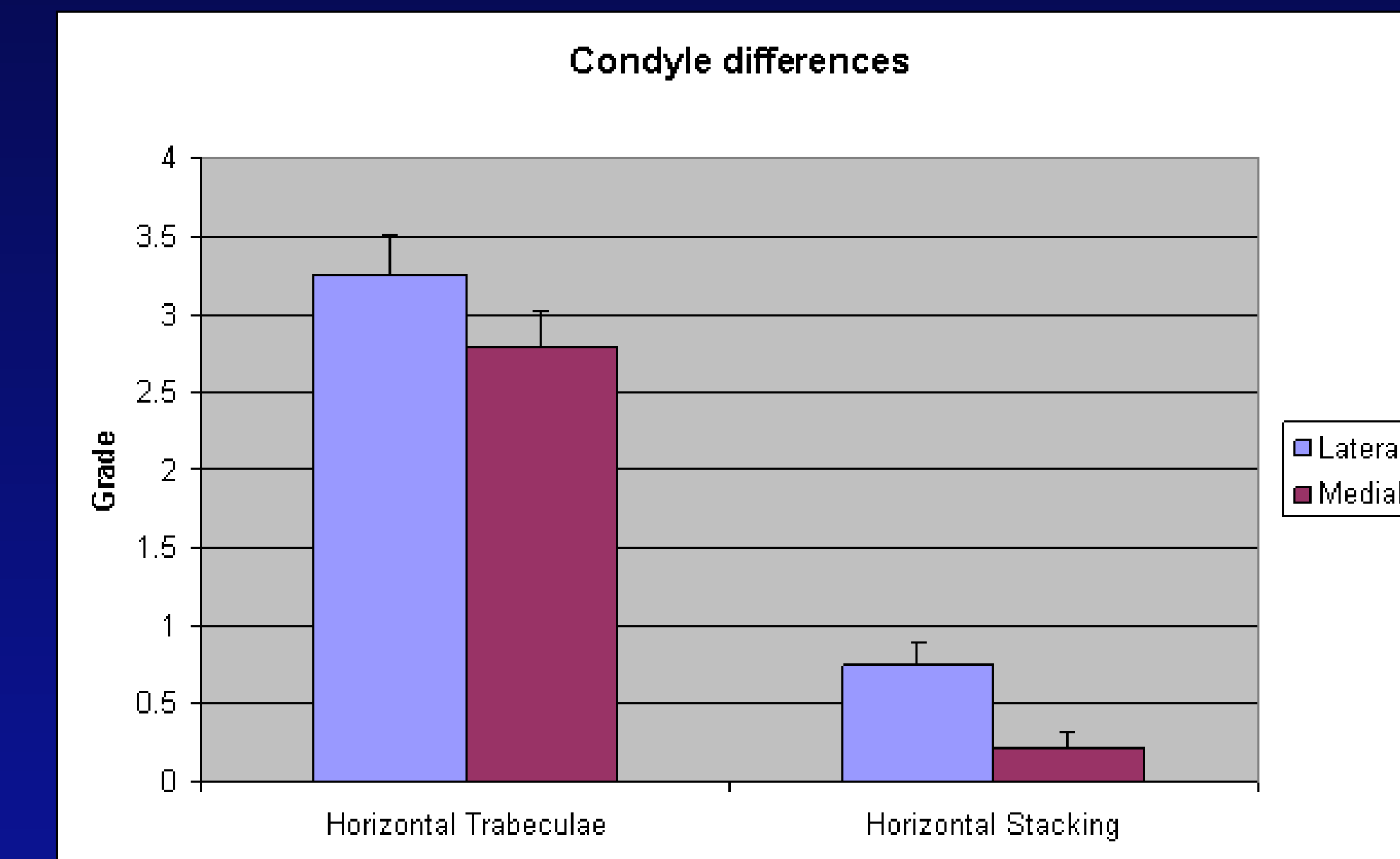


Fig. 5 Graph showing higher incidence of horizontal trabeculae and horizontal stacking in the lateral condyle than the medial condyle.

Conclusions:

The results of this study demonstrate abnormal histologic characteristics in condyles with abnormal shape and density patterns. Condyles with higher grade of bone density gradient and abnormal shape were associated with more severe osteochondral changes, including horizontally-oriented trabeculae, stacking of horizontal trabeculae and vascularization.

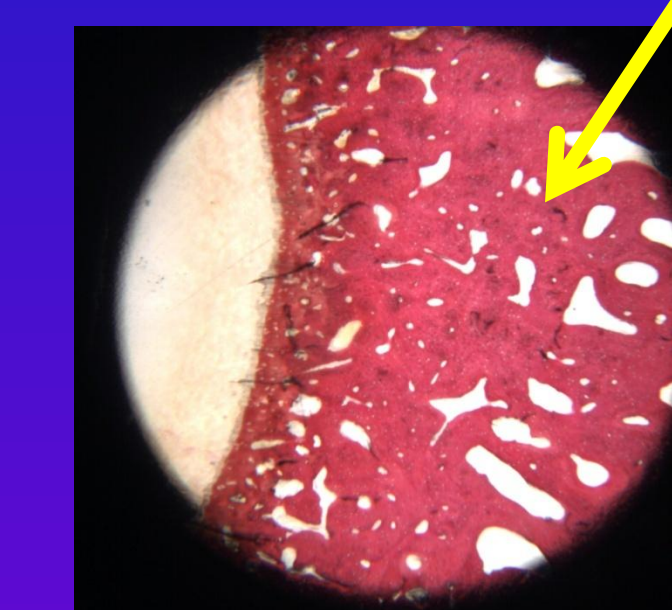
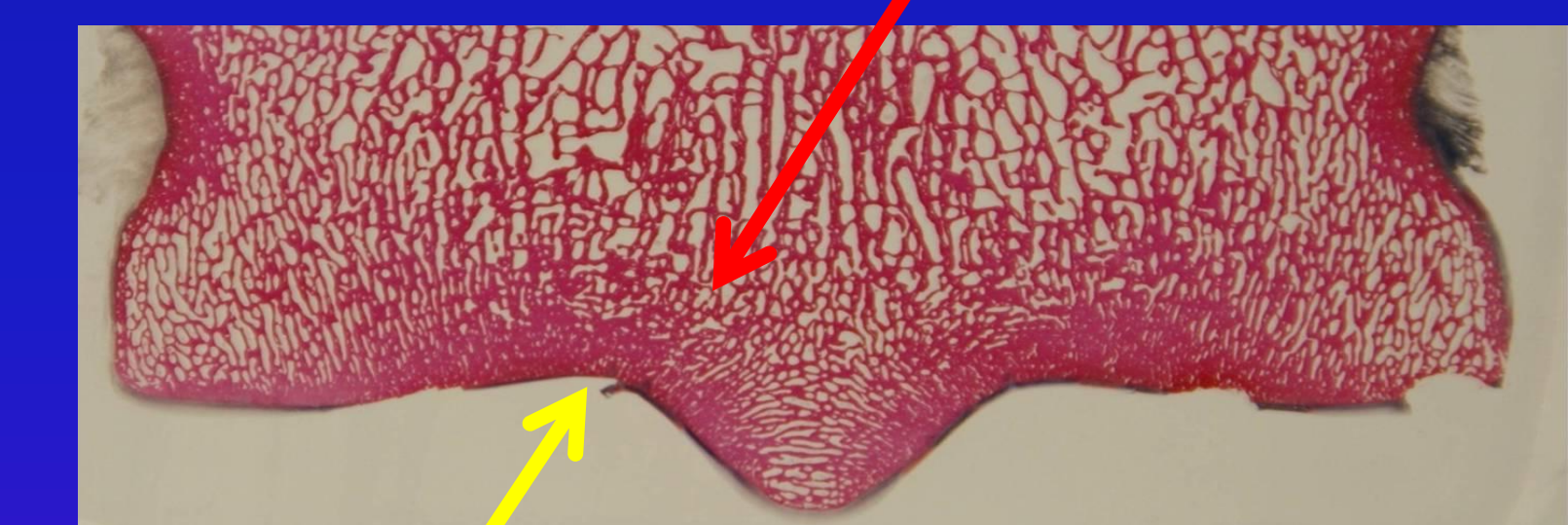
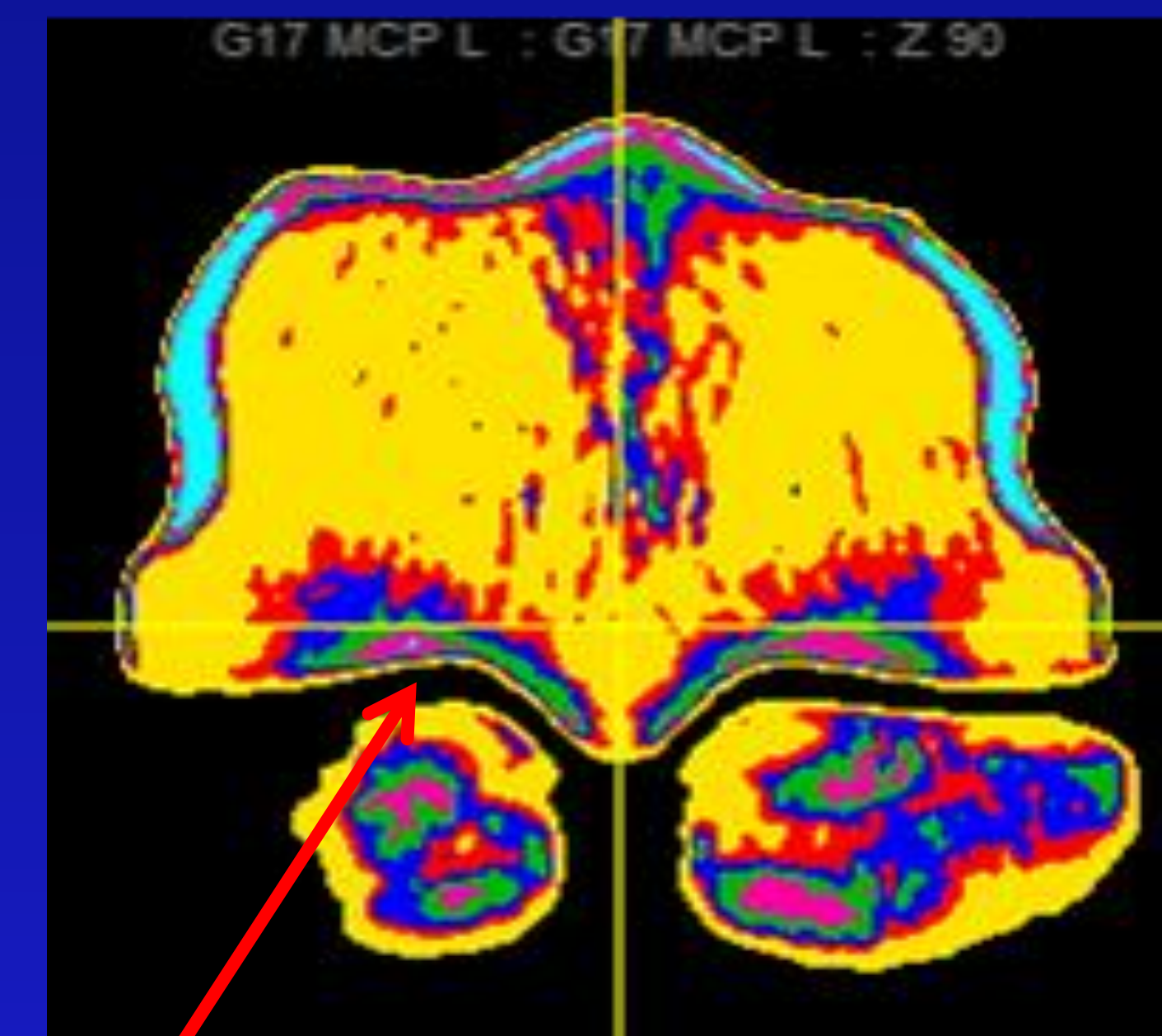


Fig. 6 Large CT gradient and associates horizontal trabeculae seen on low and high magnification.

Future Directions:

Future CT scans may be a predictive and non-invasive method of detecting osteochondral disease before catastrophic injury occurs.

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