Assessment of bone healing during antegrade intramedullary rod femur lengthening using radiographic pixel density

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No relevant conflict of interest

INTRODUCTION

Femur lengthening using intramedullary (IM) rods represents an extraordinary innovation, but patients must restrict their weight bearing until sufficient bone healing is observed at the regenerate site. The assessment of said healing is based on a subjective evaluation by the surgeon of plain radiographs, and this evaluation is subjective and affected by experience.

PURPOSE

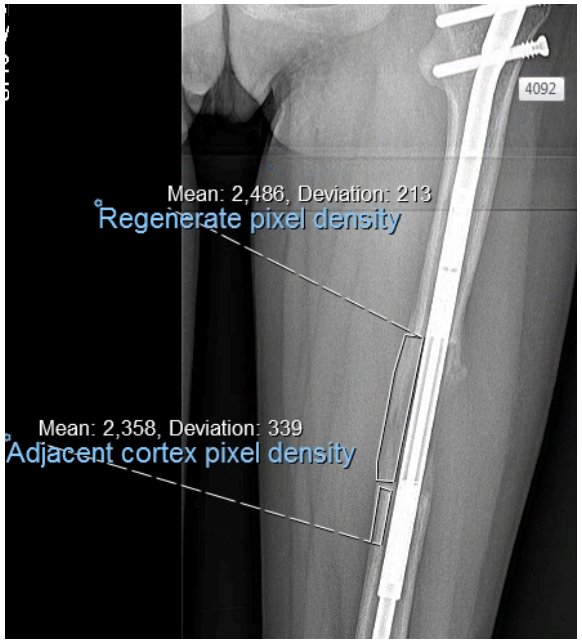
To investigate bone regenerate pixel density on a picture archiving and communication systems (PACS) monitor to: 1) assess the progression of bone healing at the regenerate site; 2) define a threshold pixel value for bone healing.

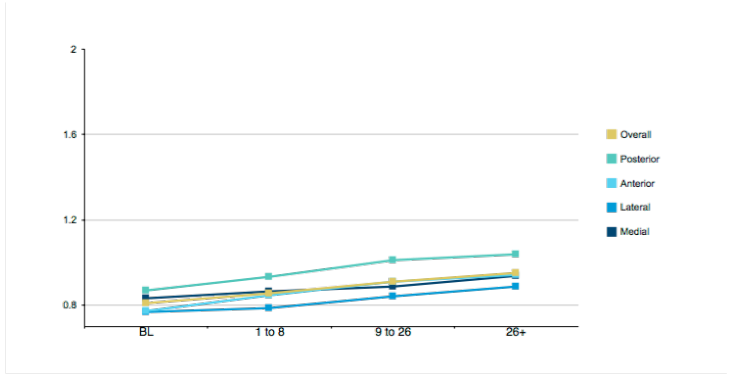
METHODS

Thirty-two consecutive patients who underwent antegrade femur lengthening using an IM rod at a minimum of 1-year follow up were included in this retrospective study. Twenty-two (69%) were male, and 10 (31%) were female. Mean age was 26 years (range, 12 to 48 years). Serial, 2-view radiographs of the femur were assessed by a single operator starting at the completion of lengthening (week 0). The pixel density of the lateral, medial, anterior, and posterior cortices was measured in each patient at every postoperative visit. These values were then compared to the adjacent 2 cm of bone just distal to the regenerate. The pixel density ratio (PDR) was calculated, and subsequently correlated to the subjective assessment of bone healing by one of the senior authors.

RESULTS

Mean distraction was 41.7 mm (range, 20 to 70 mm). Bone regenerate healing was clinically declared by the treating surgeon at mean 8.5 weeks (range, 4 to 18 weeks). The mean PDR at bone healing was 0.84 at the lateral cortex, 0.89 at the medial cortex, 0.92 at the anterior cortex, and 0.98 at the posterior cortex. The overall PDR corresponding to bone healing was 0.90, which was significantly ($p<0.001$) greater than the value at the previous clinic visit (0.82), when bone was not clinically declared to be healed. The PDR at bone healing did not correlate with patient sex, age, laterality, or distraction length.





CONCLUSIONS

The findings of the present study introduce the PDR as an objective measurement that can be used to monitor bone healing and establish a threshold value for bone union. The PDR is a rapid, objective, and easy method for the detection of bone density changes in distraction osteogenesis of the femur using an antegrade IM rod. This will be particularly useful to less experienced surgeons, and serve as a valuable aid to senior orthopedists in unclear cases. Furthermore, the PDR can be useful as an objective measurement in clinical research.