

Figure 4. Serial pixel value measurements at follow-up show graft incorporation over time.

Results

The mean age was 8.09 years (range, 1 to 15 years). Follow-up duration ranged from 6 to 24 months. The mean PVR values (in the region of ceramic substitute) at the first follow-up and final visits were 1.471 and 1.079, respectively. Wilcoxon signed rank test for PVR data showed a statistically significant ($p < 0.0001$) change in the density of the graft, when the PVR measurements at the first visit were compared with those at the last follow-up visit.

All subjects showed a pattern of gradual graft incorporation. Figure 4 indicates gradual incorporation of graft over a period of 2 years with decreasing density and PVR approaching 1. The intra-class correlation coefficient (ICC) for intra-observer reliability showed good agreement between the repeat measurements (A=0.86, B=0.92, C=0.91). The mean ICC for intra-observer reliability was 0.89. Inter-observer reliability between the three (A, B, C) observers was calculated for each pair of observers for

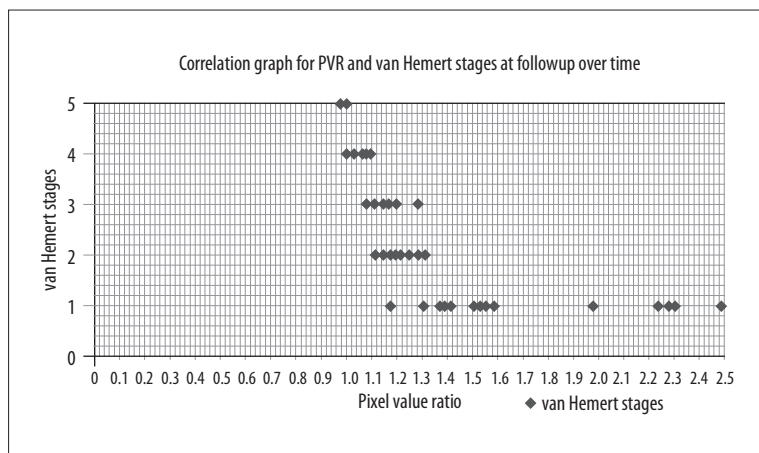


Figure 5. Negative correlation between van Hemert Scoring and pixel value ratio. $R = 0.9428$ ($P < 0.0001$).

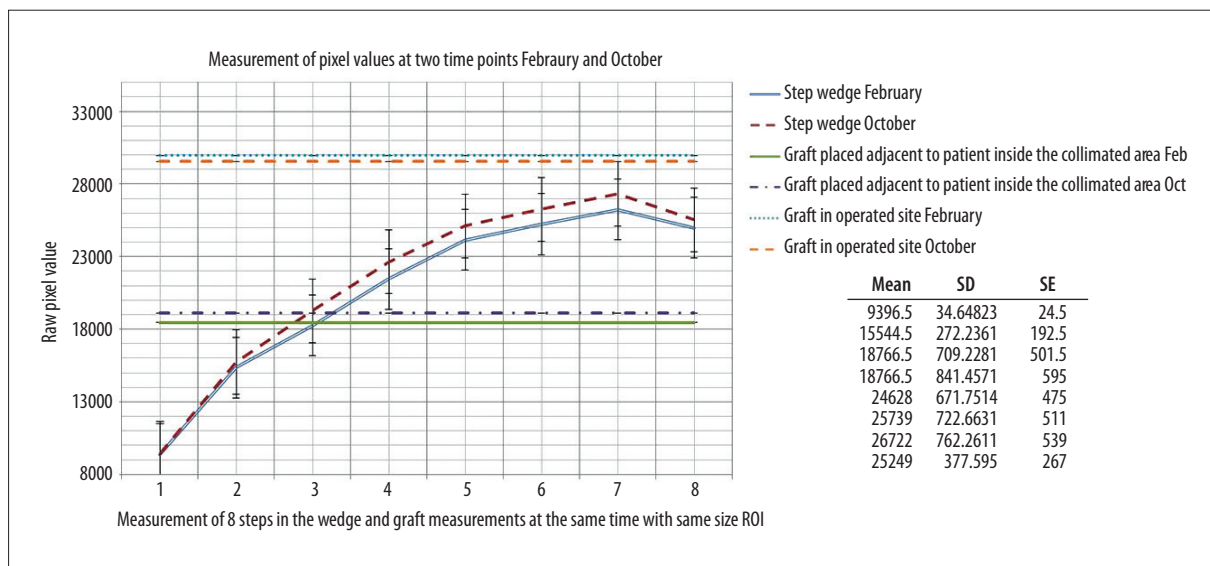


Figure 6. Illustrates the pixel values for 8 steps from the step wedge placed adjacent to the patient at two different time points. An average variation of 19% (12.8 to 31) in the pixel values was observed, if the same exposure factors and machine was used. The variation of the pixel values may be attributed to the back scatter radiation from the imaged area. A variation of 31% was observed in the pixel values of graft between 2 time points. Mean/Standard Deviation (SD) and Standard Error (SE) for step wedge given.

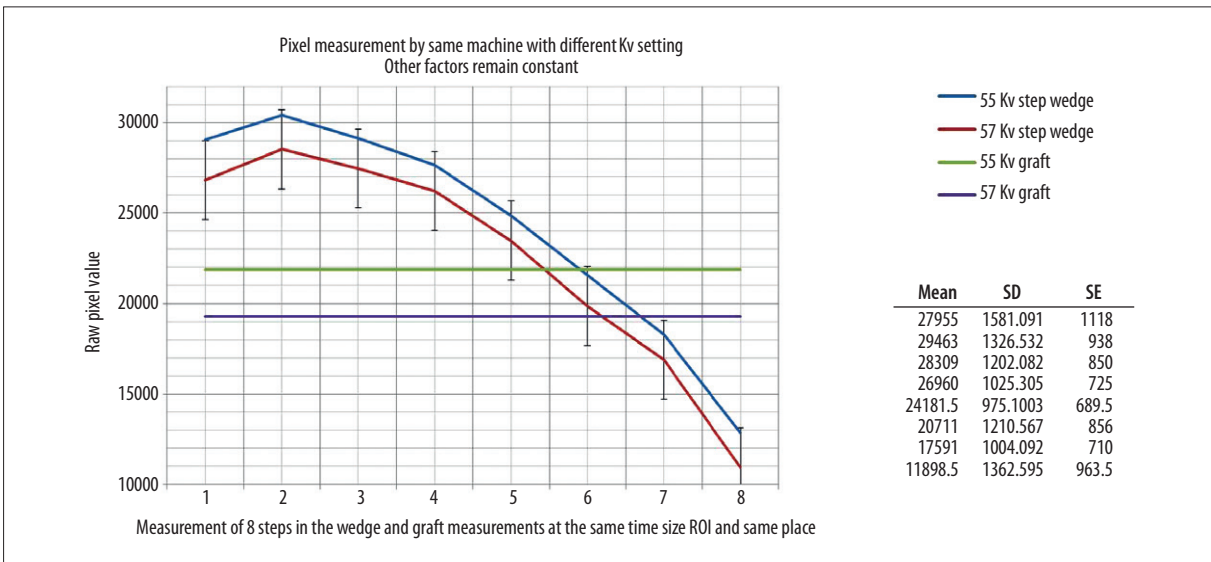


Figure 7. Illustrates the pixel value measurement for 8 steps from the step wedge using different exposure factors in the same machine using automatic exposure control. An average variation of 7.6% (5.2 to 14.9) in the pixel values was observed. A variation of 11% was observed in the pixel values of graft. Mean/Standard Deviation (SD) and Standard Error (SE) for step wedge given.

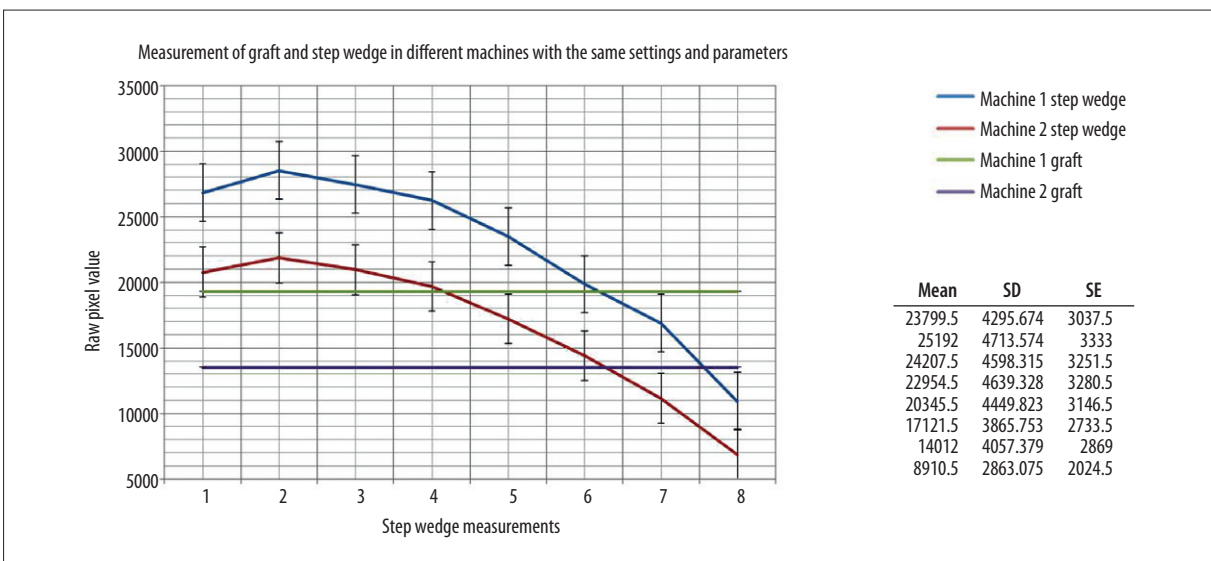


Figure 8. Illustrates the pixel value measurement for 8 steps from the step wedge using same exposure factors with different machines. An average variation of 27.5% (22.6 to 37) in the pixel values was observed. A variation of 30% was observed in the pixel values of graft. Mean/Standard Deviation (SD) and Standard Error (SE) for step wedge given.

both time points (A and B; B and C; C and A). Interclass correlation for inter-observer reliability for pairs of observers showed a strong agreement between the observers [first measurement – 0.69 (C vs. A), 0.78 (A vs. B), and 0.85 (B vs. C); second measurement – 0.74 (A vs. C), 0.82 (A vs. B), and 0.7 (B vs. C)]. Spearman correlation revealed an inverse relation between the PVR and the objective scores assessed using the van Hemert staging system (Figure 5). Spearman correlation coefficient was statistically significant ($r = -0.94, p < 0.0001$) for van Hemert stages and PVR over the period of follow-up.

When validating the radiographic technique it was observed that the pixel values of the step wedge and graft

were similar when the same machine, with a constant kV and mAs, was used, irrespective of the size of the ROI. Hence, the PVR (pixel value of step wedge/graft) was constant. However, pixel values changed with different parameters and settings in the same machine or in different machines with the same settings (Figures 6–8, respectively).

Discussion

The pixel value ratio was found to be a reliable indicator of bone graft incorporation in our study. It was reproducible and comparable with the radiographic scoring system of Van Hemert. However, it was influenced by individual machine parameters and thus requires a standardized

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