A New Variable Depth Control Drill That Provides Real Time Depth Measurement With Improved Accuracy Over Standard Wire Depth Gauges.

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(493 words without title and names)

Background/Purpose: Standard depth gauge measurement techniques for determining screw length in Orthopaedic Surgery are inaccurate and time consuming. Present intra-operative techniques include the wire depth gauge, drill bit depth markings, spring depth gauges, and fluoroscopic assessment. The Variable Depth Control (VDC) device, a new handheld robotic drilling technology, provides real time depth measurements that are significantly more accurate. VDC technology also provides real time depth control integrally related to its depth measurement.

Methods: Bone models were created using bi-cortical surrogate bone blocks placed upon standard FBI Ballistic Gels (Sawbones part numbers 1522-1132 and 1522-1135, Pacific Research Laboratories, Vashon, WA). The bone models ranged in nominal depth from 15 to 27 mm and were randomized. Sharp 3.2 mm drill bits were utilized for all 100 trials.

Five orthopaedic surgeons of varied clinical experience were introduced to the VDC device and allowed to perform 3-5 test holes to familiarize themselves with the new device. Each surgeon then completed 10 drill trials with a Standard drill and used a wire gauge to measure the hole depth and 10 drill trials with a VDC drill which gave a graphical and numerical readout of the hole depth. The hole depth was measured and recorded for each trial. The data were analyzed using StatPlus:mac software.

Results: The average discrepancy for the hole measurements using the clinically accepted depth gauge tool as compared to the average pre-recorded caliper depth was 2.6 mm. The average discrepancy for the hole measurement using the VDC technology was 0.6 mm. This is a statistically significant improvement (paired t-test, $p < .001$), see Figure 1. Figure 2 demonstrates VDC's depth control ability which allows the surgeon to stop the drilling process at any depth desired, for example just before penetrating into a joint space. Figure 3 demonstrates the material strength (density) awareness provided by the VDC's wireless GUI (Graphical User Interface) allowing the surgeon to stop the drill bit before penetrating the far cortex.

Conclusion: In 100 measurement trials, the Variable Depth Control (VDC) technology outperformed currently accepted wire depth gauge measurement techniques. VDC technology allows the surgeon to know the screw length anytime in the drilling process eliminating the use of the wire depth gauge. Eliminating the use of the wire depth gauge saves time and also avoids the inadvertent plunge of the wire gauge past the far cortex. More accurate depth measurement may reduce costs by saving time, reducing screw wastage from errant measurements, and potentially reducing radiation exposure to surgeons by reducing the over use of fluoroscopy to verify screw length. Future VDC studies with cadaveric bone are planned followed by human clinical trials.

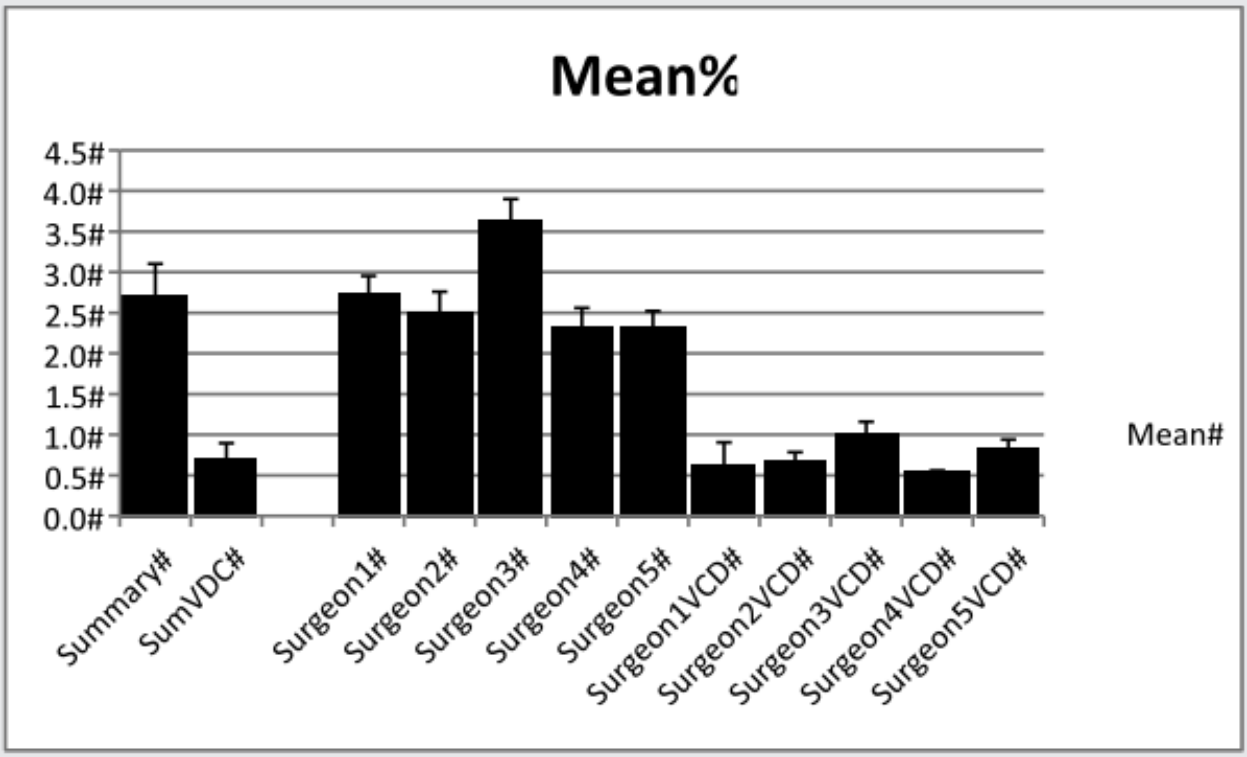

Figure 1. Error in depth measurement for 5 surgeons, each performing 10 Standard drill trials and 10 VDC drill trials.

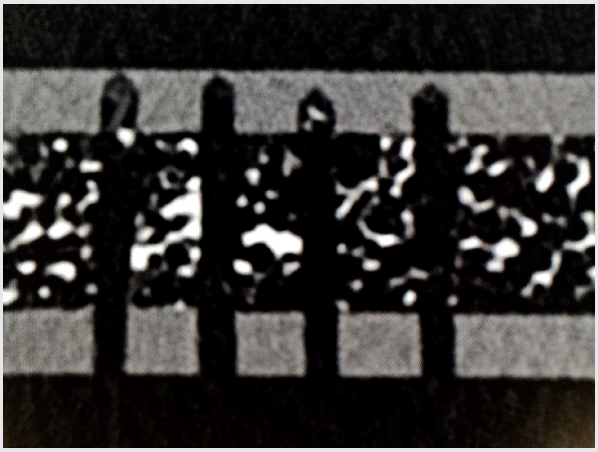

Figure 2. VDC technology allows precise control of the depth of the drill bit.

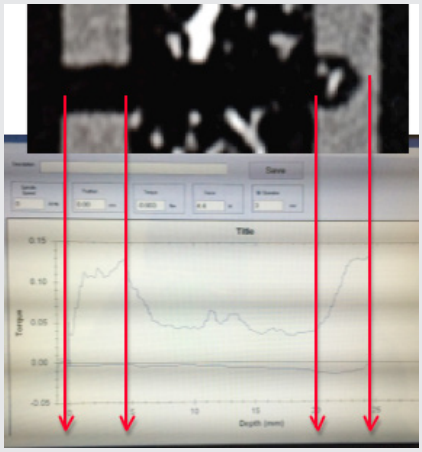

Figure 3. The VDC GUI gives situational awareness in the form of drill bit depth and bone strength in real time.