Can Hypodermic Needle Injections Be Successfully Simulated and Analyzed in the Laboratory?

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Ultrasound Guided Foam Sclerotherapy is a treatment where a physician injects sclerosant foam along the length of a patient's varicose vein. The same hypodermic needle is used to perform multiple injections on the same patient and in this example patient discomfort is a common complaint. If hypodermic needles were more efficient at passing through skin tissue, patient discomfort could be reduced. To develop solutions to achieve this, a method for testing hypodermic needle performance was required. For this investigation, a purpose built injection simulator was developed, which had the ability to perform injections in a consistent automated manner while measuring the forces exerted by the needle. Two possible skin substitutes were tested; the first was a synthetic material referred to as basic synthetic skin. This was medium density foam based and was highly consistent in structure. Butchered porcine belly was also used as a substitute. This material was selected as porcine skin bears an acceptable resemblance to human skin. Hypodermic needles were tested in two different states into both skin substitutes. The first group consisted of unmodified needles; the second, unlubricated needles. Normally hypodermic needles are coated with silicone lubricant to improve patient comfort. It was removed so that results from both groups could be compared with establish its effectiveness. The injection simulator was used to insert a needle to a depth of 9 mm into the skin substitute at a rate of 4 mm/s, the needle was allowed to dwell for 6 s and then removed at 4 mm/s. Data from each injection were captured and stored later analysis. Both skin substitutes performed differently, with basic synthetic skin requiring a greater force for both insertion and removal, when compared with porcine belly. When injected into basic synthetic skin, standard needles displayed performance degradation throughout use, with insertion and removal force gradually increasing after each injection whereas unlubricated needles required a constant insertion force. This performance degradation was attributed to the lubricant coating wearing. When injected into porcine belly, standard needles did not display performance degradation; this was attributed to the pickup of oily fluid from the skin tissue. Unlubricated needles displayed slight performance degradation, which was attributed to debris pickup by surface imperfections on the needle surface. The injection simulator designed was suitable for purpose; however, different skin substitutes may be required. Basic synthetic skin was suitable for testing friction reduction techniques; however, porcine belly provided inconsistent results. The lubricant used on hypodermic needles was significant in needle performance and needle tips were not blunted after 25 injections.

Autologous Transfusion Device for Use in Resource-Limited Settings

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The lack of donated blood available for emergency transfusions in the developing world is a critically important issue that can significantly affect the prognosis and recovery of hemorrhaging patients. Autologous transfusion, in which a patient receives a transfusion of his or her own blood, is often used to reduce the need for donated blood. Clinicians in resource-limited settings have developed an improvised method of performing autologous transfusion using a soup ladle and simple gauze filter. This procedure is commonly used in cases of ruptured ectopic pregnancy, during which patients can lose up to 2 l of blood through internal hemorrhage. The process involves several labor- and material-intensive steps, which can cause complications due to excessive environmental exposure and handling of the blood. The aim of this research was to develop a low-cost blood salvage device applicable to resource-limited settings capable of replacing the current method.

