Securement Strength Characteristics of Active Mechanical Catheter Securement Devices for PICC and Central Catheters

STUDY SUMMARY

Background

The use of peripherally inserted central venous catheters (PICCs) has become more widespread in recent years. An increase in power injectable procedures as well as the psycho-social implications of implantable ports has increased PICC usage in hospitalized and home-care patients requiring intermediate to long term intravenous therapy. PICC lines are associated with a variety of complications including catheter occlusion, infection, dislodgement, leakage and phlebitis. The most common PICC complication occurring 5-31% of PICC patients is dislodgement followed by bloodstream infections which occur in approximately 2-20% of PICC patients.[1] One third of all central catheter patients may be subject to premature removal of the catheter due to these types of complications.[1-2] Recently, the wide spread use of sutureless securement devices has replaced the more invasive and uncomfortable method of subcutaneous securement by way of sutures. The sutureless securement devices available for use today fall into three main categories of securement: Active-Mechanical Securement, Passive-Tape Based Securement and Sub-Cutaneous Securement. The main goal of the sutureless securement device is to stabilize and secure the catheter to prevent catheter movement, micropistoning and dislodgement; all which are associated with increased risk of bloodstream infection and premature catheter removal. There are many choices when it comes to sutureless securement devices, however, in the active-mechanical securement category there are only two brands available that provide an active locking mechanism which mechanically secures the catheter wings.

Purpose

To test the physical and performance characteristics of active mechanical securement devices.

Methods

Ten (10) samples of each manufacturer's mechanical securement device were subjected to the 90^0 Pull Force Test, Catheter Micro-Pistoning Force Test and Catheter Micro-Pistoning Movement Test. The results of each test were recorded for each brand of mechanical securement device.

Products tested:

Commonly used PICC Securement:

Bard® StatLock® PIC0220 hereinafter Device 1

New Design PICC Securement:

Starboard Medical™ Clik-FIX™ WCS-1000 hereinafter Device 2

90^0 Pull Test:

A 90^0 pull force test was performed to establish peak force (lbs) required to dislodge the catheter from the securement device. The test utilized the variable speed Pull/Push test stand which included the Chatillion TCM-1000, Force gauge Chatillion DFGS, Pull Test fixture, luer lock to catheter connection and a glass block. The catheter securement device was attached to the glass block and placed inside of the pull test fixture. The Catheter with the luer lock connection was secured in the locking device and connected to the force gauge Chatillion DFGS. The variable speed (Pull speed: 2.4 inches/minutes or 1 mm/sec) was activated and at the point of catheter dislodgment from the securement device the peak force was displayed on the force gauge and recorded in pounds (lbs).

Catheter Micro-Pistoning Force Test:

The Catheter Micro-Pistoning Force Test was performed to establish if the unidirectional force applied on the catheter above the securement point results in the transfer of the force below the securement point. The catheter was modified by attaching and connecting string loop at the 10cm mark of the catheter. The securement device was attached to the Delrom block secured to the table top. The catheter with the luer lock connection was secured in the securement device and connected to the force gauge Chatillion DFGS #1 representing a connection above the securement point. The string loop on the other side of the catheter was connected to force gauge Chatillion DFGS #2 representing a connection below the securement point. This gauge was secured to the table surface. The Force Gauge #1 was intermittingly moved away from the securement point, applying a pull force of 2-4 lbs to the catheter. Simultaneously, force Gauge #2 measured the force transmitted to the catheter distally from the securement point. *(Figure 1)* The measurement of the force transmitted to the catheter directly correlates with the energy available to create micro movements of the catheter at the insertion point, i.e., micropistoning. Both applied and transmitted peak force were recorded in pounds (lbs).

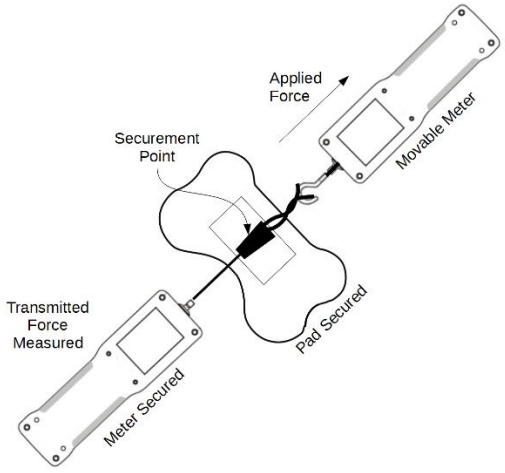

Figure 1. Catheter Micropistoning Force Test

Catheter Micro-Pistoning Movement Test

The Catheter Micro-Pistoning Movement Test was performed to establish if the unidirectional force applied on the catheter above the securement point results in catheter body movement below the securement point.

A fixture consisting of a tube of a larger I.D then the test catheter O.D was used. The tube simulates a vein passage through which the catheter can slide if the force applied above the securement point is transmitted distally from securement point.

The securement device was attached and secured to the test fixture, which was secured to the table top. The catheter was threaded through the tube and via luer lock connection connected to the force gauge Chatillion DFGS. The force gauge was intermittingly moved away from the securement point exerting a pull force of 2-4 lb. *(Figure 2)*. The movement of the catheter in relationship to the end of the tube on the test fixture was measured in millimeters and recorded.

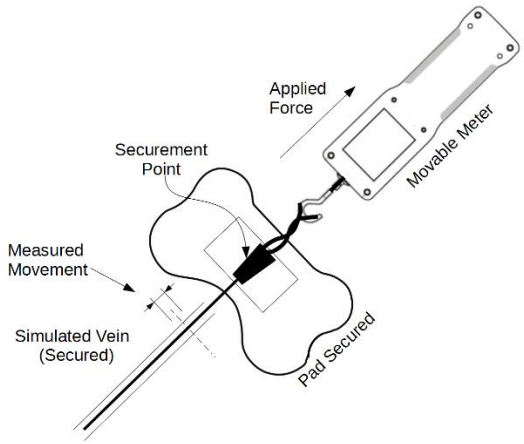

Figure 2. Catheter Micropistoning Movement Test

Results

90⁰ Pull Test

The average peak force (lbs) required to dislodge the catheter from the securement devices tested are shown. (*Figure 3*)

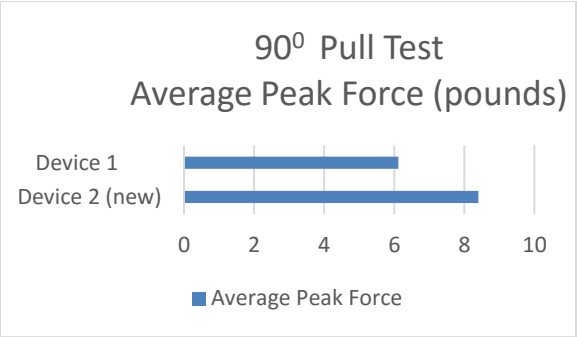

Figure 3

With the new securement device, Device 2, an average peak pull force of 8.40±0.96 lbs produced catheter dislodgement. The observed failures with Device 2 were catheter pulling out of securement device, Tricot separation from the foam and locking device separation from foam pad. With the commonly used securement device, Device 1, complete catheter dislodgement from the securement device was observed when the average peak pull force of 6.12±1.55 lbs was applied. The failure observed with Device 1 was catheter pulling out of the securement device. The pull force needed to dislodge the catheter from the securement device was 1.37 times greater with Device 2, the new securement device when compared to Device 1, the commonly used catheter securement device.

Micropistoning Force Test:

The Micro-Pistoning Force Test measured unidirectional force applied on the catheter above the securement point and the resulting transfer of the force below the securement point. The average results are shown in *Figure 4.*

Device	Applied Force (lbs)	Transferred Force (lbs)
Device 2- new	3.22 ± 0.23	None
Device 1	3.15 ± 0.18	0.15 ± 0.02

Figure 4

The average pull force applied to the catheter above the securement point when secured in the new securement device, Device 2, was 3.22±0.23 lbs. This pull force did not cause any transfer of force distally below the securement point.

With Device 1, the average pull force applied to the catheter above the securement point was 3.15±0.18 lbs and resulted in an average transfer force of 0.153±0.02 lbs to the distal side of the catheter below the securement point.

Catheter Micropistoning Movement Test:

The Catheter Micro-Pistoning Movement Test demonstrated that unidirectional force applied on the catheter above the securement point does result in catheter body movement below the securement point for each device tested. When the catheter was secured with the Device 2 and subjected to an average pull force of 3.15±0.42lbs applied to the catheter above the securement point, catheter movement distal to the securement point averaged 0.23±0.06mm. When secured with Device 1 and subjected to an average pull force of 3.02±0.62 lbs applied to the catheter above the securement point, catheter movement distal to the securement point averaged 3.2±0.30mm. *(Figure 5)*

Securement Device	Applied Force (lbs)	Distal Movement (mm)
Device 2 -new	3.15 ± 0.42	0.23 ± 0.06
Device 1	3.02 ± 0.62	3.2 ± 0.30

Figure 5.

The movement distal to the catheter securement point was 14 times greater with Device 1 when compared to the new catheter securement system, Device 2.

Conclusion

When securing PICC and Central Venous Catheters, the most important aspect of the securement device is its ability to actively secure the catheter to reduce catheter dislodgement and minimize catheter micropistoning. The results of the 90^0 pull force test demonstrate that new securement device, Device 2, secures the catheter better than commonly used securement device, Device 1. Micropistoning as a result of catheter movement distal to the securement point occurs during disinfection of the needleless access device, flushing, connection of the administration sets, and patient and IV pole movement. Securement devices which minimize the force and movement transfer below the securement point will reduce the micropistoning effect. The Micropistoning Force Test and Micropistoning Movement Test demonstrate that Device 2, the new catheter securement device minimizes the micropistoning effect better than the Device 1, the marketing leading catheter securement device. Catheter Securement Devices that provide ***active mechanical*** securement designed to reduce catheter movement and dislodgement provide superior stabilization for PICC and Central lines.

References:

1. *Ryder MA. Peripherally inserted central venous catheters. Nurs Clin North Am. 1993;28:937–971.*
2. *SONG L, LI H. Malposition of peripherally inserted central catheter: Experience from 3,012 patients with cancer. Experimental and Therapeutic Medicine. 2013;6(4):891-893. doi:10.3892/etm.2013.1267.*