Clinical Solutions

Research Results

Compression Performance of the Stryker Color Cuff Tourniquet: A comparative study

Key words: *tourniquet cuff system, limb occlusion pressure, cuff inflation pressure, SmartPump, Color Cuff*

Abstract: The tourniquet cuff system is often used in extremity surgical procedures to decrease intraoperative blood loss while creating a bloodless surgical field. Clinical studies have shown that minimizing cuff inflation pressures can reduce the risk of tourniquet-related postoperative complications and wound pain due to nerve and soft tissue damage. This study compares the Stryker 24″ Color Cuff tourniquet to the Zimmer 24′′ tourniquet cuff. Each cuff was inflated to four different pressures, and the cuff pressures were mapped to show pressure versus relative distance. Additionally, each Zimmer cuff was inflated to 350 mm-Hg and the pressure of the corresponding Stryker Color Cuff tourniquet was adjusted to show an equivalent compression force. The Stryker Color Cuff tourniquet demonstrated a more consistent and efficient application of pressure requiring less inflation pressure to occlude blood flow. Equal pressure distribution combined with lower overall inflation pressures allow the Stryker Color Cuff tourniquet to produce a bloodless field while potentially minimizing the risk of postoperative complications or wound pain. These results indicate a possible clinical advantage when using the Stryker Color Cuff tourniquet over the Zimmer tourniquet cuff.

Introduction:

The tourniquet cuff system is often utilized in extremity surgical procedures. Once applied to the patient, the cuff can be inflated to a desired cuff inflation pressure, also known as limb occlusion pressure (LOP), using an attached pump. The LOP can be defined as the minimum pressure required to stop the flow of arterial blood into the limb distal to the cuff[1] and can be calculated by either the surgeon or surgical staff.

The role of the tourniquet cuff system in surgery is to decrease intraoperative blood loss while creating a bloodless surgical field to facilitate other procedures.[2] A bloodless surgical field can be accomplished by minimizing LOP and providing even pressure distribution across the width of the cuff. Clinical studies have shown that minimizing cuff inflation pressures can reduce the risk of tourniquet-related postoperative complications and wound pain due to nerve and soft tissue damage.[3,4]

Stryker has recently enhanced their disposable tourniquet cuff to ensure more surface area contact and even pressure distribution for patient limbs. As a result of these enhancements, Stryker conducted a comparative study between the Stryker 24″ Color Cuff tourniquet and another commonly used tourniquet cuff, the Zimmer 24″, to determine if any differences exist between compression force or pressure distribution across the width of the cuff.

Methods:

Compression values were collected for both tourniquet cuff systems using the Tekscan® I-Scan software (Tekscan, Inc., South Boston, MA). For test setup, a 6″ solid Delrin cylinder was used to mimic the diameter of a human limb and a 5210N sensor was affixed to the cylinder. For each test, one Stryker Color Cuff tourniquet and one Zimmer cuff were secured to the cylinder in the same fashion. A Stockinette was placed between the cylinder and each cuff.

Each cuff was inflated to four different pressures: 150 mm-Hg, 250 mm-Hg, 350 mm-Hg, and 450 mmHg. Both cuffs were inflated using a Stryker SmartPump Tourniquet System (Stryker Instruments, Kalamazoo, MI) to minimize variability during testing. Cuff pressures were mapped utilizing the I-Scan software and screenshots were captured to show pressure maps and pressure versus relative distance. Additionally, each Zimmer cuff was inflated to 350 mm-Hg and the corresponding Stryker Color Cuff tourniquet was adjusted to show an equivalent compression force (lbs).

Results:

For this study, a total of 6 tourniquet cuffs were tested (3 Stryker, 3 Zimmer). All tourniquet cuffs were 24″ in size, which is routinely used in clinical practice. Tourniquet cuff pressures were set to identical levels. Average cuff compression values are listed below in Table 1. For each input pressure, the Stryker Color Cuff tourniquet provided more overall compression force than the Zimmer tourniquet cuff, with a range of 8.7-13.3 lbs. Therefore, to achieve the same overall compression, a lower input pressure is needed for the Stryker Color Cuff tourniquet than the Zimmer tourniquet cuff.

Pump Inflation Pressure (mm-Hg)	Average Stryker Color Cuff Compression (lbs)	Average Zimmer Cuff Compression (lbs)	Delta (lbs)
150	93.7	85.0	8.7
250	148.0	138.3	9.7
350	190.0	179.7	10.3
450	238.7	225.3	13.3

Table 1. Average cuff comparison at various pump settings.

The Stryker Color Cuff tourniquet also showed a more equal pressure distribution while a majority of the Zimmer tourniquet cuffs tested showed areas of either high or low pressure throughout the width of the cuff. Figure 1 contains a pressure map comparing the Stryker Color Cuff tourniquet (top) versus the Zimmer tourniquet cuff (bottom) at 150 mm-Hg. The green vertical lines apparent in the pressure map for Zimmer indicate minimal pressure to the specific areas and subsequent unequal pressure distribution. In addition, the compression force values show that the Stryker Color Cuff tourniquet can reach compression force (102lb) at a lower pump pressure when compared to the Zimmer cuff (89lb), a difference of approximately 15%.

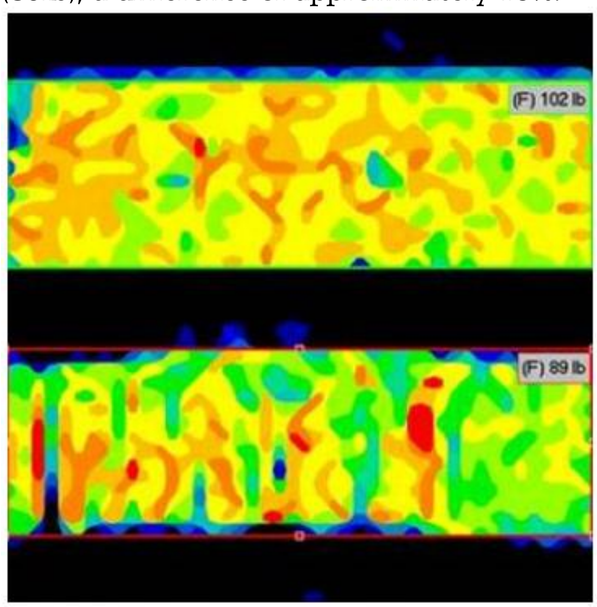

Figure 1. Pressure map as observed at 150 mm-Hg pump setting. Top map: Stryker Color Cuff tourniquet. Bottom map: Zimmer tourniquet cuff.

Specific areas of both high and low pressure can be seen again with the Zimmer cuff in Figure 2, with the red vertical areas indicating high pressure. It should be noted that while the compression force values are almost equal, the pump settings were quite different at 305 mm-Hg and 350 mm-Hg for the Stryker Color Cuff tourniquet and Zimmer cuff, respectively.

Discussion:

The enhanced pressurization inward toward the limb and subsequent reduced pressure variations underlying the Stryker Color Cuff tourniquet were apparent in this study. Potential "leak paths" leading to areas of high or low pressure throughout the width of the cuff were observed during pressure mapping with the Zimmer cuff at all 4 inflated pressures, whereas this phenomenon was not observed with the Stryker Color Cuff tourniquet at any pressure.

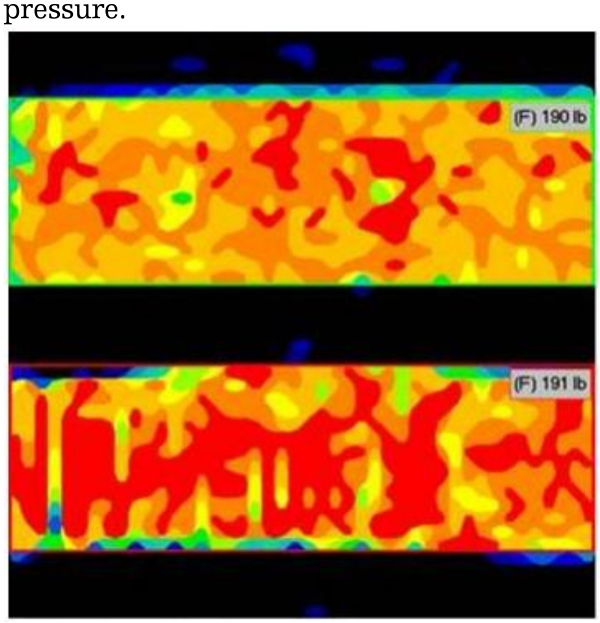

Figure 2. Top map: Pressure map as observed at 305 mm-Hg pump setting with Stryker Color Cuff tourniquet. Bottom map: Pressure map as observed at 350 mm-Hg pump setting with Zimmer tourniquet cuff.

Unequal pressure distribution could require an increased limb occlusion pressure to completely occlude arterial blood flow in the surgical limb, which in turn could lead to a greater potential for tourniquet-induced soft tissue and/or nerve injuries.

The Stryker Color Cuff tourniquet demonstrated a more consistent and efficient application of pressure throughout testing, which can be attributed to a more rigid and welded in place stiffener (Figure 3). The stiffener evenly directs pressure inward, toward the encircled limb, thereby requiring less inflation pressure to occlude blood flow. Reduced LOP can provide an advantage to the patient as demonstrated in a recent clinical study by Olivecrona et al. This study showed that patients with cuff LOPs of <225 mm-Hg had lower rates of wound complications such as delayed healing and infections.[5]

Figure 3. Cross-section of the Zimmer tourniquet cuff (left) and the Stryker Color Cuff tourniquet (right) with the welded in place stiffener.

The results of this comparative study show a potential clinical advantage when using the Stryker Color Cuff tourniquet over the Zimmer tourniquet cuff. Equal pressure distribution throughout the compression area of the cuff combined with lower overall inflation pressures can allow the Stryker Color Cuff tourniquet to produce a bloodless field during surgery while potentially minimizing the risk of potential postoperative complications or wound pain to the patient.

Stryker tourniquet part number used: 5921-024-235.
Zimmer tourniquet part number used: 60707010400.

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