Sterile Elastic Tourniquet
VS
Pneumatic Tourniquet
for Total Knee Arthroplasty

Brin, Feldman, Markusevitch, Regev, Stern, J Arthroplasty 2015
History

For more than 400 years, surgeons have used tourniquets to afford a bloodless surgical field in extremity surgery.
In 1718, French surgeon Jean Louis Petit developed a screw device to occlude blood flow in surgical sites. 

Tourniquet, from tourner = to turn
In 1800, Fredrich Von Esmarch
Developed the Esmarch's bandage- a rubber bandage that would both control bleeding and exsanguinate the limb

Superior to Petit’s device as there are no screws to loosen or cloth to tear
In 1904, Harvey Cushing created a pneumatic tourniquet.

It is superior to the Esmarch tourniquet in two ways:

1. Applied and removed quickly
2. Decreased incidence of nerve paralysis
In the 2000s, silicon ring tourniquet (Hemaclear) developed by Dr. Noam Gavriely (Technion)

The tourniquet made of elastic silicone ring, stockinet, and pull straps that are used to roll the device onto the limb
מרכב רפואי מאיר

מסוקה לפקולטה לרפואה, אוניברסיטת תל אביב
HC Tourniquet Serves 3 Functions:

1- Blood removal from the operated extremity (exsanguination)

2- Arterial flow occlusion

3- It serves as a sterile stockinet
**Easy to apply**-The pneumatic tourniquet consists of many elements (i.e., pump, gas tubes, cuff, padding) that make it cumbersome

**Sterile**

**Provides larger surgical field**-narrow profile and because it can be placed away from the surgical field
Complications of Tourniquet Use

**Tourniquet pain** - Characterized by hyperemia, hyperthermia and pain following reperfusion

**Post-tourniquet syndrome** - pain, numbness, paresis, stiffness

**Skin changes** - Blistering, ischemic necrosis, Compartment syndrome
Muscle injury:

Studies documented tourniquet-induced muscle injury at EMG and histologic studies after 2 hours tourniquet time.

The muscle demonstrated restoration to 83% of normal at 3 weeks functionally and histologically.
Nerve Injury

Nerve injury has been documented on histologic examination, EMG and NCV studies.

Mild change at 30 minutes to complete myelin dissolution and Schwann cell hypertrophy at 3 hours.
Three factors must be considered:

1. **Duration** of tourniquet use
2. **Pressure** of inflation
3. **Design** of the tourniquet
Total Knee Arthroplasty is usually performed with the assistance of a tourniquet to create a bloodless field.
Study Purpose

To compare the amount of **blood loss**, the amount of **post op blood transfusions** and **wound complications** following the use of HC tourniquet and PT in patients undergone TKR
Methods

We reviewed the files of 301 patients on whom TKA was performed using Tourniquet

The PT group consisted of 145 patients that were operated on during 2006–2007

Since 2010, we have exclusively used the HC for TKA, hence, the second group included 166 patients who were operated on during 2010-2011
Outcome Measures

Mean decrease in Hb on the 1st and 3rd POD’s relative to pre-op levels

Post-op blood transfusions within the first week after surgery

Amount of blood drained from the intra-articular space within the first 24 h after the operation

Wound complications within 3 months of the operation
All patients were operated on by the same arthroplasty staff, under spinal or general anesthesia.

A dose of 2 g cefazolin was given IV shortly prior to the skin incision.

The PT was inflated to 100–150 mmHg above the patient's systolic blood pressure.

In all the knees, hemovac drains were used for 24 h.

All patients were treated with subcutaneous enoxaparin 40 mg per day for 35 days following the operation.
### Table 1
Demographics.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Sterile Elastic Tourniquet N = 166</th>
<th>Pneumatic Tourniquet N = 145</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Males</td>
<td>28.3%</td>
<td>26.2%</td>
<td>ns</td>
</tr>
<tr>
<td>Age</td>
<td>71.85 ± 8.6</td>
<td>70 ± 8.6</td>
<td>ns</td>
</tr>
<tr>
<td>BMI</td>
<td>29 ± 5.2</td>
<td>29.5 ± 4.9</td>
<td>ns</td>
</tr>
<tr>
<td>Spinal Anesthesia</td>
<td>142</td>
<td>124</td>
<td>ns</td>
</tr>
</tbody>
</table>
RESULTS

Both groups experienced a significant decrease in Hb on POD 1 and 3.

In POD 1, Hb dropped by $2.78 \pm 0.98$ g/dl in the PT group and $2.53 \pm 0.95$ g/dl in HC group ($P < 0.0001$).

The decrease in Hb on POD 3 was also greater in the PT group ($3.28 \pm 1.18$ g/dl) compared to the HC group ($3.0 \pm 1.14$ g/dl) ($P < 0.0001$).

There was no significant difference in the number of patients who received a blood transfusion between the groups.
There was a significant difference in the amount of blood drained from the knee in the **PT group** $346.1 \pm 186.3$ cc, and in **HC group** $252.8 \pm 142.4$ cc ($P 0.001$)

10 cases of superficial wound infections and 1 wound dehiscence in the **PT group**

6 cases of superficial wound infections and 1 case of wound dehiscence in the **HC group**

There is a higher percentage of wound complications within 3 months of the operation in the **PT group** (7.7% vs. 4.2%)
There were no cases of deep infections in both groups

There was 1 case of DVT in the PT group and 2 cases in the HC group
## Results

### Table 2
Main Results.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Sterile Elastic Tourniquet</th>
<th>Pneumatic Tourniquet</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N = 166</td>
<td>N = 145</td>
<td></td>
</tr>
<tr>
<td>Hb pre-op</td>
<td>13 ± 1.2 g/dl</td>
<td>13.2 ± 1.2 g/dl</td>
<td>P = 0.143</td>
</tr>
<tr>
<td>Hb reduction first post-operative day</td>
<td>2.53 ± 0.95 g/dl</td>
<td>2.78 ± 0.98 g/dl</td>
<td>P &lt; 0.028</td>
</tr>
<tr>
<td>Hb reduction third post-operative day</td>
<td>3 ± 1.14 g/dl</td>
<td>3.28 ± 1.18 g/dl</td>
<td>P &lt; 0.045</td>
</tr>
<tr>
<td>Blood drained from the knee at first 24 h</td>
<td>252.8 ± 142.4 ml</td>
<td>346.1 ± 186.3 ml</td>
<td>P &lt; 0.001</td>
</tr>
<tr>
<td>Wound complications within 3 months</td>
<td>7/167 (4.2%)</td>
<td>11/143 (7.7%)</td>
<td>P = 0.189</td>
</tr>
</tbody>
</table>

Hb = hemoglobin.
Discussion

There is a significantly lower post-op Hb reduction in the HC group in POD’s 1 and 3.

The difference between the 2 groups was small but it could change the patient’s overall clinical condition.
Discussion

A small difference in Hb level can play a role in the decision for blood transfusion, might predispose the patient to increased risk for cardiopulmonary events, transfusion reactions, delayed ambulation and increased health care costs.
We measured a significant lower blood drainage volume in a range of 100 cc.

This reduction reflects a decrease in intra-articular bleeding.

We assume that this is because the exsanguination effect of HC tourniquet.
We found no difference in the rate of blood transfusion.

This most probably is related to the non-standardized clinical criteria for transfusions in our department.
Two studies have demonstrated 100% contamination among the pneumatic tourniquets.

Our results showed higher percentage of wound complications in the PT group within 3 months of the operation.

The difference is not statistically significant, but there was a tendency toward more wound complications in the pneumatic tourniquet group.

These results might have been significant if our groups were larger.
The main disadvantage of the sterile tourniquet is the cost = 70 EUR

We believe that this will be offset by cost savings due to fewer complications and improved patient well-being
We support using the sterile elastic exsanguination tourniquet during TKA
Pulmonary Embolism after Application of a Sterile Elastic Exsanguination Tourniquet (HemaClear™) - Case Series and review of literature

Feldman Viktor, Biadsi Ahmad, Slavin Omer, Tauber Israel, Nyska Meir, Yaron Brin
Thank You