CONTROLLED HYPOTENSION and MINIMAL INFLATION PRESSURE: A NEW APPROACH FOR PNEUMATIC TOURNIQUET APPLICATION IN UPPER LIMB SURGERY

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INTRODUCTION

Pneumatic tourniquets are used:

- To reduce blood loss
- To provide optimal operating conditions

However, compression of the tissues under a tourniquet is associated:

- With soft tissue injuries involving muscle, artery, skin and peripheral nerves
INTRODUCTION

To minimize the risk of complications from excessive inflation pressures:

- The use of wider tourniquet cuffs
- Use of minimal inflation pressures
AIM OF THE STUDY

- Apply “Controlled Hypotension” with a propofol-remifentanil to reach minimal tourniquet inflation pressures

- Compare the effectiveness of this technique with conventional tourniquet inflation pressures in patients scheduled for upper extremity surgery under general anesthesia
MATERIAL & METHOD

- After the Hospitals Ethic Committee approval
- Informed consent was obtained from 36 adult, ASA physical status I-II patients scheduled for upper extremity surgery
Exclusion criteria

- Cerebrovascular disease
- Hypertension
- Renal and/or hepatic insufficiency
- Peripheral claudication
- Severe anemia
- Hypovolemia
MATERIAL & METHOD

Patients were randomized:

■ (Group 1, n 18)
  Normotensive anesthesia
  Conventional inflation pressures

■ (Group 2, n 18)
  Controlled hypotension
  Minimal inflation pressures (CHAMIP)

A pneumatic tourniquet, 11 cm width, was applied with a layer of “soft-roll” under wrap
MATERIAL & METHOD

- Anesthesia was induction:
  - Propofol 1.5–2.5 mg/kg IV bolus
  - Remifentanil 0.5 µg·kg⁻¹·min⁻¹ continuous infusion
  - Rocuronium (0.8–1.2 mg/kg for endotrach. Intubation

- Maintainance:
  - Propofol (4–5 mg·kg⁻¹·h⁻¹)
  - Remifentanil (0.3–1µg·kg⁻¹·min⁻¹) continuous infusion to provide normotension in Group 1 and hypotension (SAP: 80–100 mmHg; MAP 60 mm Hg) in Group 2
MATERIAL & METHOD

- In Group 2, the digital plethysmograph was applied to the 2nd finger to determine the minimal inflation pressure.
- The tourniquet was inflated until the arterial pulsations disappeared on the oscilloscope. This pressure was recorded as occlusion pressure.
- The limb was exsanguinated with an elastic bandage before tourniquet inflation.
- Group 1: Conventional P (250-300 mm Hg)
- Group 2: Min. inflation P (Occlusion P + 20 mm Hg)
MATERIAL & METHOD

RECORDS

- The circumference of the upper extremity, tourniquet application times
- SAP & tourniquet inflation P at 0, 5, 15, 30, 60, 120 min
- Surgeon satisfaction of the surgical site
- On the day after surgery, the patients were examined for complications such as skin damage, nerve palsies, vascular; and asked whether or not they felt pain, burning, coldness, numbness, or paraesthesia on their hands
## RESULTS

### Demographic Data

<table>
<thead>
<tr>
<th></th>
<th>Group I (n=18)</th>
<th>Group II (n=18)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (yr)</td>
<td>30.2 ± 12.5</td>
<td>33.5 ± 14.2</td>
</tr>
<tr>
<td>Gender (M/F)</td>
<td>12/6</td>
<td>14/4</td>
</tr>
<tr>
<td>Extr. Circumf. (cm)</td>
<td>28.9 ± 1.7</td>
<td>29.3 ± 1.9</td>
</tr>
<tr>
<td>Tourniquet per. (min)</td>
<td>111.5 ± 10.3</td>
<td>116.2 ± 20.7</td>
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![Graphs showing blood pressure levels](image-url)
RESULTS

Table 2. Surgeon’s Opinion About the Performance of the Tourniquets and Tourniquet Inflation Pressures

<table>
<thead>
<tr>
<th>Surgeons opinion</th>
<th>Group 1</th>
<th></th>
<th></th>
<th>Group 2</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Start</td>
<td>Middle</td>
<td>End</td>
<td>Start</td>
<td>Middle</td>
<td>End</td>
</tr>
<tr>
<td>Satisfactory</td>
<td>18</td>
<td>18</td>
<td>18</td>
<td>18</td>
<td>17</td>
<td>18</td>
</tr>
<tr>
<td>Less than satisfactory</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Unsatisfactory</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Group 1: 3 paresthesia & numbness (2\textsuperscript{nd} post-op h)
Group II: No such complaint
Cushing (1904) introduced the pneumatic tourniquet

Safe limits for duration of tourniquet ischemia and inflation pressure are still discussed

PT are associated with temporary or permanent damage to soft tissues, blood vessels

So, it seems logical to limit the tourniquet pressure to a level that will provide hemostasis
DISCUSSION

What is done to determine minimal inflation P:

- Levy et al. & Reid et al. using Doppler technique, recommended 202.3 ± 34.2 and 190 mmHg
- Estebe et al. & Hagenouw et al. used pulse oximetry to confirm the absence of the arterial pulse to determine the minimum inflation P
- Newman and Muirhead used SBP ± 35mmHg [Satisfactory with 166 ± 19.6 mm Hg]
- Association of Operating Room Nurses recommended SBP ± 50-75 mmHg to obtain a bloodless field
DISCUSSION

- It is rational to relate the tourniquet pressure to the patient’s blood pressure.
- Studies recommending “Minimal Inflation Pressure” were performed with normotensive patients.
- It is possible to reach smaller inflation pressures by decreasing the SBP.
- Remifentanil offers superior intraop. hemodynamic stability and maintains intact CBF.
- With propofol and remifentanil combination blood pressures were successfully maintained at 60mmHg to protect cerebral perfusion pressure.
DISCUSSION

With this technique:

- Minimal inflation pressures ranged between 110-140mmHg (mean, 118.2mmHg)
- A bloodless surgical field was obtained almost in all cases
- The surgeon was satisfied with the performance of the tourniquet in almost all cases
- In the case which was rated as “less than satisfactory” oozing started after the 1st h and lasted approx. 15 min and disappeared spontaneously
DISCUSSION

- Paralysis after use of a tourniquet is a well-recognized complication
- Direct pressure of the pneumatic cuff is regarded as the main cause of nerve lesions; ischemic injury may also play a role
- In our study 3 patients in Group 1 complained of paresthesia, that may have been related to high inflation pressures

**CONCLUSION:** To reach real minimal inflation pressures with the pneumatic tourniquet we suggest the CHAMIP technique may be a good choice
REFERENCES


