

Use of a New Exsanguination Tourniquet in Internal Fixation of Distal Radius Fractures

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Abstract: We describe our experience using a new device that results in a bloodless field in open repair of distal radius fractures. The device, an exsanguinating tourniquet (HemaClear model/40, OHK Medical Devices, Haifa, Israel), replaces the traditional methods of limb elevation, Esmarch bandaging, pneumatic tourniquet pressurizing and the associated components. HemaClear/40 is an elastic silicon ring with a tubular elastic sleeve rolled onto it. The device has attached straps that, when pulled, unroll the sleeve, rolling the ring mesially on the limb. The pressure exerted by rolling HemaClear/40 is supra-systolic thereby exsanguinating the limb and occluding the arterial inflow. Our experience in 49 patients demonstrated quick application, superior exsanguination and that the device could be placed on the forearm instead of the upper arm. No side effects or complications were noted. In our opinion, the fact that HemaClear/40 is a sterile, single-patient device makes it superior over the traditional technology.

Key Words: bloodless surgical field, ORIF, fracture wrist

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HISTORICAL PERSPECTIVE

Bloodless limb surgery was first introduced by Friedrich von Esmarch in 1873 using an elastic (“Esmarch”) bandage that was further improved in 1908 by Dr Cushing with the introduction of the pneumatic tourniquet. This century-old technique is broadly used in upper and lower extremity surgery despite significant drawbacks such as time consumption and postoperative clean-up. The existing tourniquet system consists of many elements (ie, pump, gas tubes) that make it cumbersome. The tourniquet cuff is often nonsterile and, therefore, must be placed at the proximal part of the limb, away from the surgical field. In addition, the methods of exsanguination (limb elevation and/or Esmarch) may leave a substantial amount of blood in the vessels.^{1–3}

Recently, we started using a novel exsanguination tourniquet^{4–6} in upper extremity operations. We report here the use of the device in 49 consecutive distal radius internal fixation patients.

INDICATIONS AND CONTRAINDICATIONS

HemaClear is used in procedures that require a bloodless surgical field and can replace the traditional method (Esmarch+Tourniquet).

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The authors of this manuscript do not own any stocks in OHK Medical Devices and neither they nor their family have any benefits from the sale of this product.

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FIGURE 1. HemaClear is placed on the fingers.

Contraindications include:

- Not leaving HemaClear on the patient's limb for more than 120 minutes.
- Not placing HemaClear directly over the ulnar nerve (at the elbow) or peroneal nerve (at proximal tibia).
- Not using HemaClear on patients with poor peripheral blood flow, edema, or deep vein thrombosis.
- Not using HemaClear if the limb has significant skin lesions (skin disease, burns).
- Not using HemaClear if the limb is infected or has a malignancy.
- Immediate removal of HemaClear if the device does not stop the blood flow to the limb.



FIGURE 2. Fingers are held together and the straps are pulled proximally.

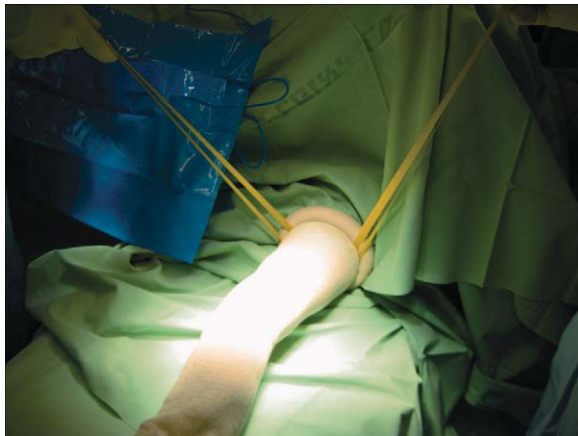


FIGURE 3. Straps are pulled proximally and the sterile stockinette unrolls onto the limb.

Warning:

If the limb is unstable (fracture, dislocation), use axial traction to stabilize limb during HemaClear application.

TECHNIQUE

HemaClear performs 3 functions:

1. Blood removal (exsanguination)
2. Arterial flow occlusion
3. Placement of sterile stockinette

HemaClear may be used on the upper or lower extremities and is available in 4 circumference ranges: 14 to 28 cm, 24 to 40 cm, 30 to 60 cm, and 50 to 90 cm. In this study, we used the HemaClear/40 (24 to 40 cm) only.



FIGURE 4. Protective card inserted beneath the ring and the HemaClear is cut using a scalpel.

HemaClear consists of a silicon ring wrapped in a stockinette sleeve and pull straps.

The physician places the ring on the fingers (or toes) and then pulls the straps proximally. The silicon ring rolls mesially and the stockinette sleeve unrolls onto the limb (Figs. 1–3). If the limb is unstable due to fracture or dislocation, axial traction by 2 operators should be used.⁷

During the proximal rolling, the ring exerts pressure and squeezes the blood away from the limb, thus performing the exsanguination function quickly and effectively.

When the elastic ring reaches the occlusion location, the pulling motion is stopped. The ring exerts pressure on the limb at this position, blocking arterial blood flow into the limb and thus acts as a tourniquet.

PRESSURE BY HemaClear® 40 / Medium / Yellow						
Patient Systolic Blood Pressure <190 mmHg	DISTANCE FROM FINGERS / TOES (cm) TO OCCLUSION LOCATION					
	20-30	30-40	40-50	50-60	60-70	70-80
24-26	231	224	216	208	199	190
26-28	233	228	222	215	206	196
28-30	251	242	232	222	214	202
30-32	270	260	248	236	229	214
32-34	283	274	265	249	244	226
34-36	325	304	288	263	259	238
36-38	NPD	333	314	288	274	249
38-40	NPD	368	344	339	311	261

How to use the HemaClear® Pressure Table:

Measure the Limb Circumference at the Occlusion Location and select the correct HemaClear model (S,M,L,XL). Measure the Distance from the tips of the fingers/toes to the Occlusion Location. Refer to the appropriate color coded Pressure Table. Find the column in the Table that corresponds to the distance and the row in the Table that corresponds to the Limb Circumference at the Occlusion Location. The number in the column-row intersect is the pressure in mmHg that the HemaClear ring applies at the skin surface.

NPD – Non Physiological Dimension.

FIGURE 5. HemaClear pressure table.

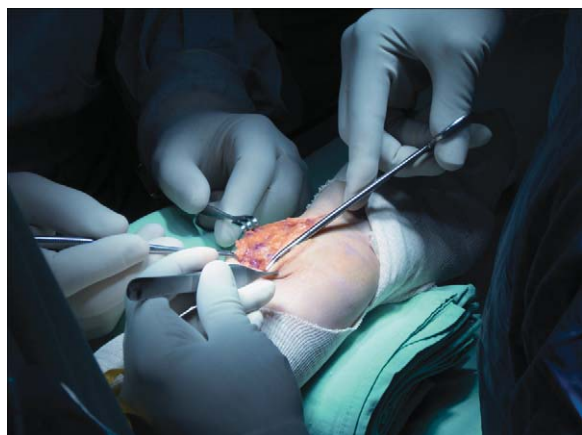


FIGURE 6. Bloodless surgical field using HemaClear.

During the proximal movement of the device over the limb, the stockinette sleeve unrolls onto the limb, covering it entirely up to the occlusion level and thus drapes a sterile stockinette over the surgical field.

When the surgical procedure is over, the protective card is inserted beneath the ring and the HemaClear ring is cut using a scalpel (Fig. 4). The stockinette is then cut away using scissors so that the blood flow into the limb is resumed.

RESULTS AND CONCLUSIONS

We performed ORIF (open reduction internal fixation) in 49 distal radius fracture patients [17 men and 32 women of 49.14 ± 18.05 y (range, 17-83 y)]. No complications or adverse effects of using HemaClear were noted. No tourniquet failure was observed, there were no signs of tourniquet paralysis/paresis/lost of sensory innervations and no signs of tourniquet burns. The patients had a systolic blood pressure within the range of 90 to 160 mm Hg (123.82 ± 15.6 mm Hg) and the circumference of the limb was 22 to 33 cm (26.25 ± 2.23 cm). The pressure under the HemaClear ring was 216 to 274 mm Hg. The pressure was determined according to patient measurements taken at the occlusion site as defined by the pressure table (Fig. 5). The tourniquet time with HemaClear was of 20 to 100 minutes (48.04 ± 20.21 min). In all the patients, HemaClear was placed on the forearm approximately

12 cm above the wrist. The clarity of the surgical field was invariably excellent (Fig. 6). The application time on an average took less than 15 seconds and the preparation of HemaClear was more simple in comparison to the multiple components of the traditional tourniquet method. The cost of the HemaClear device was equivalent to the alternative combined cost of a sterile cuff, an Esmarch bandage, a stockinette, and other materials. In addition the workflow was better and the tourniquet machine was available for use in other operating rooms.

Three major advantages of the HemaClear:

- (a) The device is sterile, simple, and easy to use.
- (b) The device can be placed on the forearm close to the surgical incision. This reduces the volume of tissue under ischemic conditions and allows better control over operative site exposure.
- (c) The device provides consistent occlusion compared with the pneumatic tourniquet that may leak.

It is reasonable to conclude that HemaClear is a useful addition to the available perioperative techniques in upper extremity surgical procedures.

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