Compression Bandage, not Tourniquet. Experience in 68 Patients with Traumatic Amputation after Mine Injuries

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TOURNIQUET, A SUBOPTIMAL TREATMENT

Sixty eight patients with traumatic amputations after mine injuries were treated in the demilitarized zone between Iraq and Kuwait. Most were seen during a three week period of Iraqi mine harvesting. During the first days, continuos bleeding distally to applied tourniquets were frequently observed. Orders were issued to remove any applied tourniquets and dress the wounds with a tight elastic bandage. Three out of 18 patients died during the first part of the period compared to 1 of 50 during the last part. The new directives led to visibly less hemorrhaging. Hemoglobin at admission increased and fewer patients needed transfusions. In extensive crush injuries and traumatic amputations a tight bandage applied from the end of the extremity and in proximal direction should be used. Tourniquet should not be used.

1.0 INTRODUCTION

Stopping of external hemorrhage has the highest priority in combat casualty care. ”Hemostasis” with a tourniquet has a strong position with the public. It is effectiveness is questionable. In the fall of 1991, the effect of tourniquets were observed in patients injured by antipersonnel mines in the demilitarized zone between Iraq and Kuwait.

2.0 MATERIAL

In the fall of 1991, 157 patients were taken care of after mine explosions by the military medical unit in the United Nation mission in the demilitarized zone between Iraq and Kuwait. The injured patients were brought to one of two first aid posts in the desert and 109 were evacuated to a role 2+ field hospital. One patient had an open chest wound, two had tracheal puncture wounds, while one had penetrating head injury. Twenty seven patients had eye injuries, 13 being penetrating. Sixty eight patients had major amputations, seven of them had two extremities blown off. Sixty four major surgical procedures were performed.

One hundred and forty eight of the patients were seen during a three week period of Iraqi mine harvesting in the antitank mine fields in the desert. These fields consisted of more rows of antitank mines several meters apart. Small antipersonnel mines had been placed around the antitank mines. The patients had mostly stepped on the antipersonnel mines or picked them up. In some cases the fuse of an antitank mines had exploded after being dismantled.

After first aid treatment the patients were either evacuated by helicopter or by ambulance to the field hospital. Helicopter was used during daylight and when there was not a sandstorm. Evacuation time from injury to hospital was regularly four to six hours or more.

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3.0 METHODS

The surgical detachment worked according to the principles of a light field hospital. The patients were operated upon if necessary, stabilized and evacuated to Iraqi hospitals some 50 miles away. Operated patients were kept until the following day. All amputations were open with planned primary delayed closure five days post injury.

In amputation cases tourniquets had always been put on by the patients' comrades in the field. Additional tourniquets were in the initial period applied by the medical corpsmen. Rapid intravenous infusion was started with one liter of Dextran and continued with Ringer's acetate. With this treatment the patients were often found circulatory unstable upon hospital admission. Continuos bleeding distally to applied tourniquets was frequently observed (figure 1). Hemoglobin was often low. On September 28th orders were issued to remove any applied tourniquets in the field, pack the damaged soft tissue and cover the wounds with a very tight elastic bandage. Rapid intravenous infusion was given only to patients with altered consciousness due to low blood pressure. As a routine only a slow intravenous drip was started. Patients received blood transfusions when hemoglobin was lower than 7 g/100ml and there was need of volume replacement. When hemoglobin was lower than 5 g/100ml, transfusion was given for the anemia.

Figure 1: Traumatic amputation of right lower extremityafter stepping on an antipersonnel mine. There is bleeding through the bandages in spite of tourniquets put on both below and above the knee. There was substantial blood soiling on the litter.

The 68 patients of the 109 patients evacuated to the field hospital suffering traumatic major amputations are analyzed. Patients were followed as long as they were under the administration of the surgical unit. Registrations before and after September 28th, when the new first aid routines came into use, were compared. The effect of tourniquet and infusions is evaluated by comparing hemoglobin and transfusion need and initial clinical course. Chi-squared test with Yate's correction for small numbers, Fisher exact test or Student's t-test have been used.

4.0 RESULTS

Twenty patients altogether (13%) died during observation. Four of the 109 patients evacuated to the field hospital died (4%). One patient with amputated lower extremity was stabilized and evacuated to rear

hospital, but he died in the ambulance, the tourniquet obviously not being effective. An other patient died two days postoperatively from brain damage caused by anemia, fall in blood pressure and consequent low output cardiac failure.

Two patients had extensive hemorrhages from large wounds in the groins and thighs. They died during transport before they reached the field hospital. The last of these were in deep shock without peripheral circulation when found. Intravenous lines could not be established in the field. He was the only patient among those who were evacuated to the hospital, that died in the last part of the observation period. Of the hospitalized 68 amputees, 3 of 18 (17%) died during the first period, 1 of 50 (2%) during the last period ($p<0.05$) (table 1).

The new routines led to less hemorrhaging observed by less soiling of blood on the litters (figure 2). Hemoglobin value at admission was higher in the last period (mean 10.5 g/100ml versus 8,6 g/100ml, $p<0.05$). The three patients that died in the first period were infused to low hemoglobin values: 5.6 and 4.6 gram/100ml. Patients in the first period were often described as having "watery bleeding from the wounds". Fewer patients needed blood transfusions after the use of tourniquet was disbanded (13/50 (26%) as compared to 10/18 (56%), $p<0.05$). Hemoglobin value at admission was higher in the last period (table 2).

Dates 1991	Treatment	Number	Transfusions
July 31th – September 27th	Tourniquet	18	3 (17%)
September 28th –October 14th	Not tourniquet	50	1 (2%) *)

*) $p<0.05$ chi-squared test

Table 1: Mortality in 68 patients with major amputations after mine injuries before and after the use of tourniquets was disbanded.

Dates 1991	Treatment	Number	Transfusions
July 31th – September 27th	Tourniquet	17	10 (56%)
September 28th –October 14th	Not tourniquet	50	13 (27%) *)

*) $p<0.05$ Student's t-test

Table 2: Hemoglobin values at hospital admission before and after the use of tourniquets in amputations was disbanded.

In the first part of the period the patients were often very unstable. In three cases immediate operation with clamping of the femoral artery through a medial incision on the femur, was performed. With the new routines there was time for complementation of further evacuation or operation without hurry.

Blood transfusions were given to 24 patients, 23 with amputations. Fewer patients needed transfusions after the use of tourniquet was disbanded (table 3), but the mean number of transfusions to those who received any, remained the same, 2.3 units.

Dates 1991	Treatment	Number	Transfusions
July 31th – September 27th	Tourniquet	18	10 (56%)
September 28th –October 14th	Not tourniquet	50	13 (27%) *)

*) $p<0.05$ chi-squared test

Table 3: Patients needing blood transfusions before and after the use of tourniquets in amputations was disbanded. The median number of transfusions to those who needed it was 2.3 in both groups.

Urine output was low in several patients, but normalized in all shortly after admission. Renal function could not be further monitored.

The age of the patients in the first and last part of the observations period was mean 33,2 +- 9 and 29,9 +- 7 years (p=0,13). Range was 9 to 51 years. They were all men.

Figure 2: Correct treatment in traumatic amputation. Complete hemostasis has been achieved by packing the soft tissue and applying a very tight compressing bandage from the end and in proximal direction.

5.0 DISCUSSION

A tourniquet will not stop bleeding from the bone marrow of a crushed extremity. A tourniquet is usually made from a piece of cloth. It compresses the artery over a short length. Some blood will seep by. This will lead to venous stasis and increased bleeding. Tourniquet below the knee will not work. One of the arteries here passes between bones (figure 3).

Figure 3: This tourniquet would not have been effective even if it had been tighter. While "tactical tourniquets" may be useful in given situations when correctly applied, tourniquets usually worsen the injury.
(Photo: Tromsoe Mine Victim Resource Center, Norway)

In wounds the arteries will usually contract, in some cases after the blood pressures has dropped. Copious intravenous infusions will elevate the blood pressure and bleeding may restart. More infusions are needed to maintain the blood pressure and the patient is hemodiluted. If cardiac output falls due to rebleeding, the patient is in a worse situation with combined hypovolemia and anemia. In cases with short evacuation time, the documentation from urban traumatology is convincing. In long evacuation time, the subsequent anemia from seeping hemorrhage over a long time, is probably as dangerous as some hypotension.

Prehospital blood pressure and the exact amount of intravenous fluid given was not recorded sufficiently well to be analyzed in this study. Less and more careful infusions were used during the latter period. That weakens the consclusion somewhat as hypotensive resuscitation may have been responsible for some of the observed improvement.

Hemostasis with a tourniquet as the hemostatic remedy has a strong position with the public. It is not excluded in some first aid books [1]. It is, however, emphasized that it should be applied only when satisfactorily control of the bleeding has not been achieved with a tight bandage. To us that will only be a situation with a trapped, crushed extremety and ongoing arterial bleeding. A tourniquet is a risk to the survival of remaining stump of the limb and may lead to unnecessary loss of knee or elbow.

A tourniquet left on for a long time may lead to reperfusion injury. Inflammation induced injury caused by reperfusion of hypoperfused tissues are greater than the hypoperfusion in itself. The reperfusion damage with massive destruction of the microcirculation in the injured limb may occur after 60 minutes of local low flow [2,3,4]. The reperfusion injury is, however, not only a microvascular catastrophe affecting the hypoperfused limb. Inflammatory mediators affect vital organs as well, especially the gut mucosa seems to be vulnerable [5,6,7,8,9]. In hypotensive patients where the splanchnic bed is poorly perfused, we should regard tourniquets as a considerable risk not only to the limb, but also to the life of the victim.

The argument that tourniquets as last resorts should be allowed when "effective pressure dressing" does not control the bleeding rises problems. It is not easier to teach correct application of effective tourniquets

than to teach application of compressive bandages, as we learnt by our medical corpsmen in Iraq. Quite contrary, results are better when tourniquets are avoided [10,11]. Effective wound packing may be thought successfully to a variety of personnel [12]. Studies indicating improved control of limb bleeding by tourniquet in certain situations are not always all that convincing as it may be difficult to ascertain that the protocol indications were met [13] (figure 4).

**Figure 4: By stressing the use tourniquet all sorts of misconceptions arise.
(Photo: Norwegian Air Ambulance)**

Battlefield tourniquets in situations where meticulous wound packing and dressing can not be undertaken, "tactical tourniquets", may be used under fire or in evacuation from a mine field. The tactical tourniquet should as soon as possible be replaced by a compressive bandage before reperfusion injury poses a problem (figure 5).

We were able only to register the early mortality and early complications. All patients with decreased urine output initially, regained normal output within few hours after admission. All had good oxygenation after restoration of the circulation. One patient with double amputation and tracheal puncture was septic when evacuated to the rear hospital on the third day.

In mine injuries the mortality is considerable [14]. With long evacuation times to hospital, only patients with lacerations and extremity injuries can be expected to reach hospital alive. Among the 109 patient evacuated to the field hospital, one had a chest wound, two tracheal puncture wound, and none abdominal injuries. Among patients hemorrhaging to death before transport could be arranged, at least two had intrathoracic and intraabdominal injuries. Postmortem examinations were not performed.

6.0 CONCLUSION

Tourniquet has no place in the treatment of hemorrhaging in traumatic amputations after mine injuries. A tight compressing bandage should be applied from distal end and in proximal direction.

**Figure 5: It is probably easier to learn to apply a compressive bandage than make an effective tourniquet. In this case great innovation is shown, but little understanding.
(Photo: Tromsoe Mine Victim Resource Center, Norway)**

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