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TEMPORARY INTRAVASCULAR SHUNTS IN PATIENTS UNDERGOING DAMAGE CONTROL AT THE LOURENÇO JORGE MUNICIPAL HOSPITAL IN RIO DO JANEIRO: EXPERIENCE OVER THE LAST 4 YEARS

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Abstract: The study is based on the evaluation of cases of Temporary IntraVascular Bypasses (DIVTs) performed in the last 4 years in patients undergoing damage control at the Hospital Municipal Lourenço Jorge in Rio de Janeiro, considering the injured vessel, material used, conformation of use (linear or "loop"), use of anticoagulants, patency, limb salvage, complications and mortality. Of the 12 patients, 10 were victims of gunshot wound trauma (PAF) and 2 were victims of blunt trauma, none received systemic anticoagulation in phase 2 (resuscitation in the intensive care unit - ICU), non-dedicated materials were used (such as Nelaton probes), with patency of 93%, mortality of 33% and only 1 amputation, concluding that DIVTs are of fundamental importance to avoid the deadly triad, and this case series portrays the relevance of this therapeutic arsenal.
Keywords: Vascular trauma; Injury of extremities; Temporary intravascular shunt; Damage control.

INTRODUCTION

Vascular lesions of the extremities cause two serious problems: hemorrhage and ischemia, which threaten the patient's life and the functionality of the limb. In emergency scenarios, with circumstances that do not always allow transfer to a specialized service, the conduct must be based on damage control techniques, in order to quickly obtain hemostasis and restore peripheral arterial flow, something possible to achieve with the use of temporary intravascular shunts (DIVTs).[1,2]

Despite being a concept of recent applicability, the use of DIVTs in trauma has its beginnings in the last century, when Payr in 1900 proposed a "sutureless anastomosis", using an extraluminal magnesium ring device. As early as 1915, Tuffier described a tube attached to the lesional stumps in an attempt to preserve perfusion of the limb. Despite the

high rates of occlusion of the device, in this period of history the only option left to the surgeon was ligation or amputation.[3,4,5]

The seventies were, without a doubt, a milestone in the understanding of the use of DIVTs, when Milklos Eger (1971) proposed staged surgery, today known as Damage Control Surgery.[4]

Although the concepts of aggressive revascularization remain ingrained in many surgeons, the concept of temporary *shunts* has become a well-described method in the literature to control hemorrhage and temporarily restore blood flow.[2] Furthermore, global experience has demonstrated the effectiveness of this technique, as well as satisfactory results, with a reduction in amputation rates.[6,7]

The article in question aims to demonstrate a retrospective analysis of 16 DIVTs in 12 patients included in the damage control surgery protocol at Hospital Municipal Lourenço Jorge (HMLJ) in Rio de Janeiro over the last 4 years and its results.

MATERIAL AND METHODS

The study period is from March 2020 to January 2023, involving 12 patients with 16 DIVTs in total: cervical (1), abdomen (1) and extremities (14), all of them included in the damage control protocol.

The variables analyzed were the following: injured vessel, material used, conformation of use, use of anticoagulants, patency, limb salvage, grafts performed, complications and mortality.

The study in question has no conflicts of interest or financial support.

DESCRIPTION OF CASES

Of the 12 patients evaluated, 10 were victims of penetrating trauma, while 2 were victims of blunt trauma.

Regarding surgeries associated with the procedure, we had 8 laparotomies, 1 cervicotomy and 1 sternotomy, and all underwent wide fasciotomy. These data reinforce the seriousness of patients upon admission.

It is worth noting that non-dedicated materials were used, such as Nelaton probes, and that no patient received systemic anticoagulation in phase 2 (resuscitation in the intensive care unit - ICU).

Of the 15 injured vessels, we mention those in the table below:

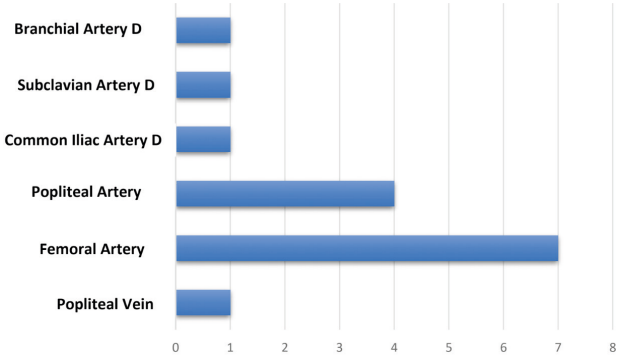

Table 1: Statistics of HMLJ-RJ cases.

Regarding the conformation of use, we had 8 cases in the linear conformation (illustrated in Figure 1), and 7 cases in the "loop" conformation (Figure 2).

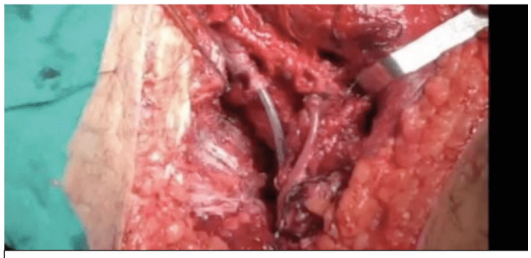

Figure 1: Photos taken from the study cases.

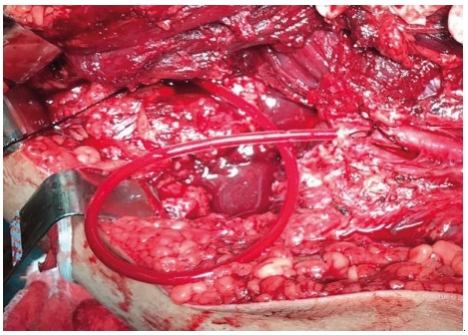

Figure 2: Photos taken from the study cases.

We perform the following grafts:

- Reverse internal saphenous vein (8);
- Great reverse saphenous vein (1) – reconstruction of the subclavian artery was performed, shown in Figure 3;

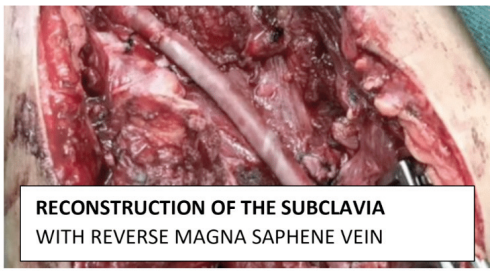

Figure 3: Photos taken from the study cases.

- Duplicated internal saphenous vein (3), shown in Figure 4;

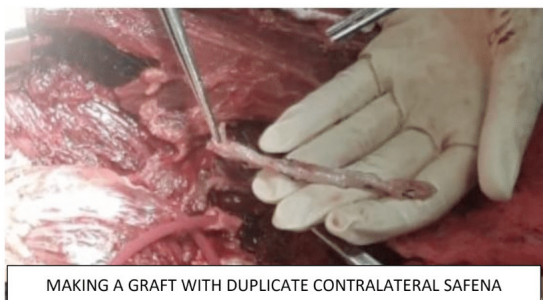

Figure 4: Photos taken from the study cases.

- Spiral internal saphenous vein (1), illustrated in Figure 5;

Figure 5: Photos taken from the study cases.

- Reverse Basilic Vein (1);
- Duplicated Basilic Vein (1), shown in Figure 6.

Figure 6: Photos taken from the study cases.

DISCUSSION

Temporary arterial *shunts* are intended to maintain limb perfusion while surgeons schedule definitive repairs.[8] With an acceptable complication burden and no mortality attributed to the technique, DIVTs must be considered.[9]

Indications for its use depend on the patient's clinical condition, the surgeon's experience and hospital resources.[1] Among them, we can list:

- Mutilating extremity injuries: the time for definitive repairs increases ischemia time, justifying initial revascularization with DIVTs.[1]
- Complex repair of the carotid artery in Zone III of the neck (from the angle of the jaw to the base of the skull).[1]
- "Damage control" in intra-abdominal injuries or truncal vascular injuries.[8]
- Little specific surgical competence: in

the probability of prolonged ischemia, transfer to a specialized service may not be possible, therefore the placement of a DIVTs allows early revascularization, without compromising the definitive.[1]

- Large number of victims: the insertion of DIVTs can shorten surgery times and manage several multiple trauma patients in less time, potentially postponing definitive revascularization until the critical phase has passed.[1]

Shunts are placed open in wounds exposed to contamination. At the time of its removal, an extra-anatomical vascularization (*by-pass*) is mandatory if there is insufficient tissue to cover a location.[8,10]

The main complementary procedures of DIVTs involve:[11]

- Venous shunt: placing a venous *shunt* instead of ligation can improve extremity perfusion and thus reduce rates of thrombosis, compartment syndrome, postoperative contractures and amputation.[2,11,12]

The patency of a temporary arterial *shunt* will be compromised if the adjacent main vein has been ligated. This ligature must be removed so that a temporary venous shunt can be inserted.[8]

- Fasciotomies: if there is a risk of compartment syndrome hours after revascularization, there is also a chance of impaired functionality of the extremity and secondary thrombosis. For this reason, fasciotomy is highly recommended (after insertion of the DIVTs).[11,12]

Among the most described complications are thrombosis, displacement of the DIVTs during transport with consequent hemorrhage.[1, 2]

Regarding post-operative management, there is a discussion about whether or not to start anticoagulation.[3] The duration of patency and the need for systemic anticoagulation remain under discussion, but some authors believe that the shunt can remain open for 52 hours without systemic anticoagulation.[3,11] There is no data that postoperative heparinization decreases the incidence of *shunt* thrombosis.[8]

A 4 to 18% rate of thrombosis after DIVTs is estimated, but it was related to the length of stay before definitive revascularization.[11] Anticoagulation is only indicated when there is other potential bleeding, such as chest and abdomen.[1] Thrombosis of an arterial *shunt*, although uncommon, is associated with overwhelming muscle damage at the distal end or lack of adequate venous return.[11]

There are some recommendations to avoid the risk of thrombosis, including: adapting the diameter of the material to the diameter of the vessel, washing the artery with heparinized saline solution beforehand, performing venous diversion in the presence of associated venous trauma, and the fasciotomies themselves.[1,7]

The time for definitive revascularization must be determined by the patient's clinical condition, but it is recommended that it be done within 24 hours.[1,10]

RESULTS

Of the 12 patients in the study, 4 of them died, for a total mortality rate of 33%. Among them, 3 died early, that is, less than 36 hours after admission (related to the deadly triad); 1 patient died considered late (within 3 weeks), due to pulmonary sepsis. Acute renal failure (rhabdomyolysis), pneumonia and skin infections were some of the main complications associated with these patients.

Regarding patency, we calculated a rate of 93% in total: there were 11 patients with 14 DIVTs taken to the reconstruction phase, obtaining 1 DIVT failure, in a popliteal artery (with reconstruction after 36 hours).

The average time for reconstruction

(definitive approach) for all these patients was 20.5 hours (minimum 12 hours and maximum 36 hours).

We achieved an 88% limb salvage rate: only 1 amputation due to late infection of the affected limb. The rest were not part of this count because there were 3 early deaths.

Figure 7 and 8: Images of one of the study patients, months after surgical treatment, sent and provided by the patient himself.

CONCLUSION

Early revascularization of ischemic limbs is a fundamental step in managing complex vascular injuries of the extremities.[13]

A self-constructed *shunt* is low-cost and safe to insert and does not require special training. It provides rapid hemostasis, restoring vessel flow before transfer to a specialized center, allowing surgeons to manage other associated injuries without rushing.[13]

The case series presented, despite the limited number of patients, demonstrated satisfactory effectiveness of the use of DIVTs in critically ill patients with vascular injuries undergoing damage control surgery at Hospital Municipal Lourenço Jorge – RJ.

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