



Intravascular Shunt in Management of Limb Trauma- A Review

**Hashem Bark Awadh Abood^{1*}, Abdulaziz Munahi Alanazi²,
Falah Bader Alhajraf³, Wejdan Nawaf Mesfer Alotaibi⁴, Bushra Saad Alghamdi⁵,
Shahd Ali H Alramadhan⁶, Daliah Abdulrahman Alharbi⁷,
Asia Abdullah Alamri⁸, Salman Abdulrahman Alhumud⁹,
Mohammad Nabil Khojah⁵ and Shda Fahad Khalil¹⁰**

¹Dr. Samir Abbas Hospital / Jeddah King Fahad Hospital - Albaha, Saudi Arabia.

²Prince Sattam Bin Abdulaziz University, Saudi Arabia.

³Arabian Gulf University, Bahrain.

⁴King Khalid University, Saudi Arabia.

⁵Ibn Sina National College for Medical Studies, Saudi Arabia.

⁶Royal College of Surgeons Dublin, Ireland.

⁷Imam Mohammad Ibn Saud University, Saudi Arabia.

⁸Shamal Almatar PHCC, Saudi Arabia.

⁹King Faisal University, Saudi Arabia.

¹⁰Batterje Medical College, Saudi Arabia.

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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Review Article

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ABSTRACT

Vascular injuries to the upper or lower limb in the context of significant soft tissue loss, fractures, or other life-threatening injuries are associated with a high amputation rate. Complex extremity vascular injuries in which acute arterial insufficiency combined with severe or prolonged shocks are

*Corresponding author: E-mail: ha-abood@moh.gov.sa;

unacceptable because warm, warm, skeletal muscle time is often exceeded before adequate revascularization, and are associated with extended ischemia periods or fractures or soft tissue wounds. Revascularizing the limb is essential for the success of the limb rescue. Selective intravascular temporary shunting hence allows better overall care of the patient and can therefore be predicted to increase both limb rescue and patient survival rates. The aim of this article was to review and summarize results of previous literature regarding effectiveness on intravascular shunting as management of limb trauma as well as reviewing its potential complications.

Keywords: Trauma; limb; extremity; shunting; revascularization; surgery.

1. INTRODUCTION

Every year, trauma causes around 41 million emergency department visits and 2.3 million hospital admissions in the United States. Extremity vascular injury affects around 0.5–4% of all trauma hospitalizations. Vascular trauma can occur as a result of iatrogenic, penetrating, or blunt injuries to the extremities; nevertheless, penetrating trauma accounts for 80% of occurrences [1].

Vascular injuries to the upper or lower limb, especially when combined with severe soft tissue loss, fractures, or other life-threatening injuries, are linked with a high amputation rate. Rapid diagnosis, bleeding control, resuscitation, and surgical intervention remain hallmarks of treatment. Vascular structures that cannot be ligated or embolized usually require exposure and healing [2]. In addition to a wide range of soft-tissue issues affecting the skin, muscles and tendons, or the neurovasculature, the underlying cause of damage and subsequent consequences has often been connected with other corporate and organs regions with a systemic compromise potential [3].

Complex extremity vascular injuries, in which acute arterial insufficiency is combined with severe or prolonged shocks, are unacceptable because warm, warm, skeletal muscle time is frequently exceeded before adequate revascularization, and are associated with extended ischemia periods, fractures, or soft tissue wounds. The limb must be revascularized in order for the limb rescue to be successful. Despite the fact that early surgery was successful in recovering roughly 95% of the injured limbs [4].

Vascular lesions are used to diagnose the "hard signs" of arterial damage, such as external pulsatile haemorrhage, rapidly growing hematoma, absent distal pulse, artery bruise, or an ischemic limb. The vast majority of

individuals with these illnesses need 95 percent expected intervention. Absence of pulse is not a reliable predictor because up to 25% of patients with severe arterial injuries who require treatment have normal pulses distal to the injury. Pre-operative arteriography may be discovered in individuals like these, especially if they are hemodynamically stable [5,6].

Transient intravascular shunts in both the damaged artery and vein may immediately impact the lower extremities of the ischemia. This temporary treatment provides enough time to address subsequent life-threatening injuries, tissue disturbance, and skeletal fixation without prolonging the life of the lower limb ischemia. Selective intravascular temporary shunting provides for improved overall patient care and can thus be expected to boost both limb rescue and patient survival rates [7].

The two most prevalent reasons for shunting in trauma are damage control and orthopaedic fixing timing. Trauma societal guidance suggests that ischemia period is reduced to fewer than 6 hours to allow maximal leg rescue. Restore blood flow via temporary shunting in case of simultaneous bone damage, but for "stable bone damage," urgent vascular restoration is advocated [8,9].

It is extremely desired because to its high limb recovery and minimal shunt complication rates. Damage treatment in an Iliac artery injury is typically limited to surgical or temporary closure; vascular repair is unlikely to occur in the acute environment. TIVS reduces amputation, fasciotomy, and mortality rates in patients with iliac artery injuries that require damage control by 47 percent, 93 percent, 43 percent, and 73 percent to 43 percent, respectively [10].

2. METHODOLOGY

A searching of databases PubMed, Google Scholar, and EBSCO using the following terms in

different combinations: trauma, limb, extremity, shunting, revascularization, surgery along with other key words. We included all full texts in making up of this study. The authors extracted qualitative data, and then the author's names, year, study type, methodology, and the result were reported. Inclusion criteria included all relevant studies with similar objectives as our study. Exclusion criteria included all studies irrelevant to our study. No software has been utilized to analyze the data. The data was extracted based on specific form. Data were reviewed by the group members to determine the

initial findings, and the modalities of performing the surgical procedure. Double revision of each member's outcomes was applied to ensure the validity and minimize the mistakes.

The search of the mentioned databases returned a total of 94 studies that were included for title screening. 68 of them were included for abstract screening, which lead to the exclusion of 33 articles. The remaining 35 publications full-texts were reviewed. The full-text revision lead to the exclusion of 27 studies, and 8 were enrolled for final data extraction (Fig. 1).

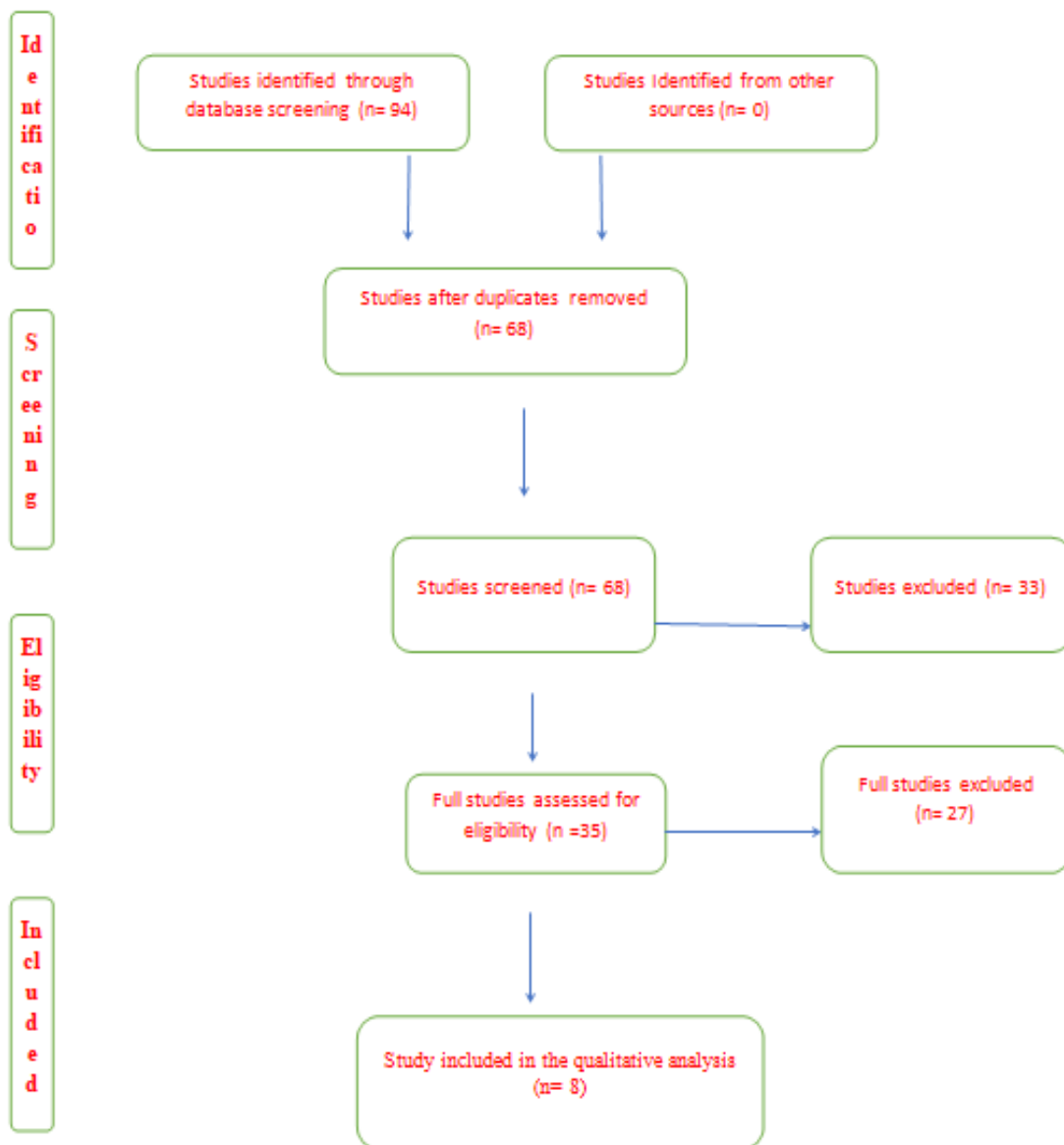


Fig. 1. The included studies had different study designs

3. LITERATURE REVIEW

A prospective observational analysis to identify TIVS usage using the multi-établist registry recently in 2021 and its implications on early extremity salvaging revealed 78 patients from 24 trauma sites with temporary intravascular shunts (TIVSs). Shunts accelerate limb perfusion and lead to decreased amputation rates during the early treatment period. TIVS should be part of a more aggressive approach to restore infusion for the most wounded and ischemically affected individuals [11].

There is standardized shunt usage in the military and the sharp drop in amputation rates throughout the decades. An analytic of the Global War on Terror vascular injury initiative aimed at providing perspective on the impact of TVS on limb savings and estimating the long-term freedom from amputation included 64 and 61 extremity arterial injuries in a vascular case and inspections, respectively reported; TVS benefits, albeit not statistically significant, are proposed. Amputation is associated with lesion specific factors of venous binding, related fracture and penetration blaster mechanism [12].

A retrospective investigation of the results with a two-year follow-up to the temporary vascular shunts in eighty patients in their military extremities. The study shows how important and useful TVSs are in managing vascular injuries at the ends of the battle. Used to restore perfusion to a damaged extremity, it does not appear that there are any detrimental consequences and no general growth in limb loss rates [13].

A report describes the results of use of temporary intravascular shunts as part of the treatment of five such patients sustaining severe blunt or penetrating injuries concluded that; the use of temporary intravascular shunts as outlined earlier can ensure that even in the case of a lower limb vascular injury that involves extensive soft tissue débridement and skeletal fixation, the surgeon still can achieve a superior vascular reconstruction without being constrained by ongoing limb ischemia [7].

Five males and two females with complex extremity vascular injuries, treated in the initial operational phase, from January 1996 through December 2000 with early insertion of an intravascular temporary shunt, and reported that 6 injured arteries were repaired using reversed vein grafts. In both wounded popliteal artery and

vein 1 patient had a TIVs implanted. Time varied between 225 and 360 minutes (median, 285 minutes). There were no complications associated with shunt implantation and all limbs could be healed. They finally concluded that early revascularization using TIVS can remove the harmful impact of prolonged ischemia and enable the surgeons to deal with other related problems without hurry [14].

A 1-year study in 10 patients with complex vascular injuries has been conducted routinely with temporary intravascular plastic shunting at the vessel disruption, allowing for immediate revascularization of the legs and suggesting that routine use of plastic intraluminal shunting has the distinct reduction potential in the context of complex vascular injuries of the extremities has the distinct potential of reducing the excess morbidity from prolonged acute arterial insufficiency noted in such injuries [15].

Zhu, Qingtang et al. performed a research to describe clinical expertise in the use of temporary intravascular shunts (TIVS) for fast restore of vascular-injured infusion to the extremities of significant vascular damage in 6 patients, which showed effectiveness in establishing shunts in 5 to 10 minutes (mean, 8.2 minutes). The bypass time was between 67 and 210 minutes. Blood infusion to the afflicted limb was enhanced following installation of TIVS. Thrombosis and partial blockage in one person who accepted amputation occurred after the shunted tubes were removed, with others retaining patentability [16].

A retrospective chart review is conducted by Włodarczyk, Jordan R et al. and the patients who received TIVS during their first operation and those who did not. The research covered 291 patients, 72 had TIVS implantation, 97 had final first repair and 122 had orthopaedic first fixation. The lack of TIVS was related with a substantial increase in compartment syndrome development. Though vascular repair during the initial operation appears to be the normal technique, morbidity is enhanced with the implantation of a TIVS [17].

4. COMPLICATIONS OF SHUNT USE

Shunts must not be considered danger free despite their prevalence and broad acceptance. Complexity ranges from 0 to 4.7 percent, particularly thrombosis and transportation dislodging [18,19]. Another essential factor is

shunt diameter; oversization may lead to intimate harm whereas undersizing. In one research, 86 percent of shunts were removed at 24 h, although the mean period for "dwell" in another was 24 hours. Shunt dwell times were not linked to thrombosis [20].

A single level I trauma center research in South Africa with civilian vascular trauma has found that shunt complication rates might reach up to 20%. Three of the seven problems in such a study were shunt dislodgments or migrations (one of which ended with death) with the other four being shunt thromboses [21].

Inaba et coll. have carried out a retrospective multicenter investigation over 9 years from 7 Level 1 trauma centers. This research consisted of 213 wounds treated with TIVS and had an overall survival of 79 percent and a permanent vascular repair survival of 81 percent. Shunter thrombosis (5.6%) and dislodging included complications (1.4 percent). No link between period of dwelling and shunt thrombosis was established. The utilization of a non-commercial tube did not affect shunt thrombosis but was an independent risk factor for the eventual failure of the transplant. The ratio for limb recovery was 96.3%. There may be no deaths due to a complication of shunt [22].

For optimizing their condition and/or transfer, Olivers, J C et al. documented on-site issues among 26 patients with a TIVS, including 4 relook shunts. No thrombosis shunt was reported for 24 hours after implantation. Two examples of shunts were displaced. One was done in an orthopaedic operation and the second occurs after damage control while the patient is being drifted into the ICU and another episode of catastrophic bleeding requiring immediate re-exploration in the theatre and the repositioning of the shunt. One TIVS migrated distally in the brachial artery, with an embolectomy catheter being removed. This incident did not cause any vascular problems [23].

5. DISCUSSION

Most or all components of the limb architecture suffer from major limb injury. The burning question in the significant limb trauma, especially in the polytrauma environment, is whether the wounded limb should be rescued or amputated [24]. A comparable decrease from 50 percent during World War II to less than 2 percent during civil wounds was caused by the move from

binding a wounded vessel to its main repair. But patients arrive late at the hospital, therefore amputation instead of the limb rescue is necessary particularly during the war [25].

To achieve consistently successful results for patients suffering complicated injuries and to provide the majority of health care systems with a good quality rehabilitation service. The introduction of the principles of radical debridging, primary repair and rehabilitation, together with the advent of a microvascular operation and stable fixing devices, made it possible for seriously wounded limbs to be rescued [26].

According to the American College of Surgeons Committee on Trauma in 2005, in order to enhance the chances of limb salvage, vascular damage should be addressed within 6 hours following injury. It is frequently treated during skeletal handling following skeleton stabilization to prevent further damage to the vessels. In certain circumstances, however, vascular restoration may result in fracture stabilization [27]. The great majority of patients with this type of surgery require a favorable 95 percent prediction. Absent pulse is not a delicate prognostic indication, with normal, distal pulses to the injury in up to 25% of patients with significant vasculature damage. The "soft signs" or a wound adjacent to a great vessel only suggest vascular trauma [28].

For vascular injuries involving the proximal part of the limb vessels, insertion of a TVS is suggested. Many varieties of TVS may be offered: Javid® or a basic Sundt® (Integra Plansboro, NJ, United States), Argyle® (Kendall Healthcare products, Mansfield, Mass, U.S.A.) or Pruitt-Inihara® (Horizon medical, Santa Ana Calif, U.S.) tubular prosthesis. Type is also available in many categories: While these prostheses have diverse forms and designs, their performance with regard to arterial flow and subarterial thrombosis in practise is more or less the same [29].

TVS should have close-knit diameters; intimate rips can occur with the usage of an excess TVS. To avoid compartmental syndrome, systematic execution of decompressive fasciotomy is advisable. The necessity to utilize anticoagulant or antiaggregant medicine on a systematic basis has not been proven in the early post-operative period. The patient must be moved as quickly as possible to a specialized vascular surgery center.

The period before final revascularization is based on the patient's general state. After placing a TVS, the long-term results for limb conservation are equal to those for initial revascularization [29].

Oliver et al. confirmed these results by a retrospective study of 35 patients published in 2013 [21]. The indications for TVS placement were damage control procedures (62%), inter-service transfers (20%), and Gustillo IIIc fractures (18%). The secondary thrombosis rate was zero at 24 hours and 16% overall. Two TVS became dislodged (one of them during transport resulting in patient death). In total, 74% of patients survived to undergo definitive revascularization and the amputation rate was 20%.

Subramanian et al. published the results of 101 TVS placements in 2008, one of the largest series [30]. The nature of the trauma was penetrating in 64% of cases. The indications for TVS placement were a damage control procedure in 44% of cases and Gustillo IIIc open fractures in 42% of cases. The secondary thrombosis rate was 5% and the rate of secondary amputation was 18%.

6. CONCLUSION

Peripheral vascular trauma is a surgical emergency. The purpose of surgical care is to restore perfusion. TIVS have an established role primarily in patients requiring either "damage control" for exsanguination or temporary vascular conduits. A temporary vascular shunt can control the bleed of the vessel while other severe injuries are given priority.

CONSENT

It is not applicable.

ETHICAL APPROVAL

It is not applicable.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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