



***Impact of temporary shunting on
extremity vascular injury: An outcome
analysis from the GWOT vascular injury
initiative***

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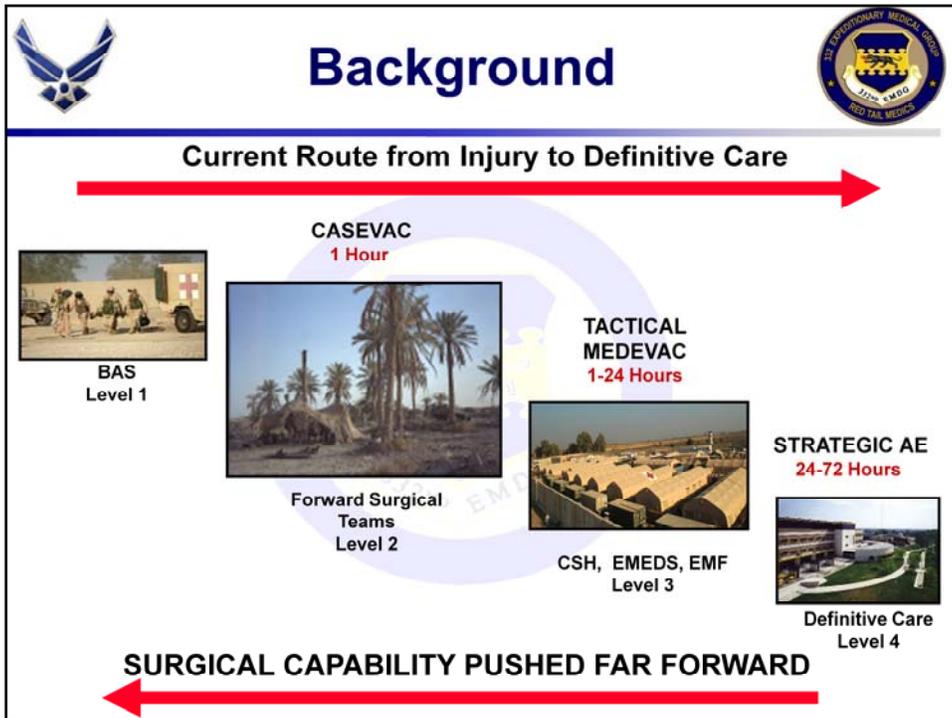
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Integrity - Service - Excellence

ATACCC members, distinguished guests...

I want to thank you for the honor of the podium and the opportunity to share our experience with vascular injury management during the Global War on Terror.

This morning I will be discussing Temporary vascular shunting and its impact on limb salvage.



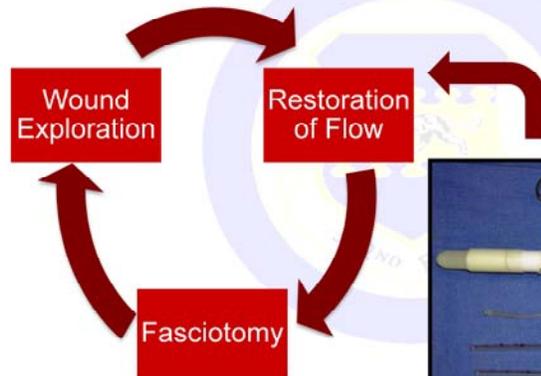
Since 2003, when the war in Iraq started, the Joint Theater Trauma System has mirrored that of the American College of Surgeons - with focused levels of care. These levels are equipped with escalating resource availability and subspecialty care as movement from point of injury to site of definitive repair occurs. A notable, yet incompletely evaluated addition to combat casualty care and vascular injury management, is the level II forward surgical team, or FST. These FSTs, positioned within 30 to 60 minutes of injury, have allowed for early patient stabilization and initiation of damage control interventions.



Background



Damage Control For Vascular Injuries



Temporary Vascular Shunts

Damage control for vascular injuries involves rapid wound exploration to identify injuries, restoration of flow to prevent ischemia, and fasciotomy to prevent further damage due to reperfusion injury. In management of select vascular injury patterns, particularly within extremities, temporary vascular shunting has been portrayed as an effective treatment to bridge the gap from injury to definitive repair.

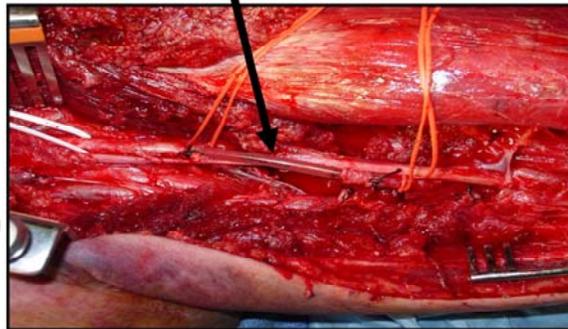


Background



Argyle shunt in brachial artery

- **Early limb salvage**
 - over 90%
- **Limited analysis**
 - Risks for amputation
 - Beneficial treatment adjuncts



Fox CJ, et al. *J Vasc Surg.* 2005; 41:638-44.
Rasmussen TE et al. *J Trauma.* 2006; 61: 15-21.
Clouse WD, et al. *J. Am Coll Surg.* 2007; 204(4): 625-632.
Woodward EB, et al. *J Vasc Surg* 2008; 47: 1259-65.
Sohn VY, et al. *Arch Surg.* 2008; 143(8): 783-7.

This deliberate paradigm shift, based on surgical expertise near time of injury, has witnessed declining early amputation rates. Individual group registries have reported early amputation rates as low as 5-10% in the short term.

Previous reports from war, particularly those from the Global War on Terror, describe strategies of vascular injury management, and their initial success. To date, this information has however, lacked comparative power and longer term scrutiny.

In particular, the effects of temporary vascular shunting on limb salvage have not been elucidated beyond its technical aspect and suggested benefit



Objectives



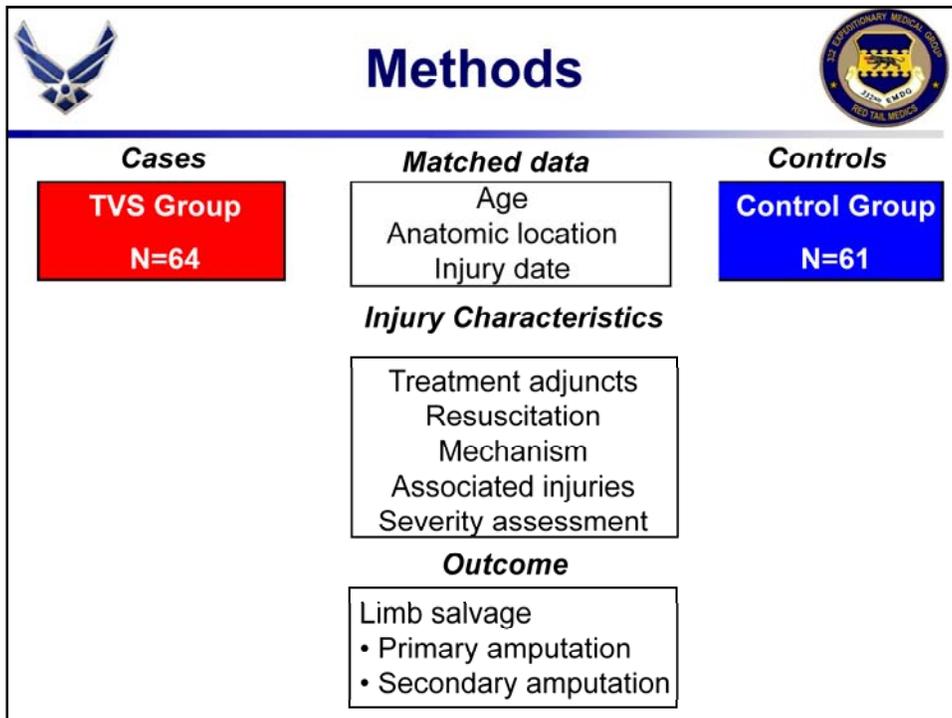
- **Define impact of temporary vascular shunts**
- **Evaluate additional factors that may influence limb salvage**
- **Describe realistic freedom from amputation**



Thus, this study's objective is to harness the power of currently available wartime registries, to define the impact of Temporary Vascular Shunting upon limb salvage after treatment for wartime vascular injury.

Additionally, this study will evaluate other factors that may impact limb salvage,

and finally, we will estimate an overall and more realistic amputation-free survival during the Global War on Terror using accepted outcomes methodology.



The TVS group consisted of 64 arterial injuries, which were matched based on age, injury location and date of injury, to 61 controls without TVS use **CLICK**

We then retrospectively reviewed charts to look at specific injury data. This included, but was not limited to, injury descriptions, treatment aspects, and severity assessments. **CLICK**

Limb salvage, defined as the maintenance of an autogenous limb with viable perfusion, was the outcome of interest. In those extremities where amputations occurred, but without an attempt at salvage, were defined as primary amputations. Any amputations that occurred after there was an attempt at limb salvage, were considered secondary amputations.



Results: Univariate Analysis



Shunt group comparison			
Characteristic	Control (N=61)	TVS (N=64)	P
GSW	30%	45%	0.1
Penetrating blast	70%	55%	
UE	26%	30%	0.67
LE	74%	70%	
Amputation	24%	19%	0.56
ISS	15.3	17.8	0.04
MESS	5.1	5.6	0.14
Level 2 care received	10%	27%	0.02
Fasciotomy	61%	66%	0.56

The table shown here demonstrates univariate shunt group comparison. The Control group, where no shunt was utilized, is reported in the left middle column. The temporary shunt group is reported in the right middle column. **CLICK**

The mean Injury Severity Score of the temporary vascular shunt group was higher than the control. Significantly more fresh whole blood and cryoprecipitate were required in the shunt group and not surprisingly, the TVS group was more likely to receive level II care. All other variables were not found to be different between groups

Not shown here, but important to note, is that associated bone, nerve and venous injuries were not different between each group.

Additionally, there were no deaths.



Results: Univariate Analysis



Amputation group comparison			
Characteristic	No Amputation (N=99)	Amputation (N=26)	P
GSW	44%	11%	0.002
Penetrating blast	54%	86%	0.002
UE	29%	23%	0.53
LE	71%	77%	0.53
ISS	15.5	20.7	0.01
MESS	4.9	7.2	<0.001
Associated venous injury	34%	54%	0.66
-- Repair of venous injury	62%	14%	0.004
Associated bone injury	48%	89%	<0.001
Associated nerve injury	28%	23%	0.35
Fasciotomy	65%	58%	0.51

There were a total of 26 amputations in the entire cohort of patients with major vascular injury, which represents an amputation rate of 21%. **CLICK**

Univariate results indicate a significant association between amputation and penetrating blast mechanism. The mean Mangled Extremity Severity Score, (which is a scoring mechanism that may be employed during initial evaluation of a severely injured extremity to guide limb salvage efforts) was significantly higher, and associated bone damage more likely, among those ultimately receiving amputation. Additionally, in those with concomitant venous injury, ligation as opposed to repair, was significantly associated with amputation.



Results: Multivariate Analysis



Effect	Relative Risk	95% CI	P
TVS Group ¹	0.43	(0.18,1.02)	0.06
MESS Score (5-7) ²	3.55	(1,12.65)	0.05
MESS Score (8-12) ²	14.96	(3.79,59.03)	<0.001
Venous repair ³	0.22	(0.05,1.02)	0.05
Associated bone injury	4.78	(1.4,16.3)	0.01

Multivariate Cox regression analysis demonstrated that bone injury, venous injury ligation, and escalating Mangled Extremity Severity scores were independent predictors increasing relative risk of amputation

Temporary Vascular Shunt use was protective, **CLICK**

Yet, was of borderline statistical substantiation.



Multivariate Analysis with Propensity Adjustment



Effect	Relative Risk	95% CI	P
TVS Group	0.47	(0.18,1.19)	0.11
Mess Score (5-7)	3.46	(0.97,12.36)	0.06
Mess Score (8-12)	16.37	(3.79,70.79)	<0.001
venous repair	0.2	(0.04,0.99)	0.05
Associated bone injury	5.01	(1.45,17.28)	0.01

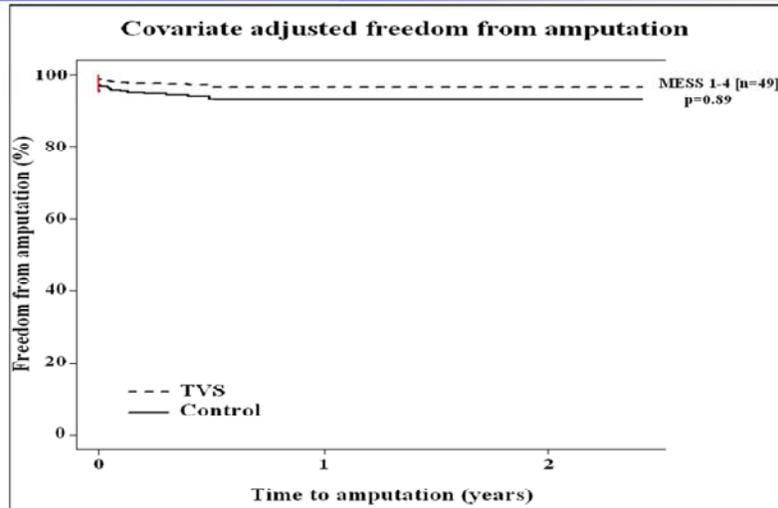
Adjusting for propensity score, which accounted for the differences seen in the Temporary Vascular Shunt and control comparison,

beneficial association with shunting was further weakened statistically. **CLICK**

Nevertheless, the degree of protective suggestion remained relatively similar.



Results



In this covariate adjusted Kaplan Meier curve,

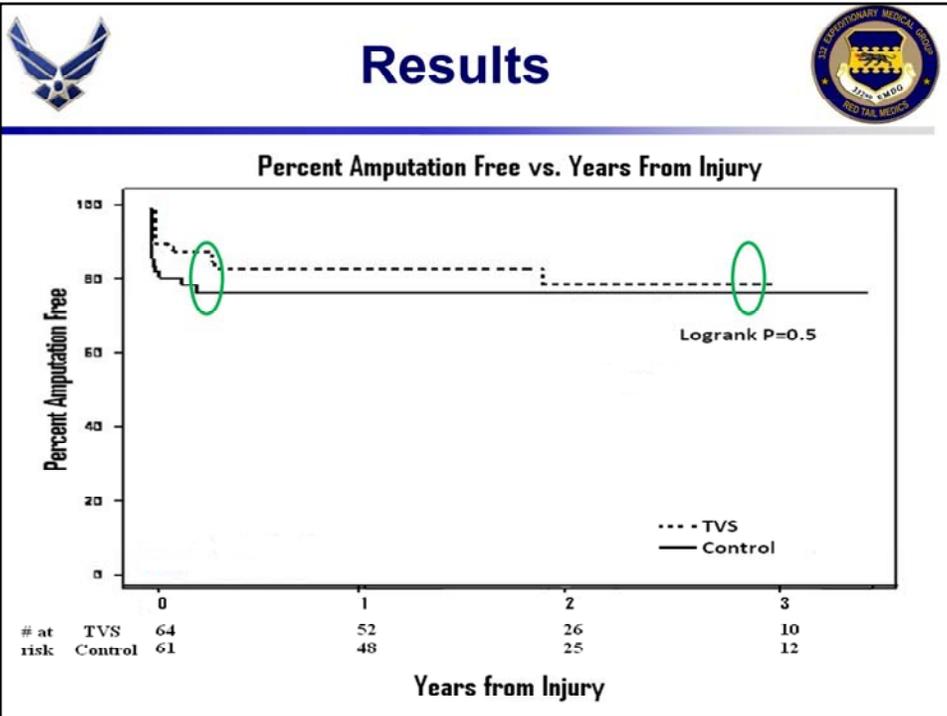
In less severely injured limbs or those injuries with Mangled extremity scores of 1-4, freedom from amputation was high, reaching nearly 95%. **CLICK**

As severity scores increased from 5-7 and then again from 8 -12, **CLICK**

there was a dramatic drop in freedom from amputation reaching 35%.

Of note, temporary shunting, as demonstrated by the dashed lines, afforded graduated, although statistically indifferent improvement in amputation-free survival based upon severity of injury.

This is demonstrated by the increasing separation of the TVS and control lines as mangled extremity score is increased.



Overall, in the 125 wartime extremity vascular injuries, Kaplan Meier actuarial estimation provided an amputation-free survival of 79% at 3 years. This was similar between the TVS and control groups.

CLICK

Early reports focused on the area highlighted here, where the benefit of shunting is obvious. However,

CLICK, we show that late secondary limb loss does occur and tempers earlier descriptions of in-theater success



Summary



- **TVS is not detrimental to limb salvage**
- **TVS may enhance salvage in severely injured limbs**
- **MESS greater than 5, fracture, and mechanism increase risk of amputation**
- **Venous repair is associated with limb salvage**
- **Freedom from amputation is 79% at 3 years**

In Summary,

TVS is not detrimental to limb salvage,

In fact, use may enhance salvage in severely injured limbs

MESS greater than 5, the presence of associated fracture, and the presence of penetrating blast mechanism increase the risk of amputation

Venous repair as opposed to ligation, is associated with limb salvage

Even with excellent early limb salvage, late secondary amputation, after wartime extremity vascular injury, does occur. This results in a more realistic

Freedom from amputation of 79% at 3 years



Conclusions



- **Use of temporary vascular shunting is justified in forward locations**
- **Venous repair should be performed**



Based upon these findings we conclude that

The use of TVS is justified in forward locations,
and,

When feasible, venous repair should be performed

I want to thank the Association again for this opportunity to share our findings, and will entertain any questions at this time.

Thank you!