Current Status of Management of Extremity Vascular Trauma

Essay

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1- IRI = ischemia reperfusion injury
2- EDRF= endothelial derived relaxing factor
3- SIRS= systemic inflammatory response syndrome
4- MODS= multiple organ dysfunction syndrome
5- ODFRs= oxygen free radicals
6- API= arterial pressure index
7- AV=arteriovenous
8- AVF=arteriovenous fistula
9- ePTFE= expended polytetrafluoroethylene
10-PSI= Predictive Salvage Index
11-MESS= Mangled Extremity Severity Score
12-NISSSA= Nerve Injury, Ischemia, Soft-Tissue Injury, Skeletal Injury, Shock, and Age of Patient Score
13- LSI= Limb Salvage Index
14- HFS= Hannover Fracture Scale
15- MESI= Mangled Extremity Syndrome Index
16- Sens = Sensitivity
17- Spec = specificity
18- NR = not reported.
19- PPV = positive predictive value
20- NPV = negative predictive value
21- WWII=world war 2
22- NTDB= National Trauma Data Bank
23- OR= odds ratio
24- CI= confidence interval
25- CFD= coloured flow doplex

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Introduction

The field of vascular trauma is one of the youngest surgical disciplines. Although physicians have long encountered the challenges of hemorrhage and ischemia from the injured vessels, most of our current knowledge of the principles and techniques involving arterial injuries had developed over the past 50 years*(**Frykberg E.R., 1995**)*.

Experience obtained from the major wars of the twentieth century provides the basis for the present approach to civilian peripheral arterial injury's management, where 90% of those injuries occur in the extremities**(*DeBakey et al., 1946).***

During World War II, ligation of the injured artery was the routine procedure as attempt for life saving. For the popliteal artery this routine resulted in amputation rate of 73% **(*DeBakey., 1946).***

In spite of the very early attempts of arterial injury repair as recorded by ***Sir Halliwell*** *1759* who repaired lacerated brachial artery and ***Prof. Murphy****; Chicago 1879* who successfully repaired a totally transected femoral artery .The formal application of arterial injury repair principles was only applied at the Korean conflict and in

spite of the time lag of 10 hours average between injury and transfer, yet the application of this technique resulted in drop of the amputation rate to 13% ***(Rich N.M., 1969).***

Further improvement continued during the Vietnam War where victim transfer time was reduced to 3 hours, together with the liberal use of autogenous vein grafts and improvement of the vascular repair skills, the amputation rate was kept the same 12.7% ***(Rich N.M., 1970).***

Physical limb trauma could be either penetrating or blunt. More than 90% of all extremity arterial injuries are of penetrating variety, which are either high velocity or low velocity injuries. The former is characterized by energy dissipation together with tissue cavitation that results in more damages than the original wound trajectory. Unlike the latter where the insult is mostly confined to the wound trajectory where the velocity is less than 1500 ft./sec ***(Perry M.O., 1995).***

Another form of penetrating injuries is the iatrogenic ones specially to the femoral and brachial arteries due to their common use in interventional techniques e.g. cardiac cath.; angiography; angioplasty …etc. These procedures carry 2-5% injury rate where females are more prone to

injury due to their smaller arterial size ***(Feld R. et al., 1992).***

Blunt arterial injuries in spite of constituting only 10% of all arterial injuries. Yet it represents more morbid injury owing to the associated fractures, dislocation and crushed soft tissues as well as other systems affection. Motor vehicle accidents and fall from heights represent the most common causes ***(White R.A. et al., 1987).***

In spite of the wide diversity of the etiological factors, the types of arterial injuries are usually; contusion, intimal disruption, punctures, lateral disruption, arteriovenous fistula or transection of the artery ***(Modrall J.G. et al., 1993).***

Timing is a very crucial factor in prognosis of the limb salvage following arterial limb trauma. Clinically an extremity trauma should be examined thoroughly for arterial injuries where presentation of such injuries could be either Frank "Hard" or Doubted "Soft".Hard signs of arterial injuries include: **a**bsent pulses; **a**ctive hemorrhage; **e**xpanding hematoma; **a**udible or palpable thrill or; distal **i**schemia with pain pallor parathesia paralysis pulslessness coldness and color changes ***(Frykberg E.R. et al., 1995)***.

Soft signs*; **unlike*** hard signs; denote only that the probability of the presence of arterial injury could not be over looked. Which includes: **s**mall or stable hematoma in the course of the artery; **i**njury to anatomically related nerve; unexplained **h**ypotension at presentation; **h**istory of active hemorrhage that no longer present and **p**roximity of the wound trajectory to a major artery ***(Frykberg E.R. et al., 1995)***.

Hard signs' presentation mandate immediate surgical exploration with no need for extra time consumption for further diagnostic workup. While soft signs represent a challenging situation where some authors advocate surgery to avoid the presence of so-called occult arterial injuries with consequent development of non-retrievable arterial diseases ***(Feliciano D.V., 1988)***.

While others advise the implementation of further work up to avoid unneeded exploration with its associated morbidity
(Rose S.C. & Moore E.E., 1988).

However the appropriate evaluation of extremity trauma for possible vascular injury must balance the need for prompt treatment against the time delay, cost, resources

availability and proper utilization of the present ones that many diagnostic tests require *(**Geuder J.W., 1985**)*.

The investigatory tools available ranges from the simple pocket Doppler screening test to the radiology ward angiography. So the problem is which to use and in which circumstances. During the early work at arterial injury management, arteriography was nearly applied to every victim of extremity trauma for fear of missing possible arterial injuries. Yet, that routine resulted in exhaust of the available resources so more specifications for the indications for arteriography are needed specially in the face of the ever developing utility of Doppler & Duplex *(**Jebara V.A ., 1991**)*.

In spite of this, arteriography has its role still in cases where actual localization of the site of the arterial injury is not possible on clinical grounds. For example, blunt limb trauma with multiple level skeletal fractures and /or sever soft tissue injury, missile injury with multiple possible sites as in shotgun wounds and missile injury that parallel the artery for long distance also in arterial injury on top of previous chronic occlusive arterial diseases *(**Roberts R.M., 1984**)*.

The debate of the value of routine arteriography in limb extremity trauma to spot out cases of asymptomatic arterial injuries was the seat of investigation for many authors. Yet, the consensus nowadays is in favor of the fact that a proper skillful clinical assessment that excludes initially arterial injury is quite enough and its missed injury rate doesn't exceeds 0.8% providing that it is conducted by a senior vascular surgeon and frequent counseling of the case is followed *(**Frykberg E.R. & Dennis J.W.,1991**)*.

On the other hand the studies supporting the rationale of routine angiography for all cases of limb trauma are based on the finding of certain cases were discarded initially on the grounds of no vascular injury detected on the initial assessment who develop some delayed vascular injury sequelae as arteriovenous fistula, delayed gangrene and/or pseudoaneurysm, Yet those studies had failed to demonstrate the cases' initial presentation and it seems that one or more of the hard signs were over looked at the initial time of assessment *(**Escobar G.A., 1980**)*.

Although it worths mentioning that reliance on physical findings should entail skillful assessment; frequent counseling and close follow up to be able to spot out cases

of occult arterial injuries that ultimately require surgery at appropriate time for best results achievement (***Anderson R.J .et al., 1990***).

The debate over the techniques of arterial injury repair is much less than before due to the continuous process of refinement since the Korean conflict. So, adequacy of repair is not a debated issue whenever a competent vascular surgeon carries it out.

Yet, prognosis and outcome of extremity arterial trauma do depend on other factors, which include **t**ime delay, **s**tate of the limb at presentation, **a**ssociated injuries of the soft tissues and skeleton which are responsible for most of the post traumatic morbidity and disability, **p**rioritization of management of associated injuries, **s**tate of the injured arteries as well as the general co-morbid conditions

So in an attempt to evaluate those prognostic factors, the work here presented, a search for the magnitude of this co-factors as well as their impact on the welfare of the vascular trauma victims as a step forward to reach a feasible consensus whenever extremity vascular trauma is encountered.

Arterial Injury

Mechanisms of injury

Vascular trauma results from penetrating, blunt, or iatrogenic injuries. The evolution of the management of vascular injuries, initially based on military experience and subsequently applied to civilian trauma, There is wide variation of clinical presentations of various forms of arterial injuries***(Coimbra R. &Hoyt D.B., 2010)***.

The initial and ultimate outcomes of vascular injury depend in large part on the wounding agent or mechanism of injury. Determining the mechanism of injury—whether blunt trauma, high-velocity penetrating trauma, or low-velocity penetrating trauma—is of the utmost importance***(Patel K.R. & Rowe V.L., 2010).***

Penetrating trauma:

The circumstances surrounding an incident of penetrating vascular trauma of the limbs, namely the type of the wounding agent, the nature of the injury and the lapse of time before evacuation to hospital, will strongly influence management. Limbs are vulnerable to injury by glass splinters, metal shards, bullets, shrapnel and other fragments from explosive devices.