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VENOUS INJURY REPAIR VERSUS LIGATION

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Abstract

This study aimed to assess the option of choice concerning venous reconstruction and simple venous ligation especially in unstable patient with life threatening visceral injuries.

A retrospective study of 347 patients operated upon for injuries of the venous system at vascular surgical unit, Al-Sader teaching hospital, from 1st of January 2005 to 31st of March 2012.

Males were affected more than females with ratio of 6.7:1, however we had increased number of the injured female. Most of the cases had either shell injury (38.3%) or bullet injury (32.6%) with total percentage (70.9%). The majority of the patients had associated injuries (90%). In this series amputation rate, and revision surgeries done for ischemic limbs were lower when patients underwent repair. Disappearance of edema in post-operative period was significantly more rapid when the injured vein was repaired. The site of venous injury was found in this study to be the major factor that determines the morbidity.

In conclusion, repair of the vein is favored when the conditions are optimal. In the presence of uncontrolled bleeding with persistent hemodynamic instability, ligation is recommended.

Introduction

The optimal management of major venous injuries continues to be a controversial topic. Although successful venous repair was reported as early as the latter part of the 19th century, ligation of a major vein trauma was an accepted method of treatment during world wars I and II. Hughes[1] reported on repair of selected cases of venous injury during the Korean War, but it was not until the Vietnam conflict that routine repair of venous injuries was advocated by Rich and Hughes[2]. Civilian experience in the past decade has corroborated the previously cited military experience in some aspect; however, the difference in wounds in civilian practice has also been emphasized in variety of experiences and results[2]. As with arterial injuries, most venous injuries occur in the extremities. Many veins are vulnerable to injury, because their relatively superficial location[3]. Reports on venous trauma are relatively sparse. Sever venous trauma is manifested by hemorrhage, not ischemia. Bleeding may be internal or external and may lead to hypovolemic shock[4]. In contrast to bright red blood in arterial injury, there is usually dark steady bleeding from venous injury[3]. In closed wound, a massive hematoma may develop. It may be impossible to determine whether such a hematoma is due to trauma to multiple small vessels or arterial injury, consequently, many venous injuries are 1st recognized at time of surgical exploration[3].

Vascular trauma occurs in about 3% of all civilian and military injuries. They follow cutting and stabbing incidents, gunshots injuries, pelvic fractures, road traffic injuries (particularly motor vehicle injuries), blunt trauma and surgical misadventures (iatrogenic) like in varicose

vein, herniorrhaphy, and hip replacement surgeries. Missile injury is the common etiology in the military traumas[5]. The number of iatrogenic injuries to the venous system has increased during the past 35 years as a result of rapid development of vascular and cardiac angiography and catheterization[6].

A positive history of trauma with symptoms and signs of venous injuries in the form of dark steady bleeding (in open wound) or massive hematoma (in closed wound) with or without symptoms and signs of shock may be highly indicative for venous injuries, however the features can be obscured or predominated by an associated arterial, peripheral nerve injuries and bone fractures. It was believed previously prompt operation based on the clinical assessment without specialized diagnostic studies, result in limb salvage and minimal morbidity[7].

Patients & Methods

A retrospective review of the records of 347 patients operated upon for injuries of venous system at the vascular surgery department, (Al-Sader teaching hospital in Basrah, south of Iraq), between 1st of January 2005 to 31st of March 2012. They were 302 male (87%) and 45 females (13%). The age range was 8-70 years with an average of 28 years, table (I) shows the demographic features of the patients.

Major central venous injuries were excluded, venous surgical interference for late complicated vascular injuries and iatrogenic venous injuries were also excluded. Patients on whom we could not trace comprehensive assessment or follow up were omitted from the study. Information was obtained from the hospital records and direct evaluation of patients.

Table I: The demographic features of the 347 patients.

	Features	Patients	Percentage
Gender	Males	302	87%
	Female	45	13%
Age	1-10 years	20	5.8%
	11-20 years	70	20.2%
	21-30 years	150	43.2%
	31-40 years	66	19%
	41-50 years	23	6.6%
	51-60 years	11	3.2%
	61-70 years	7	2%
Type of Injury	Penetrating trauma	309	89%
	Bullet injury	113	32.6%
	Shell injury	133	38.3%
	Sharp stabbing object	54	15.6%
	Glass shell	9	2.6%
	Blunt trauma	38	11%
	Road traffic accident	32	9.2%
	Fall from height	6	1.7%

Vital signs routinely checked in casualty department at time of presentation. Patients were classified into four groups depending on their hemodynamic state (table II). This classification has a relation to the management as well as shown later.

The initial management for all patients was blood grouping and preparing of an adequate cross-matched blood. Routine laboratory examinations, ECG, were performed in few patients with positive history or suspicion of ischemic heart disease or diabetes mellitus or renal failure. Radiography was done for all patients except for those with sever shock state or patients who had already radiography from the referring hospital. Abdominal ultrasonography were performed for 5 patients with abdominal tenderness. All patients admitted to the theatre without vascular imaging techniques because they were not available at time of admission.

Table II: Classification of patients according to their hemodynamic state.

Category	Pulse rate	Systolic blood pressure	Pulse pressure	No. of cases
Group A	<100	Normal	Normal	121 (34.8%)
Group B	>100	Normal	Decreased	142 (41%)
Group C	>120 weak	Decreased	Decreased	59 (17%)
Group D	> 140 or	Marked	Marked	25 (7.2)
not palpable		decreased or undetected	decreased or undetected	

Initial assessment and care of the patient with peripheral vascular trauma focuses on control of external hemorrhage and diagnosis of ischemia. Hypovolemia and shock were managed by controlling external blood loss, and restoring blood volume by an adequate infusion of cross-matched blood and i.v. fluid, adequate peripheral line were ensured. In an ischemic extremity, assessing the severity of ischemia and identifying the arterial segment involved are the key considerations. Documentation of the neurologic status of the injured extremity and assess it for compartment syndrome. In hemodynamically unstable trauma patient, a diminished arterial pulse or a cold or pale extremity is difficult to assess, so the diagnosis of ischemia often depends on comparison to the contralateral extremity. A policy of prophylactic parentral antibiotic administration had been adopted routinely to all trauma patients.

The management of injured veins consisted of lateral vienorrhaphy, venous patch angioplasty, end to end anastomosis, interposition saphenous vein graft, and ligation. Intra-operative heparin administration, when not contraindicated, is given and continued until patients become ambulatory and then switched to aspirin.

Time interval between the time of injury and time of operation ranged between 1 and 72 hours with a mean of 7.4 hours.

The diagnosis of major venous injuries was made in the operating room in all cases, isolated venous injuries were found in 35 patients (10%), the majority of patients had associated injuries (90%); arterial injuries were most common associated injuries (table III).

Table III: Associated injuries.

Associated injuries	Number of patients	Percentage
Arterial injury	286	82.4%
Nerve injury	66	19%
Bone fracture	112	32.3%
Joint dislocation	6	1.7%
Lung and diaphragm injury	17	4.9%
Abdominal visceral injury	19	5.5%

Period of hospital stay ranged from 3 days up to 21 days, the mean was 9.3 days. After surgery patients were transferred to the surgical care unit where vital signs, viability of injured limb (color, pulse, movement, and temperature) were checked hourly. Critically ill patients were continuously and intensively monitored. Edema was estimated clinically (mostly by using tape measure) and compared with other side.

Post operatively, all affected extremities were elevated until edema, if present, is resolved. Doppler study was performed for 30 repaired veins between the 3rd and 5th post-operative days. In outpatient department, patients were followed clinically for any late complication of vascular surgery like venous obstruction, varicose vein and venous ulcer.

Results

Femoral vein was the most common venous injury accounted for 31.4% of total venous injuries, followed by brachial veins (venae comitantes of brachial artery), (table IV). Ligation was performed in 216 injured veins while the remaining were repaired. Lateral venorrhaphy was done for 66 injured veins (50.4%), end to end anastomosis in 55 injured veins (42%), venous patch graft was performed to three injured veins (2.3%), and interposition saphenous vein graft in 7 injured veins (5.3%), (table V).

Table IV: The frequency of the injured veins.

Site of venous injury	No. & percentage of venous injury		Ligation	Repair
Brachial vein	97	(27.9%)	97	-
Femoral vein	109 (31.4%)		42	67
Popliteal vein	53	(15.4%)	21	32
Cephalic vein	10	(2.9%)	10	-
Internal jugular vein	3 (0.9%)		1	2
Basilic vein	15	(4.3%)	15	-
Subclavian vein	12	(3.4%)	1	11
G. Saphenous vein	18	(5.2%)	14	4
External jugular vein	12	(3.4%)	11	1
Axillary vein	9 (2.6%)		4	5
External iliac vein	7 (2%)		-	7
Innominate vein	2 (0.6%)		-	2
Total		347	216 (62.3%)	131 (37.7%)

The incidence of overall post-operative limbs oedema was 19.8% of injured veins which underwent repair; while it was 45.4% when the veins were ligated (provided that neck veins injuries are excluded). About 7.7% of all patients with venous injury discharged well from the hospital with residual oedema; most of them underwent venous ligation (24 patients = 88.9%) and only (3 patients = 11.1%) underwent venous repair. It is obvious that disappearance of oedema in post-operative period was significantly more rapid when the vein was repaired (table VI).

Amputation was performed for 17 (4.9%) patients post operatively. All those patients underwent venous ligations and concomitant fasciotomies and all of them had associated arterial injury, which are repaired, with the exception of two patients where ligation of brachial and

femoral arteries was done. However ligation of the brachial vein in the remainder was uneventful. Revision for limb ischemia post operatively was performing for 10 patients (2.9% of total injured veins); all of them underwent previous venous ligation. Time interval between primary operation and revisions time ranged between 24hours and 48 hours with a mean of 34hours. Three patients were operated for debridement of local necrotic tissue on the 5th and 6th post-operative days.

Table V: Distribution of patients according to the method of repair.

Injured vein	Ligation	Lateral repair	Venous patch	End to end anastomosis	Saphenous vein graft	Total
Brachial vein	97	-	-			97
Femoral vein	42	37	2	25	3	109
Popliteal vein	21	15	-	17	-	53
Cephalic vein	10	-	-	-	-	10
Internal Jugular Vein	1	2				3
Basilic vein	15					15
Subclavian vein	1	4		5	2	12
Great Saphenous vein	14	2		2		18
External jugular vein	11	1				12
Axillary vein	4	2	-	3		9
External iliac vein	-	2	1	2	2	7
Innominate vein	-	1	-	1	-	2
Total	216	66	3	55	7	347

Hemodynamic state of patients played an important role in planning the decision for the kind of surgery. Patients with poor hemodynamic state (group D) underwent ligation of their injured veins regardless of the site of the injured vein. Fasciotomy was performed as prophylactic measure for 97 injured veins; all of them underwent venous ligation.

Table VI: Postoperative morbidity in relation to type of surgery.

Morbidity	Total venous injuries	Ligated vein	Repaired vein
1.Oedema			
A. 4th post operative day	124 (35.8%)	98 (79%)	26 (21%)
B. at hospital discharge	27 (7.7%)	24 (88.9%)	3 (11.1%)
2. neurological defect			
A. motor & sensory	54 (15.5%)	33 (61.1%)	21 (38.9%)
B. sensory only	12 (3.5%)	8 (58.3%)	4 (41.7%)
3. wound infection	25 (7.2%)	16 (64%)	9 (36%)
4. amputation	17 (4.9%)	17 (100%)	0
5. revision	10 (2.9%)	10 (100%)	0
6. impaired limb Function	9 (2.9%)	7 (77.8%)	2 (22,2%)
Total	280 (80.7%)	215 (76.8%)	65 (23.2%)

The patency of the repaired vein estimated by Doppler study and clinical examination. Doppler ultrasound was performed for 30 repaired veins of the lower extremities between 3rd and 5th post-operative days. All of them showed positive flow; the remaining cases followed clinically and there were no clinical evidence of venous thrombosis; actually there were no signs of deep venous thrombosis or pulmonary embolism recorded clinically at period of

follow up whether the vein was ligated or repaired.

Nine patients died (mortality rate 2.6%), all of them presented in poor hemodynamic state (group D) at time of arrival. Two of them suffered from femoral artery and vein injuries with abdominal injury; while the other from Innominate vein injury. All of them died in the theater from irreversible shock.

Discussion

Ligation versus repair as a management of venous injury currently remains a controversial topic. Therefore, our inquiry is do we have any evidence that venous repair is better than ligation? This is clearly the most important question to be answered. In this study we had 347 patients underwent venous surgery in Al-Sader teaching hospital between 1st of January 2005 to 31st of March 2012. This can be considered as a high number of cases if we compare it with studies that done by others like the study done by Sharba[8] which included 87 patients had been taken in two years and another study done by Meyer J.P[9] that included 36 patients taken in tow years also. This difference, as we think is due to unstable political situation and increase violence action in Iraq in the last decade.

Eighty seven percent of patients in our study were male while (13%) were female, which is high in comparison to other studies[8-11]. This significant difference may be explain by that most of patients in our study were injured by shell that affect both male and female in the same ratio, however, the percentage still higher in male because the male is the more active gender in Iraq. The age range was 6-70 years with an average of 28 years, most of patients were young (2nd and 3rd decade of life = 63.4%), that is similar to other studies[8-12].

The mechanism of injury was either penetrating (89%) or blunt trauma (11%). This is similar to Meyer, 1987[9] and Ekim et al 1998[10] results, but higher than other authors results[8,12,13]. Most of the cases had either shell injury (38.3%) or bullet injury (32.6%) with total percentage (70.9%), other authors have no patients got shell injuries, they have only patients with bullet injuries[8,9,13], this is mostly due to the weak grip of law and lawlessness in Iraq at time of the study.

Hemodynamic state of patients played an important role in planning the decision of types of surgery. Patients with poor hemodynamic state (group D) (7.2%) underwent ligation of their injured veins regardless the site of the injured vein. This results supported by all other studies[8,10,11,14].

Isolated venous injury were found in 35 patients (10%), the majority of patients had associated injuries (90%); and this findings are greatly differ from other studies[8,15] that show (13.3%) and (23.4%) for isolated venous injury because most of our patients had shell injury that accompanied by additional insult to soft tissue, bone and internal viscera.

In this series amputation rate in femoral and Popliteal veins injury was 4.9% all of them had venous ligation, we hadn't lost any limb following venous repair[8,10,16,17] regardless of long term results. Insurance of venous patency during the initial 2 weeks following the injury perhaps improves patency rate in a new arterial anastomosis before development of collateral venous canals[10]. Revision surgeries were done for ischemic limbs in 10 patients (2.9%) where ligation of lower limbs injured vein were done with concomitant arterial reconstruction[4,8]. This may reflect that ligation of injured vein may increases the need for revision surgeries, and that the repair of veins in the lower limbs (femoral and popliteal veins) is far better than ligation.

The site of venous injury was found in this study to be the major factor that determine the morbidity. No significant morbidity were recorded after ligation of upper limb veins, neck veins or veins distal to the knee; while most morbidity resulted from

ligation of popliteal and femoral veins. Although repair of injured vein is recommended whenever possible, these veins should just be ligated if the injury is extensive, if the patient is unstable, or if there are other multiple sever injuries.

The effectiveness of venous reconstruction versus ligation in the prevention of post operative oedema is also contested issue. In our study, the overall incidence of post operative limb oedema was 19.8% of injured veins whom underwent repair; while it was 45.4% when the veins ligated (neck veins injuries are excluded). Rich, 1982[2] reported a 51% incidence of significant post operative oedema in patients with popliteal vein injuries managed by ligation compare with a 13% incidence if venous repair was attempted. Timberlake et al 1986[15] reported that although transient oedema developed in up to 32% of patients managed by venous ligation, no patient had a permanent problem with extremity swelling on long term follow up. We conclude that venous repair is associated with lower post operative morbidity than ligation. Open fasciotomies were performed as a prophylactic measures for 97 injured veins; all of them underwent venous ligation. (following ligation a prophylactic Fasciotomy may be done to obviate the risk of compartment syndrome)[18,19].

We hadn't recorded any case of deep vein thrombosis and pulmonary embolism in our follow up period[4,20], while other studies recorded (39%)[1], (22%)[10], and (19%)(13) of the patients had developed deep venous thrombosis, our treatment protocol of intra operative Heparin administration, when not contraindicated, and hence continued until the patients became ambulatory after that switched to Aspirin tablet 100 mg a day, might have help in the prevention of thrombosis.

Overall mortality rate was 2.6% in this series i.e. nine patients died secondary to profound bleeding and shock. In Ekim et al 1998[10] study, the mortality rate was (3%) while in Nitecki et al, 2007[4] study, the mortality rate was zero, this difference in mortality rate depends on the selection of cases, site of injury chosen for study and complexity of the injury.

In conclusion, repair of the injured vein is favored when the conditions are optimal, in the presence of uncontrolled bleeding with persistent hemodynamic instability, ligation has been recommended. It is obvious that disappearance of oedema in post operative period was significantly more rapid when the vein was repaired. The only disadvantage of venous repair is the time required for repair, and possibly the only indication for venous ligation are complex lacerations or associated injuries that mandate priority.

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