The THAI Journal of SURGERY 2014;35:
Official Publication of the Royal College of Surgeons of Thailand

Original Article

Peripheral Vascular Injuries in a Thai Northern Tertiary University Based Trauma Center Level I between 2007 - 2011

KaweesakChittawatanarat, MD, PhD, FRCST*
Kritsada Phruksawatnon, MD, FRCST*
Narain Chotirosniramit, MD, FRCST*
Kamtone Chadacham, MD, FRCST*
Tidarat Jirapongcharoenlap, MD, FRCST*
**Department of Surgery, Faculty of Medicine, Chiang Mai University, Chiang Mai, Thailand*

Abstract

Background: **Peripheral vascular injury (PVI) is commonly associated with major trauma especially orthopedics injury. However, detailed descriptive data in Thailand especially in the Northern region were not available.**

Objective: **To describe the PVI over a five-year experience in our institute between 2007 and 2011after trauma team was organized.**

Methods: **All of the PVI records during January 2007 - September 2011 were retrieved from the hospital database. Injury characteristics, time to surgery, severity scoring and operation types were recorded and analyzed.**

Results: **A total of 176 injured patients were included in this study. The median occurrence of injury was 35 cases per year (range 23 - 51 cases). Male was predominant gender (87.5%). Median age (Interquartile range, IQR) was 30 (21 - 43) years. Lower extrimity PVI was occurred higher than upper extremities PVI (59.1% vs. 40.9%). The most common injury sites of upper extremity and lower extremity were radial arteries (12.5%) and popliteal arteries (26.7%) respectively. Of these, 47% underwent vascular repair with conduits (44.3% with reverse saphenous vein graft (RSVG), 2.8% with synthetic PTFE graft) and 29% were repaired without conduit. The amputation rate was 15.3% with median (IQR) of Mangled Extremity Severity Score (MESS) was 7 (7-8) and significant higher than non amputation group (p<0.001). Fasciotomy rate was 6.8%. Significant risk factors of amputation were female (p=0.013), MESS score (p<0.001), skeletal and soft tissue score (p<0.001), limb ischemic score (p<0.001), shock score (p<0.001), lower extremity injury (p=0.014), blunt injury (p=0.011), popliteal artery injury (p=0.018), associated nerve (p=0.006), and associated bone injury (p=0.015).**

Conclusion: **PVI is frequently found injury in the Northern Tertiary University-based hospital. Lower extremity PVI occurred higher than upper extremity PVI. Female gender, MESS score and its components, blunt injury type, sites of injury of lower extremity and popliteal, associated nerve and bone injuries were associated with the risk of amputation.**

Keywords: **Amputation, fasciotomy, Mangled Extremity Severity Score, peripheral vascular injury, popliteal artery injury.**

Correspondence address: *Kaweesak Chittawatanarat, MD, PhD, FRCST, Department of Surgery, Faculty of Medicine, Chiang Mai University, Chiang Mai, Thailand; E mail: kchittaw@gmail.com; Tel: +66-53-945533; Fax: +66-53-946139*

Introduction

The results of treatment of peripheral vascular injury depends on many factors such as ischemic time, associated bone and soft tissue injury, patient age and vital sign, and severity of ischemic limbs[1]. In the recent meta-analysis review, the predictive factors of severe lower limb amputation were preoperative hypotension, popliteal artery injury, and associated bone and nerve injury[2]. These factors were integrated in severity scoring of "Mangled Extremity Severity Score" (MESS)[1]. The score were validated in both of lower and upper limb vascular injuries[1,3,4].

In the mid 2006, the specialized trauma team was established in the Department of Surgery, Faculty of Medicine, Chiang Mai University[5,6]. This team has the primary responsibility on all of the peripheral vascular injuries admitted to the Maharaj Nakorn Chiang Mai Hospital except iatrogenic vascular injury. The objective of this study was to present data of the peripheral vascular injury in a five-year experience at our Institute between 2007 and 2011 after the trauma team was set up.

Materials and Methods

Medical records of all patients who were admitted due to peripheral vascular injuries (International Classification of Diseases [ICD 10] coded as S45, S55, S75 and S85) between January 2007 and December 2011 were retrieved. Incomplete medical records, previous operations from other hospitals or iatrogenic injury were excluded. Data included age, gender, site of injury, mechanism of injuries, estimated time from injury to surgery (ischemic time), associated bone or nerve injury, severity of vascular injury measured by MESS scoring system, and all procedures during admission.

Data was analyzed by the STATA software version 11.0 (STATA Inc., College Station, TX). All continuing variable data differences were tested using Student's t test for normal distribution data and reported as mean ± SD or median (25-75 inter-quartile range [IQR]) for non-parametric distribution and tested with Mann-Whitney U test. For categorical variables, Pearson's chi-square was used. Logistic regressions were used to determine amputation risk. Statistical significance was considered when $p < 0.05$.

Results

Data of 202 patients were retrieved from hospital database during a 5 year-period. Twenty six patients were excluded (20 with incomplete medical record, 4 with iatrogenic injury and 2 with vascular reconstruction performed from other hospitals). A total of 176 patients were included in this study. Of these, amputation rate was 15.3% (salvage vs. amputation: 149 vs. 27). Primary and secondary amputation were 19 (10.8%) and 8 (4.5%) respectively. The median incidence rate of injury was 35 cases per year (ranged 23-51 cases). Male was predominant gender (87.5%). Median age was 30 years (IQR 21 - 43). In Table 1, the three most common mechanisms were motorcycle accidence, cut wound and gunshot wound respectively. The occurrence of injury was comparable between upper and lower extremity (41% vs. 59%). However, lower extremity had significantly higher amputation rate than upper extremity injury ($p = 0.01$). The most common injury site of upper extremity and lower extremity was radial (12.5%) and popliteal artery (26.7%) respectively.

In Table 1, amputation rate in five-year range was 7.7 - 23.5%. Amputee patients were younger than non-amputee group (p=0.054). Female had significantly higher percentage of amputation than male (31.8% vs. 10.4%; p=0.005). Motorcycle accident was the major mechanism in amputated patients (87%). About 60% of amputated patients suffered from popliteal artery injury. Ischemic time of amputated patient was significantly longer in amputated patients (p=0.048). Although length of hospital stay was slightly longer in amputated group, there was no statistical significant difference. Regarding operative methods, Forty-seven percent of patients underwent vascular injury repair with conduit (44.3% reverse saphenous vein graft [RSVG], 2.8% synthetic PTFE graft). Twenty-nine percent of patient underwent primary vascular repair without conduit. Secondary amputation rate after RSVG repair was 7.7% (6/78). Superficial femoral artery was ligated in one patient due to unstable hemodynamic and amputation was performed eventually. Thirteen patients had distal artery ligated and limbs were survived. Negative exploration was found in only 1.70% of all injuries. Fasciotomy rate was 6.8% (12/176). Details of patients who had fasciotomy were demonstrated in Table 2. In Table 3, detailing

Table 1 Characteristics of patients

Parameters	Salvage (N=149)	Amputate (N=27)	All (N=176)	*P* value
Age in years (IQR)	30 (21 - 44)	28 (19 - 39)	29.5 (21 - 43)	0.308
Male (%)	134(89.93)	20(74.07)	154(87.50)	0.022
Year (%)				0.289
2007	21(14.09)	2(7.41)	23(13.07)	
2008	29(19.46)	6(22.22)	35(19.89)	
2009	39(26.17)	12(44.44)	51(28.98)	
2010	36(24.16)	5(18.52)	41(23.30)	
2011	24(16.11)	2(7.41)	26(14.77)	
Mechanisms (%)				0.017
Motor cycle accidence	79(53.02)	22(81.48)	101(57.39)	
Cut wound	31(20.81)	0(0.00)	31(17.61)	
Gunshot wound	15(10.07)	1(3.70)	16(9.09)	
Laceration wound	11(7.38)	0(0.00)	11(6.25)	
Fall from height	4(2.68)	1(3.70)	5(2.84)	
Car accident	1(0.67)	1(3.70)	2(1.14)	
Penetrating injury	6(4.03)	0(0.00)	6(3.41)	
Crush injury	1(0.67)	1(3.70)	2(1.14)	
Blast injury	1(0.67)	1(3.70)	2(1.14)	
Site of injuries (%)				0.057
Upper extremity	67(44.97)	5(18.52)	72(40.91)	
Axillary	11(7.38)	1(3.70)	12(6.82)	
Brachial	16(10.74)	3(11.11)	19(10.80)	
Radial	22(14.77)	0(0.00)	22(12.50)	
Ulnar	12(8.05)	0(0.00)	12(6.82)	
Both radial and ulnar	6(4.03)	1(3.70)	7(3.98)	
Lower extremity	82(55.03)	22(81.48)	104(59.09)	
Common femoral	1(0.67)	0(0.00)	1(0.57)	
Superficial femoral	18(12.08)	1(3.70)	19(10.80)	
Popliteal	32(21.48)	15(55.56)	47(26.70)	
Anterior tibial	7(4.70)	2(7.41)	9(5.11)	
Posterior tibial	14(9.40)	4(14.81)	18(10.23)	
Tibioperoneal	1(0.67)	0(0.00)	1(0.57)	
Peroneal	1(0.67)	0(0.00)	1(0.57)	
Dorsalis pedis	1(0.67)	0(0.00)	1(0.57)	
Vascular spasm	7(4.70)	0(0.00)	7(3.98)	
Extremities (%)				0.010
Upper extremity	67(44.97)	5(18.52)	72(40.91)	
Lower extremity	82(55.03)	22(81.48)	104(59.09)	
Type of operation (%)				<0.001
Intraoperative angiogram	5(3.35)	1(3.70)	6(3.41)	
Alone	3(2.01)	1(3.70)	4(2.27)	
With fasciotomy	2(1.34)	0(0.00)	2(1.14)	
Repair with conduit	77(50.33)	6(26.09)	83(47.16)	
Reverse saphenous vein graft (RSVG)	72(48.32)	6(22.22)	78(44.32)	
Alone	52(34.90)	5(18.52)	57(32.39)	
With fasciotomy	11(7.38)	0(0.00)	11(6.25)	
With intraoperative angiogram	9(6.04)	1(3.70)	10(5.68)	
Synthetic graft (PTFE)	5(3.36)	0(0.00)	5(2.84)	
Repair without conduit	51(34.22)	0(0.00)	51(28.98)	
Ligation of vessel	13(8.72)	1(3.70)	14(7.95)	
Primary amputation	0(0.00)	19(70.37)	19(10.80)	
Negative exploration (penetrating injury)	3(2.01)	0(0.00)	3(1.70)	
Injury to surgery time in hour (IQR)	3(1 - 5)	4(3 - 8)	3(1 - 5)	0.053
Length of hospital stay in days (IQR)	16 (4 - 33)	17 (6 - 33)	16 (4 - 33)	0.393

Table 2 Details of patients with primary fasciotomy

No.	Age (yrs.)	Mechanism	Site of injury	MESS	Operation	Time*
1	23	MCA	Popliteal	6	Repair with RSVG	7
2	22	MCA	Popliteal	3	Repair with RSVG	0.5
3	37	MCA	Popliteal	2	Repair with RSVG	0.5
4	24	MCA	Axillary	5	Repair with RSVG	10
5	25	MCA	Axillary	6	Repair with RSVG	14
6	21	MCA	Vascular spasm	2	Intraoperative angiogram	2
7	47	GSW	Brachial	2	Repair with RSVG	4
8	31	MCA	Popliteal	4	Repair with RSVG	4
9	45	GSW	PTA and ATA	4	Repair with RSVG	8
10	34	MCA	Vascular spasm	4	Intraoperative angiogram	4
11	36	Fall	Popliteal	5	Repair with RSVG	7
12	38	MCA	Popliteal	8	Repair with RSVG	8

*Time in hour from accident to operative room, PTA, posterior tibial artery; ATA, anterior tibial artery; GSW, gunshot wound; MCA, motor cycle accidence; MESS, Mangled Extremity Severity Score; RSVG, reverse saphenous venous graft; yrs, years.

Table 3 Detail of Mangled Extremity Severity Score (MESS)

Score	Description	Salvage N=153 (%)	Amputate N=23 (%)	All N=176 (%)	*P* value
	Skeletal/ soft tissue score				<0.001
1	Low energy (stab; simple fracture; pistol gunshot wound)	75(50.34)	1(3.70)	76(43.18)	
2	Medium energy (open or multiple fractures, dislocation)	69(46.31)	8(29.63)	77(43.75)	
3	High energy (high speed motor vehicle accident or rifle gunshot wound)	5(3.36)	12(44.44)	17(9.66)	
4	Very high energy (high speed trauma and gross contamination)	0(0.00)	6(22.22)	6(3.41)	
	Limb ischemia score				<0.001
1	Pulse reduced / absent but perfusion normal (≤ 6hrs)	91(61.49)	0(0.00)	91(52.00)	
2	Pulse reduced or absent but perfusion normal (> 6hrs) or pulse less; paresthesias, diminished capillary refill (≤ 6hrs)	41(27.70)	8(29.63)	49(28.00)	
3	Cool, paralyzed, insensate, numb (≤ 6 hrs)	10(6.76)	11(40.74)	21(12.00)	
4	Pulse less; paresthesias, diminished capillary refill (> 6hrs)	6(4.05)	5(18.52)	11(6.29)	
6	Cool, paralyzed, insensate, numb (> 6hrs)	0(0.00)	3(11.11)	3(1.71)	
	Age group score				0.694
0	< 30 years	88(59.06)	15(55.56)	103(58.52)	
1	30 - 50 years	47(31.54)	8(29.63)	55(31.25)	
2	≥ 50 years	14(9.40)	4(14.81)	18(10.23)	
	Shock score				<0.001
0	SBP > 90 mmHg consistently	115(77.18)	10(37.04)	125(71.02)	
1	Hypotension transiently	27(18.12)	12(44.44)	39(22.16)	
2	Persistent hypotension	7(4.70)	5(18.52)	12(6.82)	
	Total MESS score (IQR)	**4 (3 - 5)**	**7(7 - 8)**	**4(3 - 5)**	**<0.001**

IQR, interquartile range; hrs, hours

proportion of each MESS score was demonstrated. There were statistically significant differences between amputation and non-amputation group on all MESS score parameters ($p < 0.05$) including skeletal and soft tissue score, limb ischemic score, and shock score except age group category ($p = 0.694$). Median (IQR) of total MESS score in amputation group was significantly higher than non-amputation group 7 (7-8) vs. 4 (3-5); $p < 0.001$) (Table 3).

With the logistic regression analysis (Table 4), the

Table 4 Odds ratio of amputation

Risk factors	OR (95%CI)	*P* value
Female	6.16 (1.45 - 26.03)	0.013
Age	0.99 (0.96 - 1.02)	0.639
Skeletal and soft tissue score	17.81 (6.50 - 48.86)	<0.001
Limb ischemic score	4.50 (2.65 - 7.65)	<0.001
Shock score	3.30 (1.81 - 6.01)	<0.001
MESS score	5.13 (2.86 - 9.21)	<0.001
Lower extremity	3.60 (1.29 - 10.00)	0.014
Blunt injury	13.94(1.84 - 105.65)	0.011
Popliteal artery	3.34 (1.23 - 9.11)	0.018
Associated bone injury	4.70 (1.35 - 16.33)	0.015
Associated nerve injury	3.29 (1.42 - 7.65)	0.006

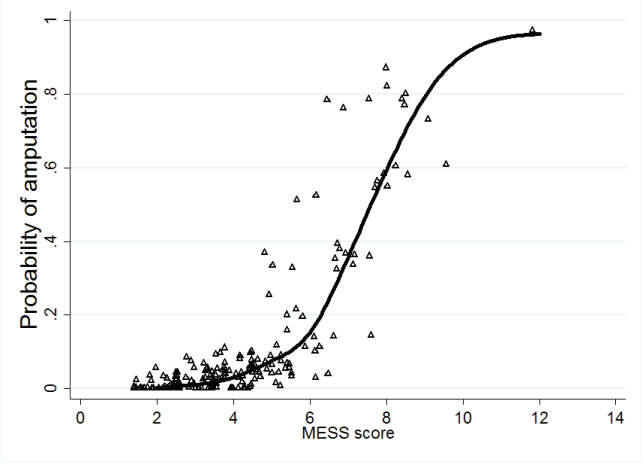

Figure 1 Amputation probability model on Mangle extremity severity score (MESS score)

following factors were correlated with increased risk of amputation: female patients, high MESS score, lower extremities, higher skeletal and soft tissue score, limb ischemic score, shock score, blunt injury mechanisms, and popliteal artery injury. Figure 1 demonstrated probability model of amputation over MESS score. The slope of amputation significantly increased after MESS score more than 6 in our predictive model patient setting.

Discussion

In the present study, the amputation rate for PVI was 15.3%. There are many factors relating with the success of limb salvage in traumatic vascular injury including fracture grading, soft tissue damage and contamination, ischemic time, associated nerve injury, venous damage, compartment hypertension, hemodynamic, mechanism of injury, age, and co-existing disorders[1]. Regarding these factors, the severity grading score of "MESS" was proposed[1]. This scoring system selected four predisposing factors for successful limb salvage prediction including skeletal/soft tissue injury, limb ischemia, shock and age[1]. Regarding the limb ischemic score, the score was doubled if the ischemic time lasted more than six hours[1]. The detailing of score in this study was demonstrated in Table 3. All of the MESS score predictors were significantly different except patient age. This finding might be explained by the unequal distribution of patient age in trauma. Nearly 90% of our patients are in age group under 50 years.

The MESS scoring is primary application on lower limb vascular injury[1,7-10]. The MESS score ≥ 7 was validated to predict amputation with 100% accuracy in retrospective survey and prospective trial[1]. In our setting, however, six patients (4%; 5 in lower and 1 in upper limb) with MESS score ≥ 7 had limb salvage. Therefore, using MESS score for primary amputation should be cautious and decision is based on individual patient especially in upper extremity vascular injury[4,11,12]. However, probability of amputation is highly anticipated when MESS score is more than 6 points (Figure 1).

In addition to MESS and its components, female, lower extremity, blunt injury and popliteal artery injury, and associated bone and nerve injury are the risk of amputation in our setting. These factors are correlated with the previous meta-analysis for traumatic lower extremity vascular injury except female gender[2]. The female patient occupied only 13.5% at all PVI. Unequal size of sample might cause distortion of outcome. The further epidemiologic study for larger sample should be further investigated.

The strength of this study was the pioneer report on PVI after trauma team established in the Northern Tertiary University-based hospital in Thailand. However, there were some limitations in this study. First, details of orthopedic injury was not classified and recorded. Type of injury might distort the amputation outcome[11]. Second, the study is retrospective based on hospital data entering code. There was no death in study population. The registry might miss some severe associated injuries. Prospective collecting data with specific protocol should be initiated in our institute.

Third, the study did not collect injury severity score (ISS). This factor might confound the PVI outcomes.

Conclusion

PVI is frequently found injury in the Northern Tertiary University-based hospital. Lower extremity PVI is higher occurrence than upper extremity PVI. Female, MESS score and its components, blunt injury, lower extremity PVI, popliteal PVI, associated nerve and bone injury are associated with increased risk of amputation.

Conflict of interests

The authors report no conflict of interest relevant to this study.

Acknowledgement

The authors gratefully thank the nurse co-coordinator and the staff at registry data unit of Maharaj Nakorn Chiang Mai Hospital trauma center for their valuable assistance.

REFERENCES

1. Johansen K, Daines M, Howey T, Helfet D, Hansen ST, Jr. Objective criteria accurately predict amputation following lower extremity trauma. J Trauma 1990;30:568-72.
2. Rerkasem K, Arworn S, Thepmalai K. Prognostic factors of leg amputation in patients with vascular injury: a systematic review. Int J Low Extrem Wounds 2006;5:78-82.
3. Boutonnet M, Pasquier P, Jault P, Pierret C, Tourtier JP. Specific patterns around the mangled extremity severity score in blast-related limb injuries. J Trauma 2011;71:785.
4. Prichayudh S, Verananvattna A, Sriussadaporn S, et al. Management of upper extremity vascular injury: outcome related to the Mangled Extremity Severity Score. World J Surg 2009;33:857-63.
5. Chittawatanarat K, Ditsatham C, Chotirosniramit N, Chandacham K, Jirapongcharoenlap T, Traisathit P. Characters of mortality and time series analysis in thoracic injury before and after rapid response trauma team establishment. Thai J Surg 2012;33:7-12.
6. Chittawatanarat K, Ditsatham C, Chandacham K, Jirapongcharoenlap T, Chotirosniramit N. Effects of rapid response trauma team in thoracic injuries in northern trauma center level I. J Med Assoc Thai 2013;96:1319-25.
7. McNamara MG, Heckman JD, Corley FG. Severe open fractures of the lower extremity: a retrospective evaluation of the Mangled Extremity Severity Score (MESS). J Orthop Trauma 1994;8:81-7.
8. Robertson PA. Prediction of amputation after severe lower limb trauma. J Bone Joint Surg Br 1991;73:816-8.
9. Rush RM, Jr., Kjorstad R, Starnes BW, Arrington E, Devine JD, Andersen CA. Application of the Mangled Extremity Severity Score in a combat setting. Mil Med 2007;172:777-81.
10. Slauterbeck JR, Britton C, Moneim MS, Clevenger FW. Mangled extremity severity score: an accurate guide to treatment of the severely injured upper extremity. J Orthop Trauma 1994; 8:282-5.
11. Sheean AJ, Krueger CA, Napierala MA, et al. Evaluation of the Mangled Extremity Severity Score (MESS) in Combat Related Type III Tibia Fracture. J Orthop Trauma 2013.
12. Togawa S, Yamami N, Nakayama H, Mano Y, Ikegami K, Ozeki S. The validity of the mangled extremity severity score in the assessment of upper limb injuries. J Bone Joint Surg Br 2005; 87:1516-9.