

Traumatic Lower Limb Reconstruction- A Kuwaiti Experience

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Abstract

Lower extremity acute trauma is a common occurrence. The reconstructive plastic surgeon must be knowledgeable enough to assist in making the correct decision through established protocol considering team work with other specialties to gain ultimate functional outcomes.

We recently carried a retrospective analysis of all cases referred to plastic and reconstructive surgery unit in Adan hospital during 4 years. We reported the cases of traumatic lower limb reconstruction done in Adan Hospital. We described the different modalities used with the corresponding statistics. We also delineated the new services offered by our growing plastic and reconstructive surgery unit.

Keywords: Trauma; Lower Limb Reconstruction; Road Traffic Accident; Kuwait

Introduction

Kuwait is a relatively small country in Western Asia, with total land area of 17,820 km² (6,880 sq. miles). The current population of Kuwait is 4,175,592, which is equivalent to 0.05% of the total world population [1]. According to the World Bank, the country has the fourth highest per capita income in the world [2]. The median age in Kuwait is currently 29 years [1]; as a result, most of the population is composed of children and young adults.

Adan Hospital is the biggest general governmental hospitals in Kuwait with total of 982-bed capacity [3]. The current expansions will increase the total bed capacity in the future to 1775 [4]. It serves a population of 1.9 million (that is about 46% Kuwait total population). Plastic and reconstructive unit in Adan hospital was established from zero in 2014 by one consultant. Other plastic and reconstructive surgeons were recruited slowly after year 2015. Since establishment, the unit is taking care of all the referrals from different hospital departments.

A car accident happens every 10 minutes in Kuwait [5]. Kuwait is known for its advanced highways and abundance of high-speed sport cars. In 2017, 71,582 accidents have occurred with accident deaths in 2017 were 429 deaths [5]. Money spent by Kuwait to deal with accidents represents around 6% of its annual gross domestic product [6].

Management of the mangled lower extremity requires multi-disciplinary team consisting of trauma, vascular, orthopedic and plastic surgeons. High-energy leg injuries are usually associated with other life-threatening injuries. Priority is given to the victim life in cases of amputated and crushed extremities.

Aim of the Study

The aim of this paper is to describe the different methods of soft tissue reconstruction used by plastic and reconstructive surgery unit in Adan hospital with simple corresponding data.

Methods

A retrospective analysis of all cases of lower limb trauma admitted to Adan hospital from 2014 to end of 2017. All cases that were consulted and evaluated by plastic and reconstructive surgery unit were retrieved. We developed our own protocol in dealing with the cases of traumatic lower limb, which is a modified version of protocol published by Mikki [7]. We used this modified protocol in our daily practice to manage traumatic lower limb defects (Chart 1). In cases of emergent accident (in the first 24 hours), where vascular injury has been repaired, we usually temporary cover the repaired vessel with local tissues. Then we assess after 7 days the wound status and if there is a need for permanent coverage. In urgent case scenarios, where there is serious structure exposed within 2 - 7 days, we usually temporary cover the exposed structure with local tissues. Then we assess after 7 days the wound status and if there is a need for permanent coverage. However, in late cases (7 - 21 days) where the case was either delayed in referral; unstable patient general condition; or unfavorable wound bed, repeated debridement with or without Negative Pressure Wound Therapy (NPWT), the patient will be covered by any ways of soft tissue coverage described below. Once the facilities for reconstructive microsurgery were completed, we started free tissue transfer as a coverage option.

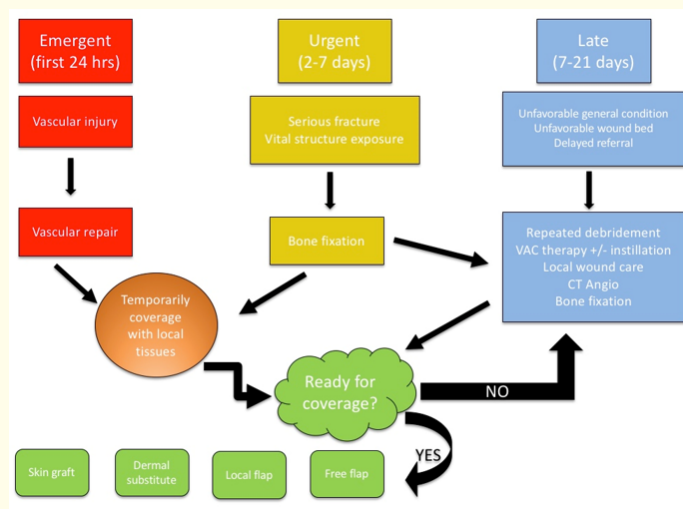


Chart 1: Our modified protocol for the coverage of traumatic lower limb raw areas.

Surgical techniques

In coverage plan, we adopted the principle of the new reconstructive ladder modified by Janis., et al [8]. Starting from the simplest option in the form of direct closure till coverage with free flaps (Chart 2).

Primary closure

Whether primary or delayed primary closure according to the wound status and whether presence of tension or edema that prevents its immediate closure. Figure 1 shows closure of fasciotomy wound using adhesive ABRA® closure system that was able to close the wound in one week only after the initial trauma.

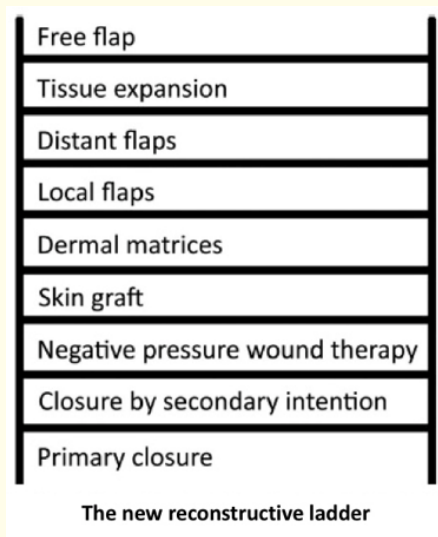


Chart 2: the new reconstructive ladder modified by Janis., et al.



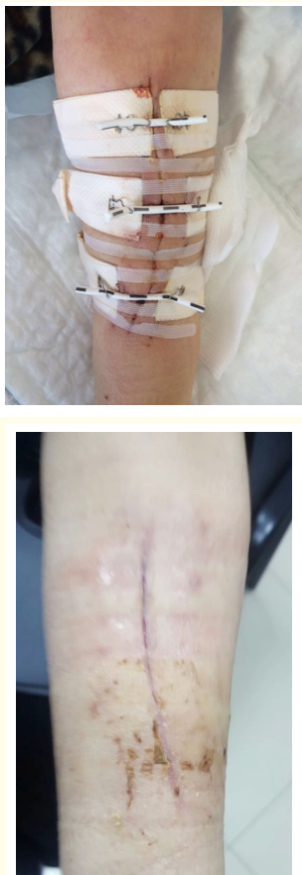


Figure 1: Application of ABRA® adhesive system in a case of fasciotomy.

Closure by Secondary intension

To leave the wound open and allow spontaneous healing by combination of granulation and epithelization. This method is best used when the traumatic raw area is relatively small or contaminated.

Negative pressure wound therapy (NPWT)

Is a therapeutic technique using a vacuum dressing, whether it is used in simple suction or with instillation, the main purpose is to promote healing and increase healthy granulation in order to definite wound coverage.

Skin grafts

Either Split-thickness skin grafts (STSG) or Full-thickness skin grafts (FTSG) are used on healthy granulating wounds or over muscle flaps. Post-operative use of NPWT is routine practice for all cases.

Dermal substitute

Many types of dermal substitutes are available in the market. However, we had used only two types, Integra® and Matriderm®. Figure 2 and 3 shows two examples of the most common and available dermal substitute in Adan hospital.

2a



2b



2c



Figure 2: (a and b) Traumatic deep raw area at the lateral side of the leg and popliteal fossa. (c) coverage Matriderm® and STSG in one stage.

3a



3b



3c



Figure 3: (a) De-Gloved wound at dorsum of the foot. (b) Stage one coverage by INTEGRA® Dermal Regeneration Template, (c) Second stage after 3 weeks by STSG.

Local flaps

Fasciocutaneous flaps or muscle flaps are routinely used as a horseshoe coverage method. Flaps can be based on a proximal or distal blood supply. The flap is advanced, rotated, or transposed into the defect. Table 1 shows the most common local and regional flaps used in our unit for reconstruction of traumatic lower limb injuries [9]. Figure 4-7 shows some examples of local flaps used in our cases in Adan Hospital.



Figure 4: Rotational flap used to cover wound at lower third of tibia with exposed tibial bone.



Figure 5: Transposition flap.



Figure 6: Delayed reverse sural flap to cover traumatic raw area at the ankle with exposed calcaneus bone.



Figure 7: A case showing combination of coverage with medial Gastrocnemius muscle flap to cover the exposed tibial bone below the knee and Integra® over the knee and STSG.

Flap	Blood supply	Indication
Bipedicle Fasciocutaneous Flap	Random	Small wounds lower leg
Gastrocnemius Muscle Flap	Sural artery	Defect in knee and proximal third of tibia
Soleus Muscle Flap	Posterior tibial and peroneal artery	Defect in middle third of tibia
Reverse Sural Artery Flap	Peroneal artery perforators	Defects of ankle, heel, dorsum of foot
Medial Planter Artery Flap	Medial planter artery	Heel and medial ankle defects
Dorsalis Pedis Flap	Dorsalis pedis artery	Lateral and medial ankle defects

Table 1: The most common local flaps used.

Propeller (perforator) flap

Perforator flaps, which was first described by Koshima and Soeda [10], supported by perforasome theory introduced by Saint-Cyr, *et al.* [11], were used in few cases. Examples of commonly used perforator flaps are Dorsal Perforator Metatarsal Artery Propeller Flap, anterior tibial artery perforator flap, and peroneal artery perforator flap.

Free flaps

When there is significant soft-tissue loss in the lower extremity with exposed bone, hardware, or tendon (Gustilo Grade 3B/C injuries) [12]. Proper pre-operative physical exam and angiogram were done preoperatively to assess blood supply and to determine where we will connect the flap vessels to for blood flow [13]. Most common free flap used are summarized in table 2 [9]. Figure 8 shows one of our free flaps.

Flap	Flap type	Arterial supply
Rectus Abdominis Flap	Muscle flap from the abdomen	Deep inferior epigastric artery
Latissimus Dorsi Flap	Muscle from the back	Thoracodorsal artery
Anterolateral Thigh Flap	Skin and fascia from thigh	Descending branch lateral femoral circumflex artery
Radial Forearm Flap	Skin and fascia from forearm	Radial artery

Table 2: Most commonly used free flaps.

8a



8b



8c



8d



Figure 8: Traumatic de-gloved wound involving medial ankle of the left foot (a) that was successfully reconstructed with muscle free flap (b) and STSG. (c) 6 months follow up and (d) one year follow up.

Results

A total of 1943 cases of post road traffic accident affecting lower limb were admitted to Adan hospital during the 4 years. Four hundred ninety-two cases were evaluated by plastic and reconstructive surgery unit team. Of those, 354 (72%) cases were operated by one of the previously described methods of reconstruction.

Cases were operated as follows: 215 (61%) cases covered with skin graft, 57 (16%) cases covered with local flap, 78 (22%) cases covered with dermal substitute (Integra® and Matriderm®), and 4 (1%) cases covered with free flap (Table 3).

Year	2014	2015	2016	2017	Total
Lower limb trauma	92	96	140	164	492
Skin graft	61	59	52	43	215
Dermal substitute (Integra/Matriderm)	17 (17/0)	12 (6/6)	27 (15/7)	22 (12/10)	78 (50/28)
Local flap	11	16	18	12	57
Free flap	NA	NA	NA	4	4
Total	89	87	97	81	354

Table 3: Total cases of trauma consulted and type of coverage by years.

We had 2 cases of failure (0.5%). The first case happened in the Early 2014. A case of crush foot, external fixator was applied by orthopedics, repair of posterior tibial artery was done by vascular surgeon. Immediate coverage of repaired vessel with local muscle flap was done. Patient stayed for 3 weeks in intensive care unit for other concomitant injuries. Unfortunately, he had non-union of fractures, infected and unstable ankle joint with insensate planter aspect (non-functional foot). Below knee amputation was done by orthopedics although viable flap. Second case of crushed foot, with exposed extensor tendons. We used island sural flap coverage that had venous ischemia. We carried debridement for the gangrenous skin and immediate coverage with Matriderm® and Split-thickness skin graft (Figure 9).

9a



9b



9c



9d



9e



Figure 9: (a) Original raw area with exposed extensor tendons of the foot. (b) Skin venous gangrene of island sural flap. (c) Status post debridement. (d) One week after coverage by Matriderm® and STSG. (e) One year later.

Discussion

Kuwait is situated in the northern edge of Eastern Arabia at the tip of the Persian Gulf and shares borders with Iraq and Saudi Arabia. Kuwait ranks number 129 in the list of countries (and dependencies) by population [1]. Since Kuwait is one of the rich countries, luxurious and high-speed sports cars are very common.

Adan Hospital serves more than half of Kuwait population especially during weekends and holiday seasons due to its proximity to camping areas and many huge sea resorts. Many advanced highway roads surround the hospital with travel roads from Saudi Arabia. High speed collisions are very frequent. Six car accidents happen every hour in Kuwait and carries 0.6% fatality rate [5]. Crossing red lights, excessive speed and the use of mobiles topped the causes of the accidents that occurred in 2017 [5]. Road traffic accidents are the second cause of death after cerebral vascular disease since 2005 (Chart 3). That is why we call it “STREET WAR IN KUWAIT” [6].

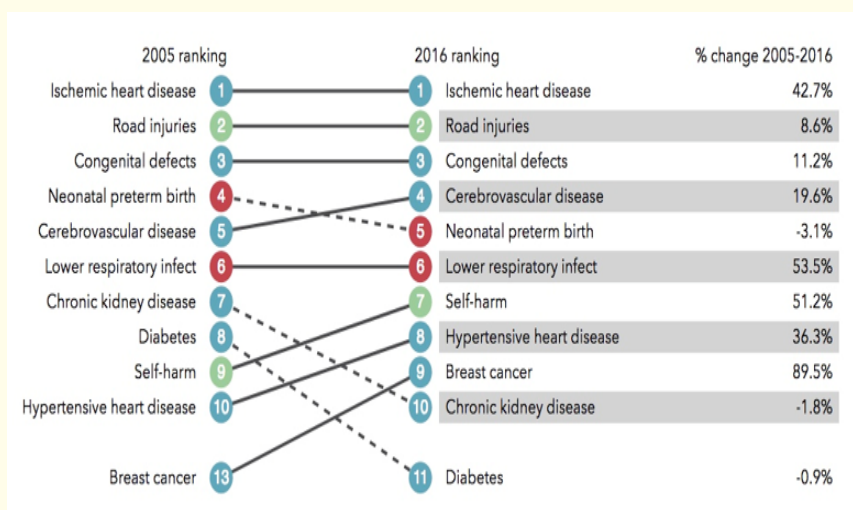


Chart 3: Causes of death in Kuwait, adapted from Kuwait | Institute for Health Metrics and Evaluation. www.healthdata.org/kuwait.

As a basic rule of LIVE vs LIMB, we do proceed with amputation of a mangled extremity in a clinically unstable patient. The same concept of Macedo., *et al* [14]. After patient stabilization, the following questions are raised: Does the extremity require revascularization? Does the soft-tissue defect treatable with local or free tissue transfer? Is any bone loss reconstructible? Is there nerve injury and is this repairable or does the nerve injury preclude a functional limb? [9].

Reconstruction of Soft Tissue Defects will be carried on only after vascular injury has been addressed and repaired by vascular surgeon, bony fixation has been accomplished by orthopedics, and all contaminated and devitalized tissue is debrided.

Early soft-tissue coverage is associated with a lower complication rate. Byrd., *et al.* [15] found that the overall complication rate of wounds closed within the first week of injury was 18% compared to a 50% complication rate for wounds closed in the subacute phase of 1 to 6 weeks. Our goal is to close wounds within 7 to 10 days to decrease the risk of infection, osteomyelitis, nonunion, and further tissue loss.

Following the modified reconstructive ladder, where we start with the simplest method of reconstruction if the wound bed permits. Table 3 clearly shows that most of our cases (61%) were covered simply with skin grafts, while 16% of cases were covered successfully with local flap and 22% of cases covered with dermal substitute (Integra® and Matriderm®). As our microscope arrived the hospital in early

2017, no cases of free flaps were performed in the first three years. As a result, only 1% of cases were covered with free flap in the whole years, all of which were done from mid of 2017 onwards (Table 3).

When we analyzed the type of reconstruction by year (Chart 4), we noticed that more complex reconstructive methods were applied as years progressed. The logical explanation is as time progressed, we progressed. We gain more experience and confidence using more complex reconstructive methods, hence more local and distant flaps were performed in the last two years. In addition, more advanced technology, in the form of advanced wound care products and equipment, was available to our facilities in the last year. More cases of free flaps and dermal substitute were used in the last year.

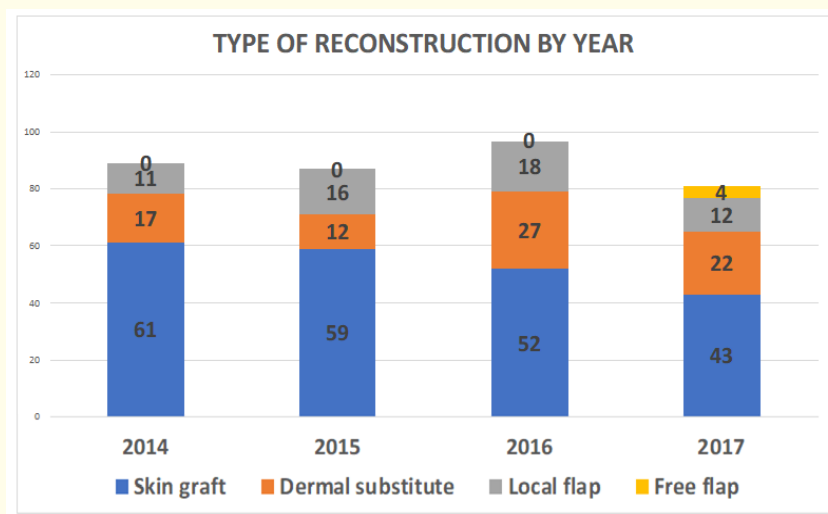


Chart 4: Type of reconstruction by year.

Conclusions

Adan hospital is the biggest hospital in Kuwait with the highest number of trauma. Plastic and reconstructive surgery unit in Adan evaluated a total of 492 post traumatic lower limb defects in 4 years. Seventy two percent of the cases needed surgical reconstruction in different forms (61% skin graft, 16% local flap, 22% dermal substitute and 1% free flap). Almost all patients were reconstructed successfully, with negligible failure rate. The introduction of plastic and reconstruction unit in Adan Hospital lead to a dramatic improvement in upgrade of positive patient health care not only in Adan hospital, but also in Kuwait.

Conflict of Interest

None.

Funding

None.

Ethical Approval

This study complied with the guidelines of the local ethics committee and was approved by all participating.

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