

ZRÍNYI MIKLÓS
NEMZETVÉDELMI EGYETEM
Doktori Tanács

LTC Dr. Várhelyi Levente

Surgical Treatment Of Blast Injuries

Author's Summary Of PhD Dissertation

BUDAPEST
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Course Leader:

MG Prof. Dr. Farkas József +, DSc
LTC Dr. Koródi Gyula, PhD

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1. The scientific problem

Nowadays, the importance and number of blast injuries, due to local war conflicts and terrorism is increasing. Since WW2 in Europe there have not been wide wars but at local revolutions, civil wars and ethnic conflicts many blast injured were reported, last time in Bosnia or Kosovo. The main source of blast injuries is the mass of landmines which may cause deaths and injuries decades after war.

In Europe, the international terrorism is the major source of danger by bombings as Madrid train and London subway bombings.

Worldwide, explosive events occur in high number in Afghanistan and Iraq where IEDs and suicide bombers explode many kinds of explosives.

In Hungary, the number of injuries from explosives is low (petards at New Year's Eve and military accidents). The EODs of the Hungarian Defence Forces regularly found explosive devices from WW2. At voluminous building and subway constructions a number of these devices is expected to appear. Therefore the EOD personnel has a high risk for blast injuries.

Factorial explosives are rare due to the hardly decreased industrial activity.

Terrorism is not a risk at the moment but the NATO-member Hungary may be targetted by terrorists in the near future. The whole Hungarian health care system has to have continous capability for treatment blast injuries.

The Hungarian peacekeeping troup (KFOR, ISAF etc.) may also be targetted by explosive attacks. Using personal protectives and armoured vehicles the combat troup are better protected from gunshots but terrorists and insurgents use explosive devices in high number to enlarge damages within a short time. Anyway, civilians are frightened when bombed by terrorists. The non-regular insurgent troup are not able to make wide military operations on scene so the bombing is the only way for fight.

The care of blast injuries which are always severe and multiple, needs teamwork. All trauma and emergency units must be always ready to care which interdisciplinary involves all surgical and ICU activities. The principles of care in war scenes and peacetime are different. The medical units of our troup must have the capabilities and readiness for care of blast injuries at any circumstances. For this, standardized principles and strategy of care needed. In the last 50 years in Hungary there are no papers published on care of blast injuries. In medical schools either the gradual or postgradual education panels have only short chapters on gunshot and blast injuries.

An actualized guideline needed which summarizes the literatural research data and additionally based on own combat experiences and contains unified principles of care. This gives the practical importance of choosing the main topics of this dissertation.

Research in the health care system of the Hungarian Defence Forces

The care of blast injuries is performed both in troup and hospital levels in HDF. In troup level, on scene, the main goal of treatment is the first aid and stabilization of vital parameters before evacuation (Role 1, MedEvac).

In homeland, the hospital care is performed after air or ground Ambulance Service transport in the former Central Military Hospital, now MoD State Health Center (SHC). This military profilled hospital gives the care with permanent capability to also civilians including all the blast injuries. Aftertreatment, rehabilitation and check of ability for service is also performed in SHC hospital level.

The scenes of care in SHC are the Emergency Unit, Department of Trauma, ICU and the OR Tract. The tasks are the stabilization of vital parameters, surgical interventions, ICU and inpatient care, aftertreatment and rehabilitation.

2. Targets of research

For creating a unified guideline for treatment of blast injuries the summarized literatural data and personal experiences and results on own cases are regarded. As a result by this process a surgical protocol is produced for use in Hungary.

The targets of research are the followings:

1. Showing the types of explosions and military explosive devices.
2. Presenting all effects of blasts on human body (mechanical and burn at the same time) and the types of blast injuries.
3. Damage control principles and use in practice in care of blast injuries.
4. Medical activity on scene and in hospital level in war circumstances and peacetime. Steps of care: primary anti-shock procedures and surgical care to penetrating injuries. Limb repair simultaneously or afterwards. Role of ICU treatment.
5. Tactical steps of care and surgical interventions based on practical experience on own cases.
6. According to these and my personal experiences setting up unified and standardized principles of care to blast injuries as practical activities and creating a guideline.
7. Medical education and training plans.

3. Methods of research

As a first step I made a study and research plan which realized later step by step. After analyzing sources I made consultations with represents of borderline disciplines (ICU-Anaest, general surgeons and, as military side, experts of explosives).

I have analyzed and am analyzing bibliographies and latest literatural sources by the internet.

I analyzed my foreign colleagues' experiences and results, I took part international conferences and had presentational talks and papers.

I searched all former documentations and case reports in the Central Military Hospital with a help from my collaegues.

I analyzed, documented and published my experiences on own cases on national and international conferences.

The main scene of research in peacetime was the Department of Trauma, State Health Center (former Central Military Hospital) which is permanently ready for definitive medical care and documentation. The number of these cases in Hungary is low so a higher number of cases I got on war scenes as a member of SFOR, KFOR and ISAF. As a senior surgeon of internatonal surgical teams at level Role 2+ I treated a number of blast cases from initial surgery to definitive and reconstructive operations. My experiences were summarized on scene.

I summarized my theoretical knowledge and experiences and created my dissertation.

4. The prescription of the scientific activity in chapters

The Index shows the structure of dissertation and steps of research.

In Chapter 1 I define my topics as it takes place in range of scientific disciplines and emergency and surgical care to the military and civilian systems. Targets and methods of research and use of results are also seen here.

In Chapter 2 a nomenclature, physics and types of blast are cleared. Types of explosives and explosive devices are presented.

In Chapter 3 I present the way of casualty care by own case reports which based my choose of topics.

Chapter 4 shows the effects of blast on human body (mechanical and heat) and their combinations. The types of blast injuries and pathogene effects of blast overpressure (barotrauma) and mechanical agents are also seen here.

Chapter 5 prescribes the principles of care of barotrauma and surgical treatment of mechanical injuries as damage control surgery.

In Chapter 6 I summarize my scientific activity, experience and it's conclusions by setting up my theses. Finally I give my recommendations for practical use and education.

Tables and figures are located either in texts or at the end of logical units. The list of foreign words and abbreviations, the appendix and the list of publications are seen in final part.

5. Summarized conclusions

I studied the international research data. I presented and published my experimental results on national and international conference talks and scientific papers.

During the treatment of blast injuries I searched and used the possible ways of surgical interventions, additional to ICU treatment.

In peacetime, between 1994 and 2009 I treated 7 civilian casualties from blast. During the same period I treated 6 military casualties with blast injury.

In war scene, between 2006 and 2010 on operational area I treated 21 casualties (both military and civilian) as a member of international trauma teams.

Having followed the principles of damage control, the major group of patients survived. In peacetime, I also performed reconstructive surgeries that I did in war scene when evacuation of some civilian patients was not possible. All these patients had an long term hospitalization and treatment. I analyzed also 15 fatalities.

6. New scientific results

1. I summarized own experiences of treatment of blast injuries first in Hungary.
2. I realized that the injuries of blast survived patients mainly caused by shrapnels as a secondary blast injury. It's life threatening manifestation is the penetrating injury. After realizing the mistakes of primary care it became clear that the investigation of penetrating injuries is essential.
3. After I analyzed the fatalities I realized that the sudden death on scene is caused by the primary blast overpressure injury. Common fatal manifestations were the cassequation of whole body and multiple amputations.
4. Working in shock room, OR and ICU I also realized that the early mortality at primary care is resulted from untreatable multiple penetrating shrapnel injuries and/or extensive burns.

5. According to 2-4 I point on that the way of treatment of blast survived patients is mainly surgical. The primary blast injury to the lungs was associated other fatal injuries.
6. I made a theoretical paper on mechanism and treatment of blast injuries based on international research data and my own experiences.
7. Based on my clinical activity and research, I created a protocol, first time in Hungarian.
8. The protocol was accepted and started using in practice in February 2010 by the Medical Command, ISAF RC North in Afghanistan.
9. As a member of international surgical teams I realized that the surgical treatment of blast patients is the most effective by pre-set trauma teams which have 1 general surgeon, 1 orthopaedic surgeon, 1 anesthesiologist, 1 anaesthetist technician, 1 or 2 nurses. One team provides care for one patient from the anti-shock procedures to surgical treatment.
10. The treatment of blast injuries is complex which needs multidisciplinary co-work (ER, trauma and orthopaedic surgeon, anaesthesiologist, general surgeon, vascular surgeon, neurosurgeon, urologist, radiologist, head-neck surgeon, burn specialist) with pre-planned order and sequences. The team leaders are the trauma surgeon and the anesthetist. The main manifestations of activity are both surgical procedures and ICU care. All trauma and emergency centers must be ready for the adequate treatment of blast injuries at any time. All staff members have to know the principles of care of blast injuries. I created an educational plan for this.

The protocol of treatment of blast injuries

Divided into two parts: prehospital and hospital care.

Praehospital care

1. Clear: site, form and magnitude of blast. What was the explosive ? When exploded ? Patient's distance to explosion and position of body. Open or enclosed scene ?
2. Secure the site and rescue providers (building collapse, fire, chemical agents, military actions).
3. Assess the number of casualties and quality of injuries. Primary triage on scene.
4. Technical rescue by firemen. EOD activity if danger of mines.
5. At individuals: airway control and respiration. Cardiac control. Resuscitation. Rewarming.
6. Monitoring, pulse oximetry. Respiratory insufficiency: intubation, respiration with no PEEP. Tension pneumothorax: detensioning. Chest tube.
7. Control of bleedings using a tourniquet if extremity conquassation or amputation seen. Local agents to wounds.
8. Analgesia, sedation.
9. Patient immobilization in vacuum-carrier until spine, pelvic and limb XR done. Use of stiff neck.
10. Cooling and covering of burned surfaces by Burn Pack. If not available, use pure water for cooling. Avoid heat loss using isolation foliae.
11. Peripheral iv. lines, fluid therapy. Intraosseal inflow if no iv. line available. Non-burn, non skull injured: permissive hypotension if blood pressure monitorable.
12. Sterile wound dressings. Immobilisation of fractures and dislocated joints.
13. Immobilisation of unexploded ordnances (UXOs). No electric devices used. Mobile phones off. Interrupt all metal and chemical contacts. Minimize rescuers' number.

Hospital care

The hospital care is provided by four phases which follows the Role 1-4 level care on war scenes. In peacetime all phases are provided in the same hospital.

Phase 1

1. Triage and re-triage.

2. Resuscitation.

Airway and circulation control.

3. Rewarming.

4. Monitoring, pulsoxymetry.

4.1. Respiratory insufficiency: Intubation/tracheostomy. Respiration with no PEEP

4.2. Pneumothorax: Chest tube.

5. Analgesia, sedation.

6. IV inflow.

Fluid therapy. 2 peripheral/1 central iv. line.

Non-burn, non skull injured: Possible permissive hypotension.

7. Diagnostic imaging procedures.

7.1. XR: Chest AP (blast lung), pelvic AP, cervical spine AP-LAT

7.2. Investigation for abdominal bleedings: Sonography to abdomen/laparocentesis.

7.3. Investigation fractures: Bilateral XRs.

7.4. CT (if available) trauma scan: skull, spine, chest, abdomen.

8. General.

Ear control for tympanic membrane rupture.

Lab tests. Blood units.

Wide spectrum antibiotics in therapeutic dosage (cefazolin 3x1 g). Tetanus prophylaxis.

LMWH.

9. Damage control (resuscitative) surgery. TASC: Tactical Abbreviated Surgical Care.

9.1. Abdominal injury: Laparotomy. Control of bleedings by shunts, ligatures and packing. Splenectomy, nephrectomy if indicated. Bowel resection. Open abdomen if abdominal compartment syndrome suspected.

9.2. Thoracic injury: Chest tube if peripheral with no bleeding. Thoracotomy if central with pulmonary and cardiac care by sutures. Lobectomy or atypical resection.

9.3. Intracranial bleeding: Burr holes/craniotomy. Impressed fragments: craniotomy.

9.4. Dislocated pelvic fractures: External fixation. Retroperitoneal packing if bleeding.

9.5. Fractures: Limb circulation reconstruction if possible. If not, amputation. External fixation of fractures. Intrafocal antibiotics. Urgent fasciotomy if compartment syndrome suspected. Drainage of all open joints. Casts.

9.6. Wound care: Extensive exploration and debridement. Removal of foreign bodies, if possible. Opened wound care. Use of VAC.

10. Burn care.

Escharotomy, necrectomy, fasciotomy. Airway burn: tracheostomy for elongated respiration.

11. ICU treatment.

Phase 2

1. ICU treatment

2. Second look (24-48 hours).

Abdominal control of bleedings. Definitive colostomy/sigmoideostomy.
Wound revisions. Change of VAC sponges in 2-4 days.
Necrectomy of burns.

Phase 3

Abdominal closure. Definitive osteosyntheses. Skin graftings.
Surgical treatment of septic complications.

Phase 4

Reconstructive surgeries: flaps, bone grafting. Treatment of non-unions.
Surgeries for increased range of motion of joints.
GI reconstruction.
Rehabilitation. Prosthetics.

Education Plan

Postgradual Education

The protocol postgradually wished to be educated on trainings for: trauma and general surgeons, orthopedists, neurosurgeons, vascular surgeons, anaesthesiologists, ICU and ER physicians. Let the candidates know the types of blasts and caused injuries and the methods of treatment according to damage control principles.

Military Medical Education

The protocol and the principles of treatment of blast injuries must be known and used by all military physicians, technicians and nurses.
Technicians and nurses must know the types of explosive devices and blasts and caused injuries. Ability to provide basic life saving procedures.
Physicians must do what mentioned above and provide all steps on each levels according to the protocol. Surgeons must be able to perform damage control surgery.

Military trainig

The basic principles of treatment of blast injuries must be a part of the training of all members of armed forces especially combat medics.
All combat personnel have to know the types of explosive devices and blasts and caused injuries. Basic life saving procedures.
Combat medics must do what mentioned above and resuscitation, iv. lines.

7. Theoretical and practical use of research and the dissertation

The main task of my research and dissertation is to give a summarized guideline in Hungarian based on international literatorial data and share my own experiences in treatment of blast injuries. The main goal is to set up unified and standardized principles for civilian and military health care providers in Hungary.

Results of reserach:

1. Unified lireatorial summary based on research data in Hungarian.
2. Recommendations for providing casualty care also for co-disciplines.
3. Protocol for both acute and reconstructive surgical interventions in treatment of blast injuries.
4. Integration of my research data and results of experience into the medical and postgradual trainings.
5. Increased knowledge of all military health care providers: troupe surgeons and physicians, technicians, nurses, combat medics. The quality of care reaches a higher level.

8. Recommendations

Based on international research data and my own practical experiences I recommend to use and educate this protocol in treatment of blast injuries in the MoD State Health Center and all Roles in military operatinal areas. Also for use in civilian hospitals and the National Ambulance Service. For the education, I recommend to use the Education Plan which may be internationally realized also in courses of the NATO Medical Center of Excellence.

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10. Curriculum vitae

Lieutenant colonel Levente Várhelyi, M.D. who is the leader of the Orthopaedic Section of the Ministry of Defence State Health Center, Budapest, Hungary, graduated his medical degree from Semmelweis Medical University, Budapest, Hungary in 1992. He joined the Hungarian Home Defence Forces in 1989 as a medical student. He have earned his certification in orthopaedics in 1997, traumatology in 1999 and hand surgery in 2001. He is been working at the Traumatology Department of Central Military Hospital in Budapest, Hungary since 1992. In 1990 and 1991 he has spent three months of a professional education at the Orthopaedic Department of Halland County Hospital in Halmstad, Sweden and in 1992 at the Traumatology Department of Milan City Hospital, Italy. In 1999 he spent a month in the Hand Surgery Department of the Chaim Sheba Medical Center, Israel. In 1998 he was serving in Bosnia as a member of SFOR and 2006-2007 in the German Field Hospital, Prizren, Kosovo of KFOR. He was serving in the German Field Hospital in Mazar e Sharif, Afghanistan as a member of ISAF from December 2008 to March 2009 and from December 2009 to March 2010.

He takes part in the medical and postgradual education of traumatology and military medicine in the Semmelweis Medical Univesity.

He speaks English and Italian. In 1989 he joined the Department of Pathophysiology of Hungarian Home Defence Forces Military Medical Research Center. He has 44 publications in radioprotection, military medicine, traumatology and orthopaedics. He was born in Budapest, Hungary in 1968. He lives there since that time.