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An Integrated Approach in Reconstructive Surgery for Complications of Multisystem Trauma

A.S. Zelyanin[1, 2, 3], V.V. Filippov[2], K.A. Petrosyan[1], D.I. Kelban[4*], D.A. Zelyanin[5]

1 Department of emergency traumatology of the musculoskeletal system

I.M. Sechenov First Moscow State Medical University of the Ministry of Health of Russian Federation, University Clinical Hospital No. 1

6 b. 1 B. Pirogovskaya St., Moscow 119435, Russian Federation

2 Moscow State University named after M.V. Lomonosov

1 Leninskie gory, Moscow 119191, Russian Federation

3 Russian Scientific Center for Surgery named after acad. B.V. Petrovsky

2 Abrikosovskiy per., Moscow 119991, Russian Federation

4 N.V. Sklifosovsky Research Institute for Emergency Medicine of the Moscow Healthcare Department

3 Bolshaya Sukharevskaya Square, Moscow 129090, Russian Federation

5 City Clinical Hospital No. 29 named after N.E. Bauman

2 Gospitalnaya Sq., Moscow 111020, Russian Federation

*** Contacts:** Dumitru I. Kelban, doctor of the department of emergency traumatology of the musculoskeletal system, N.V. Sklifosovsky Research Institute for Emergency Medicine.
Email: kelban.dmitrij@yandex.ru

SUMMARY A clinical observation of an integrated approach to surgical reconstruction of multisystem trauma complications is presented. A patient came to the Department of Reconstructive Surgery with the complication of a multisystem injury as a result of a fall on the way at the metro station 6 months before his visit. An individual treatment plan was developed based on the characteristics of anatomical and functional disorders and pathological tissue changes. As a result of staged surgical treatment, functional rehabilitation of the patient the restoration of the function of the upper and lower extremities and a stable remission of osteomyelitis were achieved. The observation period was 11 years.

Keywords: consequences, complications of injuries, reconstructive surgery, osteomyelitis, microsurgical tissue transplantation, ligament damage, tendon damage

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Affiliations

Aleksander S. Zelyanin	Doctor of Medical Sciences, Professor of the Department of Oncology, Radiotherapy and Plastic Surgery of the I.M. Sechenov First Moscow State Medical University; Professor of the Department of General and Specialized Surgery, Moscow State University. M.V. Lomonosov; professor of the Russian Scientific Center for Surgery named after acad. B.V. Petrovsky; microsurgery@inbox.ru; 30%: development of the concept of the article, writing the text of the manuscript, conducting operations
Vladislav V. Filippov	Doctor of Medical Sciences, Head of the Department of the Moscow State University M.V. Lomonosov; vfil@mail.ru; 25%: development of the concept of the article, writing the text of the manuscript, conducting operations
Karen A. Petrosyan	doctoral student of the Department of Oncology, Radiotherapy and Plastic Surgery of the Federal State Autonomous Educational Institution of Higher Education I.M. Sechenov First Moscow State Medical University; dr-petrosyan@yandex.ru; 20%: analysis of the obtained data, literature review, assistance in operations
Dumitru I. Kelban	Doctor of the Department of Emergency Traumatology of the Musculoskeletal System, N.V. Sklifosovsky Research Institute for Emergency Medicine; https://orcid.org/0000-0001-7561-8209, kelban.dmitrij@yandex.ru; 15%: analysis of the data obtained, literature review, writing the text of the manuscript, remote observation of the patient
Dmitry A. Zelyanin	Doctor of the Department of Surgery of the Upper Extremity of the State Clinical Hospital No. 29 named after N.E. Bauman; zelyanindmitry@gmail.com; 10%: analysis of the data obtained, review of the literature, writing the text of the manuscript

INTRODUCTION

At the beginning of the XXI century injuries are still relevant. The problem of injuries is determined by their prevalence, medico-social and economic significance [1–3]. The high degree of disability of victims (up to 25–45%) gives particular social significance to the problem of injuries [4, 5]. In the structure of injuries, a special place is occupied by combined trauma, which is currently one of the three main causes of mortality in the population [5–7].

Combined trauma is a distress of large modern cities and large industrial centers [9]. Constantly developing technologies and new engineering communications, in addition to positive effects, have a number of disadvantages. The Metro is one of the miraculous structures that has managed to radically change the process of urbanization. The global organization, CoMETandNova, which provides a comparative analysis of railway traffic injuries in different countries of the world, provides statistics on the number of serious injuries in the subways of different cities.

For example, according to 2013, the most traumatic metro is the metro in New York and Madrid, with the number of injured 2,617 and 1,082 people, respectively. Least of all cases of injuries were registered in Moscow in 2013 - 15 people. At the same time, the Moscow metro ranks second in the world in terms of the number of passengers transported per year. These statistics are given here as an example not to discuss transport safety in different countries, but to remind everybody that the metro is often a place where concomitant injuries are received. Passengers often sustain serious concomitant injuries while on the platform, hitting a train carriage, or falling onto railroad tracks.

It is customary to distinguish three main factors that affect the final result of the aid provided to victims with concomitant injury: the severity of the injuries received by the patient, the state of the victim's body before the injury and the effectiveness of medical measures [8]. The main goal is the primary detection of critical injuries and saving live. In this case, treatment for non-life-threatening injuries is sometimes done after the patient has stabilized [9–14].

Purpose: to present an algorithm and analysis of the results of complex staged treatment of a patient with the consequences of concomitant trauma.

Clinical observation

A patient came to the Department of reconstructive surgery with the complication of a multisystem injury as a result of a fall on the way at the metro station 6 months before his visit. First aid was provided urgently. По данным выписки, больной получил политравму (ISS>15): closed craniocerebral injury, multiple closed rib fractures, traction injury to the left brachial plexus without compromising anatomical integrity, but with impaired sensitivity and movement, axillary artery thrombosis on the left, anterior dislocation of the left shoulder, soft tissue defect in the rear of the left hand, defect in the extensor tendons of the 2nd to 5th fingers of the left hand, open wound of the right knee joint, soft tissue defect on the inner surface of the right knee joint with damage to the internal lateral ligament, patellar dislocation. Details of primary care remained unclear. Defects of soft tissues of the back of the left hand and the inner surface of the right knee joint were covered with split autodermal flaps. During the treatment, there was a positive trend in the beginning of the restoration of sensitivity and movements in the left upper limb.

An objective examination at the time of contacting our unit revealed: active and passive movements in the left shoulder joint are limited. Old dislocation of the left shoulder. Cicatricial defect of the soft tissues of the back of the left hand with soldered to the 2nd to 5th metacarpal bones, previously transplanted with an autodermal flap (Fig. 1, 2).

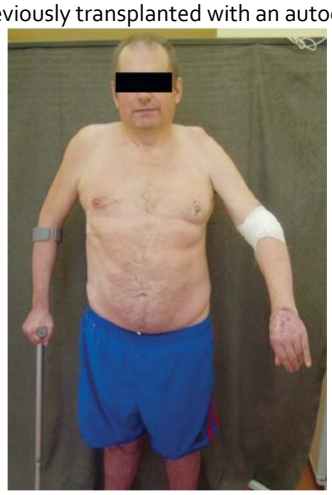

Fig. 1. Appearance of the patient

Fig. 2. View of the back of the left hand. Cicatricial defect of soft tissues

There is no active extension of the fingers of the left hand. The strength of the flexors and extensors of the left upper limb is reduced. Open wound of the cavity of the right knee joint in the center of a previously transplanted autodermal flap along the inner surface. Internal lateral instability of the right knee joint. In the wound, the articular surfaces of the femur and tibia with usurized areas of cartilage and bone tissue, fragments of the internal meniscus, Gough's fatty body, anterior cruciate ligament are visualized (Fig. 3 A, B). Right patella in the position of external dislocation. On follow-up examination, antero-inferior dislocation of the left shoulder was confirmed (Fig. 4).

Fig. 3. View of the right knee joint (A); open wound of the right knee joint cavity (B)

Fig. 4. X-ray of the left shoulder joint

Blood supply to the left upper limb is compensated, collateral. Left axillary artery is occluded. According to the data of electroneuromyography (ENMG) of the left upper limb, signs of damage to the motor fibers of the posterior scapular, suprascapular and axillary nerves in the form of a pronounced polyphasic response of a decrease in the amplitude at normal speed indicators were revealed. There are no impulse conduction blocks. The speed indicators of the propagation of excitation along the motor fibers, as well as the amplitude of the action potential of the remaining muscles of the left upper limb, studied at standard points, correspond to the norm. The picture corresponded to traction plexopathy. The data of the ENMG study of the conduction of excitation along the sensory fibers of the left upper limb at all levels corresponded to the norm. According to computed tomography of the right knee joint, focal destruction of the internal condyles of the femur and tibia was revealed (Fig. 5).

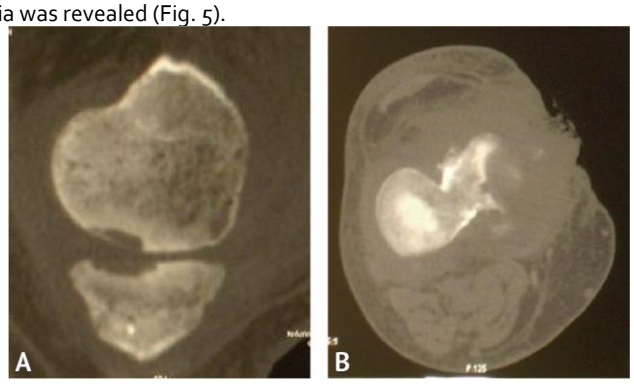

Fig. 5. Computed tomography of the right knee joint. A - slice in a sagittal projection; B - slice in transverse projection

According to the data of three-phase radioisotope scintigraphy, the focus of hyper-accumulation of the radiopharmaceutical in the bone phase is determined by more than 340% compared to the contralateral lower limb (Fig. 6).

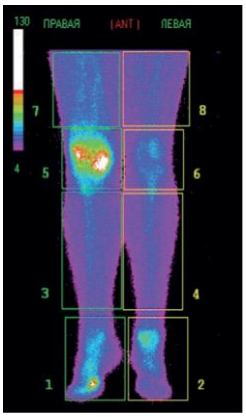

Fig. 6. The focus of hyper-accumulation of the radiopharmaceutical in the area of the epiphyses of the femur and tibia on the right

Considering the multitasking of the treatment, the first step was to perform the debridement of the right knee joint in conditions of purulent arthritis, chronic osteomyelitis of the epimetaphysis of the femur and tibia.

During the operation, a radical resection of the affected areas of the condyles of the femur and tibia, installation of flow-lavage drains, elimination of a soft tissue defect with a free revascularized musculocutaneous thoracodorsal complex of tissues was performed. The muscular portion of the revascularized tissue complex was placed on the bone wound of the condyles in the area of the resection was performed (Fig. 7, 8).

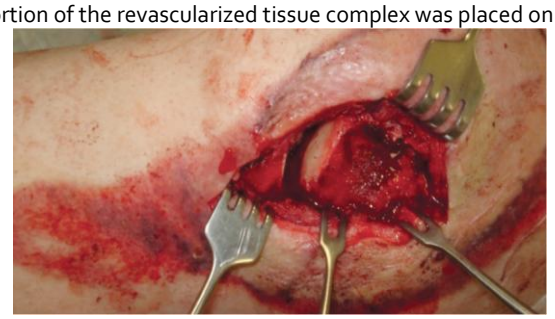

Fig. 7. View of wound defect after removal of the affected tissue in the area of the right knee joint

Fig. 8. The defect of soft tissues was covered by a revascularized musculocutaneous autograft under conditions of washing and rinsing drainage

Irrigation with antiseptic preparations carried out through the flow-lavage system installed in the cavity of the infected knee joint for 3 weeks. The postoperative period was uneventful. Thoracodorsal autotransplantat engrafted. Rehabilitation of the osteomyelitis focus has been achieved. The patient was activated with an orthosis on the right lower limb.

Four weeks after the first operation, it was decided to correct the dislocation of the left shoulder and close the defect in the back of the left hand with an inguinal flap. Taking into account the age of the injury and the sharply reduced tone and strength of the muscles of the left upper limb, the elimination of the dislocation of the left shoulder was carried out with an open approach, with the performance of lavsanosuspension (Fig. 9).

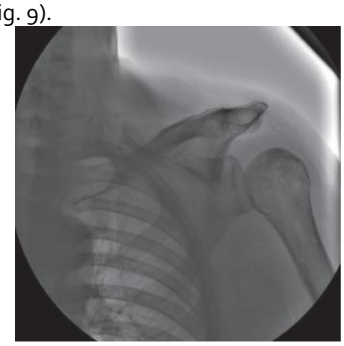

Fig. 9. X-ray of the left shoulder joint after elimination of dislocation and lavsanosuspension

The defect in the dorsum of the left hand is covered with a non-free vascularized inguinal flap due to collateral blood supply to the left upper limb (Fig. 10, 11).

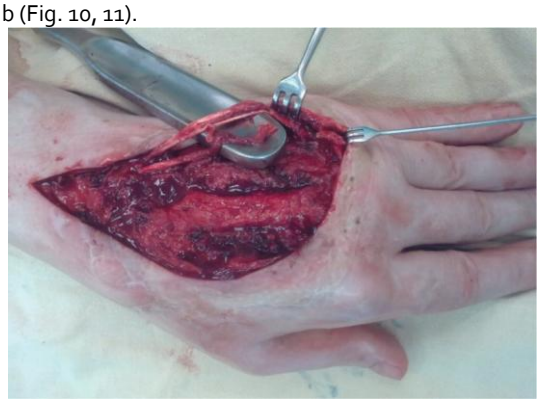

Fig. 10. Soft tissue defect on the dorsum of the left hand. Defect of the extensor tendons of the 2nd to 5th fingers. 5th toe extensor tendon stump

Fig. 11. The defect of the dorsum of the left hand is covered with a non-free vascularized inguinal flap

Cutting off the feeding pedicle of the inguinal flap was made after 4 weeks under conditions of the performed flap training with dosed clamping of the feeding pedicle and increasing exposure for 10 days. The course of the postoperative period without complications. The extensor tendon defects were eliminated 3 months after the closure of the defect on the dorsum of the left hand by performing auto tendon plasty. Auto-tendon grafts of the extensor longus of the 2nd toe were taken from both feet.

During the year, the patient underwent rehabilitation treatment and was under our supervision. Neurological disorders of the sensitivity and motility in the left upper limb regressed. Achieved full volume of extension of the fingers of the left hand (Fig. 12, 13).

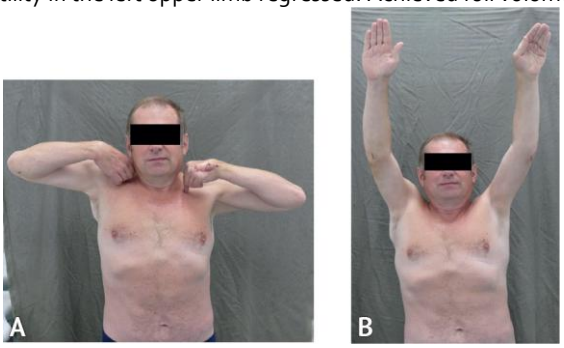

Fig. 12. Range of motion in the joints of the upper extremities: A — 90° abduction; B — abduction 180°

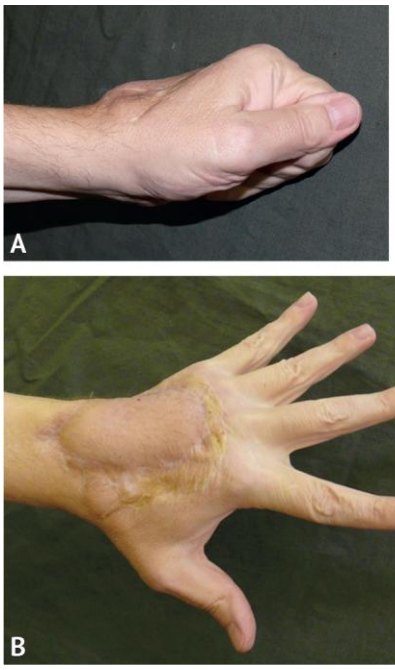

Fig. 13. The volume of flexion (A) / extension (B) of the fingers of the left hand

The external subluxation of the patella and instability of the right knee joint are preserved due to the defect of the patella retainer and the internal lateral ligament. Stable remission of the osteomyelitis focus has been achieved. Plastic surgery of the internal lateral ligament was performed with a fragment of the fascia lata of the thigh, which is located in the thickness of the muscle of the revascularized thoracodorsal autograft (Fig. 14).

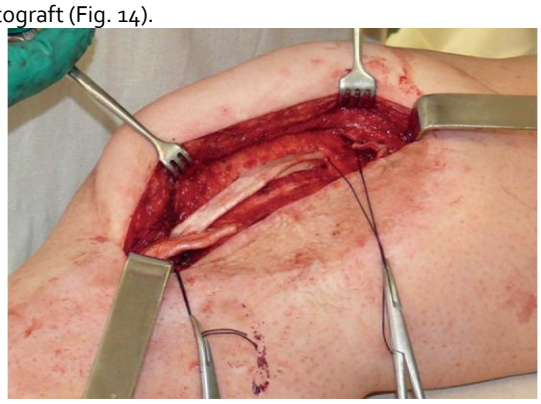

Fig. 14. Plastic surgery of the internal lateral ligament was performed with a fragment of the fascia lata of the thigh, which is located in the thickness of the muscle of the revascularized thoracodorsal autograft

Stabilization of the patella was performed according to Friedland with dissection of the capsule of the knee joint outside the patella and fixation of the rectus femoris muscle to the sartorius and vastus internal muscles.

After the rehabilitation treatment, the patient returned to professional work - he works as a teacher.

The patient was observing for 11 years. Muscle strength of the left upper limb and range of motion are comparable to that of the right. The range of motion in the right knee joint is full (Fig. 15).

Fig. 15. Range of motion in the right knee joint 10 years after surgery: A — extension; B — flexion

The stability of the ligamentous apparatus is preserved. Functional test for the consistency of the medial patella retainer positive.

According to the data of MRI of the right knee joint, post-traumatic gonarthrosis of the 2-3rd degree with areas of focal destruction of cartilage, the state after total resection of the internal meniscus, resection of the condyles of the femur and tibia is noted. During the observation period, there was a slight increase in the area of focal cartilage defects (Fig. 16).

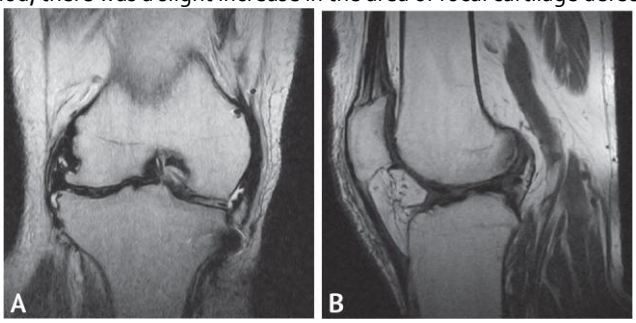

Fig. 16. Magnetic resonance imaging of the right knee joint 9 years after the operation: A — frontal plane slice; B — sagittal plane slice

DISCUSSION

According to statistics, in 35% of patients with concomitant trauma after their entering to a specialized medical institutions one or more new diagnoses are identified additionally. In 33% of cases, such patients with the consequences of concomitant trauma require surgical treatment [15].

Formation of ideas about the complex of pathological anatomical and functional disorders directly affects the definition of treatment tactics. The priority task in the treatment of the presented patient was to restore the function of the affected upper limb. At the same time, the patient had a focus of chronic purulent infection in the form of chronic septic gonitis on the right, chronic osteomyelitis of the internal condyles of the femur and tibia. The presence of a chronic purulent infection required the rehabilitation of its focus to continue the treatment of the patient in "clean" conditions. During the first operation, according to the generally accepted principles of treatment of patients with chronic osteomyelitis, radical resection of the affected areas of bone tissue, flow-washing drainage and covering of the bone wound with full-fledged tissues with good blood supply were performed [16]. Muscle tissue is known to be beneficial for tamponade of the osteomyelitis cavity [16]. In this regard, a revascularized musculocutaneous thoracodorsal autograft was used as a plastic material. Further observation showed the achievement of a stable remission of the osteomyelitis process.

In "clean" conditions, it became possible to start solving a priority treatment task aimed at restoring the function of the left upper limb. Taking into account the insufficient tone and strength of the muscles of the left upper extremity against the background of positive dynamics of regression of neurological disorders and with a favorable prognosis of recovery of motor skills (data of electroneiromyography), it was decided to perform myocardial suspension of the shoulder with the reduction of chronic dislocationa.

Restoration of the extension function of the 2nd to 5th fingers of the left hand required the preliminary elimination of the scar defect of the soft tissues using a vascularized complex of tissues. Changes in the main blood supply in the left upper extremity after the transferred axillary artery thrombosis excluded the possibility of free transplantation of a microsurgical complex of tissues. An inguinal skin and fat flap with axial blood flow on the feeding pedicle was used as a plastic material. Restoration of a full-fledged skin with underlying fatty tissue on the dorsum of the left hand made it possible to restore the integrity of the extensor tendons of the 2nd to 5th digits by performing autotendinous plasty.

Further regression of neurological disorders, restoration of muscle strength and tone, restoration of range of motion in the shoulder joint allowed achieving functional rehabilitation of the affected upper limb.

Restoration of the internal lateral ligament of the right knee joint with its location in the thickness of the muscle portion of the thoracodorsal autograft, elimination of chronic patellar dislocation made it possible to achieve a long-term positive functional result.

CONCLUSION

The presented clinical observation testifies to the complexity and versatility of determining tactics and choosing methods of surgical treatment for a patient with the consequences of severe concomitant trauma.

The formation of the algorithm for surgical rehabilitation was based on the individual characteristics of anatomical and functional disorders of both the upper and lower extremities. A comprehensive individual approach made it possible to achieve functional social, household and professional rehabilitation, which is confirmed by the analysis of early and long-term results.

REFERENCES

1. Eryukhin IA. Ekstremal'noe sostoyanie organizma v khirurgii povrezhdeniy. Teoreticheskaya kontseptsiya i prakticheskie voprosy problemy. *Medical Academic Journal*. 2002;2(3):25–41. (In Russ.)
2. Salakhov ER, Kakorina EP. Traumas and Poisenings in Russia and Abroad. *Problems of Social Hygiene, Public Health and History of Medicine, Russian Journal.* 2004;2:13–20. (In Russ.)
3. Scaela T, Rodriguez A, Chiu WC, Brenneman FD, Fallon WF Jr, Kato K, McKenney, MG, et al. Focused assessment with sonography for trauma (FAST): Result from an International Consensus Conference. *J Trauma*. 1999;46(3):466–472. PMID: 10088853. https://doi.org/10.1097/00005373-199903000-00022
4. Agadzhanyan VV, Pronskikh AA, Ust'yantseva IM, Agalaryan AKh, Kravtsov SA, Krylov YuM, et al. *Politravma*. Novosibirsk: Nauka Publ.; 2003. (In Russ.)
5. Sokolov VA. *Mnozhestvennye i sochetannye travmy*. Moscow: GEOTAR-Media Publ.; 2006. (In Russ.)
6. Ankin LN. *Politravma (organizatsionnye, takticheskie i metodologicheskie problemy).* Moscow: MEDpress-inform Publ.; 2004.
7. Bagnenko SF, Ermolov AS, Stozharov VV, Chikin AE. Osnovnye printsipy diagnostiki i lecheniya tyazheloy sochetannoy travmy. Emergency Medical Care. 2008.3:3–10. (In Russ.)
8. Ivanov PA. Problems of Treatment of Combined Trauma. *Russian Sklifosovsky Journal Emergency Medical Care.* 2014;(4):7–8. (In Russ.)
9. Chan RN, Ainscow D, Sikorski JM. Diagnostic failures in the multiple injured. *J Trauma*. 1980;20(8):684–687. PMID: 7401210 https://doi.org/10.1097/00005373-198008000-00009
10. Enderson BL, Reath DB, Meadors J, Dallas W, DeBoo JM, Maull KI. The Tertiary Trauma Survey. *J Trauma Injury Infect Crit Care*.1990;30(6):669–670. PMID: 2352294. https://doi.org/10.1097/00005 373-19900 6000-00002
11. Thomson CB, Greaves I. Missed injury and the tertiary trauma survey. *Injury*. 2008;39(1):107–114. PMID: 18164007. https://doi.org/10.1016/j.injury.2007.07.030
12. Frawley PA. Missed injuries in the multiply traumatized. *Aust N Z J Surg.* 1993;63(12):935–939. PMID: 8285905 https://doi.org/10.1111/j.1445-2197.1993.tb01722.x
13. Ferrera PC, Verdile VP, Bartfield JM, Snyder HS, Salluzzo RF. Injuries distracting from intraabdominal injuries after blunt trauma. *Am J Emerg Med*. 1998;16(2):145–149. PMID: 9517689. https://doi.org/10.1016/s0735-6757(98)90032-8
14. Giannakopoulos GF, Saltzherr TP, Beenen LFM, Reitsma JB, Bloemers FW, Goslings JC, et al. Missed injuries during the initial assessment in a cohort of 1124 level-1 trauma patients. *Injury*. 2012;43(9):1517–1521. PMID: 21820114. https://doi.org/10.1016/j.injury.2011.07.012
15. Hensgens RL, Moumni MEl, Jpma Frank FAI, Harbers JS, Duis KT, Wendt KW, et al. High delayed and missed injury rate after inter-hospital transfer of severely injured trauma patients. *Eur J Trauma Emerg Surg*. 2019. PMID: 31399747. https://doi.org/10.1007/s00068-019-01195-1 Available at: https://www.researchgate.net/publication/335080191_High_delayed_and_missed_injury_rate_after_inter-hospital_transfer_of_severely_injured_trauma_patients [Accessed 30 Oct, 2020]
16. Nikitin GD, Rak AV, Linnik SA, Saldun GP, Kravtsov AG, Agafonov NA, et al. *Khirurgicheskoe lechenie osteomielita*. Saint Petersburg: Russkaya grafika Publ.; 2000. (In Russ.)

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