

TRAUMATOLOGY

VERTICALIZATION OF PATIENTS AND AXIAL LOAD ON THE LOWER LIMBS AFTER SURGICAL TREATMENT OF UNSTABLE PELVIC RING INJURIES (BRIEF REVIEW OF THE LITERATURE)

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ABSTRACT

The article provides a theoretical review of scientific publications devoted to the rehabilitation of patients with unstable pelvic ring injuries; the features of pelvic ring damage are considered based on the specifics of the traumatic injury, the frequency of occurrence and the severity of the consequences. It is emphasized that prolonged pain syndrome due to pelvic ring injuries and the duration of the rehabilitation period negatively affect the physical and psycho-emotional state of a patient. At the same time, pelvic ring injuries are most relevant among the working population, and their consequences are quite serious, including disability and death. Consequently, the possibility of optimizing rehabilitation measures for patients with unstable injuries, aimed at restoring the functions of the musculoskeletal system in static conditions and while walking, is currently one of the urgent tasks of theoretical and practical traumatology. The possibilities of verticalization of patients and the use of axial load on the lower limbs in the postoperative period are considered as the main rehabilitation measures. It is noted that in the case of resolving the issue of axial load in case of unstable pelvic ring injury, the intensity of such load and the timing of the start of its use should be determined individually, depending on the physical condition of a patient, the characteristics of the injury and the presence of concomitant injuries. Treatment for unstable pelvic ring injuries most commonly is carried out in most cases through the use of various methods of surgical treatment and restoration of the pelvic anatomy. Based on the results of the theoretical study, it is necessary to state that, despite the obvious significance of postoperative treatment, the adequate organization of which largely determines its final result, it was revealed that the material for studying this issue is insufficient due to specific approaches to verticalization and axial load on the lower limbs, depending on type of pelvic ring injury, taking into account the individual characteristics of the injury in a particular patient.

Key words: pelvic trauma, pelvic ring injury, pelvic bones fracture, verticalization of patients, axial load on the lower limbs

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ВЕРТИКАЛИЗАЦИЯ ПАЦИЕНТОВ И ОСЕВАЯ НАГРУЗКА НА НИЖНИЕ КОНЕЧНОСТИ ПОСЛЕ ОПЕРАТИВНОГО ЛЕЧЕНИЯ ПАЦИЕНТОВ С НЕСТАБИЛЬНЫМИ ПОВРЕЖДЕНИЯМИ ТАЗОВОГО КОЛЬЦА (КРАТКИЙ ОБЗОР ЛИТЕРАТУРЫ)

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РЕЗЮМЕ

В статье выполнен теоретический обзор научных публикаций, посвящённых вопросам реабилитации пациентов с нестабильными повреждениями тазового кольца, рассмотрены особенности его повреждения исходя из специфики травматического повреждения, частоты встречаемости и серьёзности последствий. Подчёркивается, что длительный болевой синдром при повреждениях тазового кольца и длительность реабилитационного периода негативно влияют на физическое и психоэмоциональное состояние пациента. При этом повреждения тазового кольца наиболее актуальны среди трудоспособного населения, а последствия их достаточно серьёзны, вплоть до инвалидизации и летального исхода. Следовательно, возможность оптимизации мероприятий по реабилитации пациентов с нестабильными повреждениями, направленных на восстановление функций опорно-двигательного аппарата в статике и при ходьбе, является в настоящее время одной из актуальных задач теоретической и практической травматологии. В качестве основных реабилитационных мероприятий рассматриваются возможности вертикализации пациентов и применения осевой нагрузки на нижние конечности в послеоперационном периоде. Отмечено, что в случае решения вопроса осевой нагрузки при нестабильном повреждении тазового кольца величина такой нагрузки и сроки начала её применения должны определяться индивидуально, в зависимости от физического состояния пациента, особенностей травмы и наличия сопутствующих повреждений. Лечение при нестабильных повреждениях тазового кольца, как правило, проводится в большинстве случаев посредством использования различных методов оперативного лечения и восстановления анатомии таза. По результатам выполненного теоретического исследования необходимо констатировать, что, несмотря на очевидную значимость послеоперационного лечения, адекватная организация которого во многом определяет конечный его результат, выявлено, что материала для изучения данного вопроса недостаточно вследствие специфических подходов к вертикализации и осевой нагрузке на нижние конечности в зависимости от типа повреждения тазового кольца с учётом индивидуальных характеристик травмы у конкретного пациента.

Ключевые слова: травма таза, повреждение тазового кольца, перелом костей таза, вертикализация пациентов, осевая нагрузка на нижние конечности

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UNSTABLE PELVIC RING INJURIES: PECULIARITIES OF OCCURRENCE, ROLE OF REHABILITATION MEASURES

The incidence of pelvic ring injuries has increased in recent decades in populations worldwide, as a result of the increased rhythm of modern life, which contributes to an increased risk of injury. As a consequence, the issue of preventing post-traumatic pelvic injuries, which are the cause of subsequent disability, has also become relevant [1–3].

The main cause of pelvic ring injuries, including unstable injuries, is usually high-energy trauma, the variety and severity of which have increased with significant advances in science and technology. Currently, the main factor in the occurrence of unstable pelvic ring injuries is road traffic accidents, catatrauma (falls from height), and high-force impacts of various mechanisms [4, 5].

Anatomically, the pelvis is a complex of two iliac bones, two sciatic bones, two ischial bones and the sacrum – all these anatomical elements form the so-called pelvic ring. Pelvic fracture classifications are based on these anatomical and biomechanical features [6].

The first description of pelvic ring injuries was proposed by the prominent French surgeon J.F. Malgaigne in the century before last, and over the past almost three centuries; about fifty different classifications have been proposed [7].

The classification of A.V. Kaplan based on the integrity of the pelvic ring is the best known in our country [8]. This classification is quite accurate in showing the specificity of this type of injury, but only considers the integrity of the bony components of the pelvic ring injuries, not reflecting the damage to the capsular ligamentous apparatus and the resulting instability.

In 1961, G. Reppal and S. Sutherland proposed a classification of pelvic ring injuries [9, 10] based on the directions of mechanical force acting on the pelvic ring: frontal (external rotation), lateral compression (internal rotation), and vertical shear. Since this classification did not take into account pelvic ring instability, it did not allow us to recommend any treatment methods [11].

In the course of further study of biomechanics based on the approach of G. Reppal and S. Sutherland led to the development of the M. Tile classification of pelvic ring injuries, which takes into account the increasing degree of instability (partial and complete) of the pelvic ring [12]. Association for the Study of Internal Fixation (AO, Arbeitsgemeinschaft für Osteosynthesefragen), better known in Russia, as an AO Association, improved the classification of M. Tile [13], and the stability of the dorsal bone ligamentous complex was the main classification criterion.

According to the M. Tile AO/ASIF (Association for the Study of Internal Fixation) classification, pelvic ring injuries are divided into stable (type A) and unstable (types B and C). Unstable pelvic injuries are damage

to the pelvic ring, provoking bone mobility. They occur in most cases as a result of high-energy injuries, mainly caused by road traffic accidents (64.37 %), falls from a significant height (25.32 %) or sports injuries (about 2 %) [14, 15]. Such fractures are often accompanied by associated life-threatening injuries [16, 17]. Type B pelvic ring injuries are open and lateral compression fractures. There is partial destruction of the posterior pelvic ring elements, including sacral fractures and injuries to the sacroiliac complex, in cases where the pelvic ring is vertically stable but rotationally unstable.

In unstable C-type pelvic ring injuries, there is complete destruction of the posterior semicircle and displacement of bone fragments in three planes, which leads to rotational and vertical instability, accompanied by high mortality in the acute period of injury and disability in the long-term period [18, 19]. In unstable pelvic ring injuries, two or more fractures may be simultaneously involved, with displacement of the pelvic fractures causing risk of damage to internal organs, provoking the possibility of haemorrhage [20], up to and including death. Optimal patient rehabilitation tactics for pelvic bone fractures and capsular ligamentous apparatus injuries along with treatment determines the effectiveness of the implemented measures, allowing to reduce the treatment and recovery period, accelerate the restoration of joint function of the lower extremities and minimize the risk of patient disability [21, 22].

Treatment of patients with unstable pelvic ring injuries is one of the urgent and unsolved problems of modern traumatology. Pelvic ring injuries can be characterized by significant pain syndrome and cause a long-term reduction in the patient's physical activity both at the household level and in terms of social adaptation, including reduced quality of life and psychological health due to prolonged immobilization and rehabilitation, as well as the development of possible complications [23]. Provision of lower extremity support and preservation of movement in the lower extremities in the case of pelvic ring injuries should be accompanied by stable fixation with preservation of adequate repositioning [24, 25], which should ensure early activation of the patient [26–28]. The use of nonsurgical methods, which are technically simple and involve prolonged immobilization of patients with pelvic ring injuries, does not allow early activation and verticalization, which makes these methods ineffective for the treatment of these types of injuries [29]. Active surgical tactics in case of pelvic ring injuries, however, with certain technical difficulties, are accompanied by significant blood loss and excessive surgical aggression [4, 29].

The severity of pelvic ring injuries, their variety, unsatisfactory results of nonsurgical treatment methods and surgical interventions require further in-depth study of this issue [30–32]. Thereby, the issues of treatment of patients with pelvic ring injuries at all stages: preoperative, immediate operative and postoperative periods are becoming more relevant [33].

PECULIARITIES OF PATIENTS' VERTICALIZATION AND SPECIFICITY OF AXIAL LOAD IN THE POSTOPERATIVE PERIOD IN UNSTABLE PELVIC RING INJURIES: CURRENT STATE OF THE ISSUE

Immobilization syndrome accompanying patients with pelvic ring injuries, which is a set of multi-organ disorders associated with non-physiological restriction of motor activity and prolonged horizontal position of patients, remains relevant nowadays. Such condition can lead to musculoskeletal, respiratory, endocrine-metabolic, cardiovascular disorders.

Verticalization as a leading method of prevention and therapy of immobilization syndrome [34] in pelvic ring injuries allows to restore (preserve) adequate afferentation from muscle-tendon and joint receptors, to preserve the activity of reflex reactions and automatisms caused by post-tonic mechanisms, in particular, to ensure preservation of the reflex mechanism of bladder and bowel emptying, and ultimately allows to significantly reduce the recovery period and minimize the development of possible complications [35, 36].

The importance of verticalization being a mechanism of early activation of patients after surgical manipulations, the meaning of which is stable fixation and adequate repositioning of fragments in case of pelvic ring injuries, lies in maintaining or restoring the maximum possible value of the gravitational gradient – the highest angle of elevation of the patient, which does not lead to the development of signs of orthostatic insufficiency [37], i. e. the essence of which lies in the ability to maintain vital parameters stable in any position

The verticalization objective is to achieve the highest value of gravitational gradient (more than 80°), which is a prerequisite for maintaining the patient's functioning in the rehabilitation process. Verticalization is the only way to overcome immobilization syndrome – a complex of multi-organ disorders associated with non-physiological restriction of the patient's motor and cognitive activity [38]. The frequency of verticalization in relation to ways of overcoming the gravitational gradient is significant, allowing the patient's normal body function to be optimized as much as possible.

Effective treatment in cases of unstable pelvic ring injuries of AO/ASIF types B and C in order to achieve restoration of the pelvic anatomy is performed using various surgical methods by external fixation with osteosynthesis or a combination of these devices. External fixation of the pelvic ring is a minimally invasive method of osteosynthesis and is performed using various devices, the development of which has been the subject of numerous studies. They can be of various designs and modifications, used both as a temporary and definitive method of osteosynthesis [39]. When the patient's condition is unstable or critical, manipulation is limited to fixation of the pelvic ring with external fixation devices to a minimum extent. At the same time, unfortunately, the modifications of external fixation devices proposed today

are not stable enough to fix the posterior pelvis [40–43], which is the main condition for reliable fixation of the pelvic ring injury and, consequently, for the successful treatment of this injury [44].

In the stable condition of the patient, it is possible to use extramedullary and immersion fixators [23, 45, 46]. A number of authors consider ORIF (open reduction and internal fixation) as the gold standard for pelvic ring injuries [47, 48]. The open technique allows good repositioning and rigid fixation, but it is complicated, traumatic and accompanied by intraoperative blood loss [4, 49]. The implementation of these types of manipulations requires the use of expensive fixators, which are not available in all medical centres. The detailed planning of these types of surgical interventions is also performed using three-dimensional reconstruction of pelvic fractures, which entails the complexity of logistical organization, which limits the use of ORIF for pelvic ring injuries in many medical institutions [28, 50].

Irrespective of the method of surgical treatment, however, early surgical fixation in cases of unstable pelvic ring injuries allows rehabilitation measures to be initiated through verticalization and early axial loading as soon as possible. This reduces the incidence of hypostatic complications associated with prolonged bed rest and hypodynamia: pressure injuries, decompensation of comorbidities, pneumonia, muscle hypotrophy, joint contractures, phlebothrombosis and thromboembolism.

Early verticalization and axial loading of the lower extremities can reduce mortality in cases of polytrauma as well as improve functional outcomes. Additionally, the minimal surgical invasiveness of these manipulations and early rehabilitation can reduce the probability of possible complications and the duration of hospital treatment [51, 52]. All these positive factors of the therapeutic process make it possible to significantly reduce logistical and economic costs for medical institutions.

There are no reliable studies in Russia and worldwide that could show the dependence of early verticalization and early axial load on the lower extremities on the choice of the method of surgical treatment of pelvic ring injuries. There is also no universally recognized algorithm for the treatment of patients with these injuries.

Verticalization of patients in the postoperative period is performed after 2–3 months in average, depending on the type of injury and the treatment performed. Verticalization is allowed after X-ray control to assess the state of consolidation, the standing of transosseous elements and bone fragments, and subsequent axial load on the lower extremities is implemented as the pain syndrome decreases. The duration and specifics of training are determined individually and depend on the patient's age, physical condition, type of pelvic trauma, as well as the specifics of the surgical intervention performed. In the initial stages, it is necessary to maximize the patient's mobility under the supervision of the attending physician and physical therapy instructor, using various rehabilitation devices, including support devices (walkers, crutches, etc.). It is essential when using crutches

to avoid the development of "crutch paresis" [23], which occurs when crutches apply prolonged pressure to the radial nerve or part of the brachial plexus.

In unstable pelvic ring injuries, the timing of onset and magnitude of axial loading should be determined. In terms of determining the value of axial load, the patient's ability to perform a single lift of the extremity against gravity or a single repetition of a task is used as the basis for this definition [38]. The magnitude of the axial load must be high enough to be effective, on the one hand, and on the other hand, re-injury must be avoided. Axial load dosing in the postoperative period is determined based on the results of radiological examination or computed tomography of the pelvic bones using special computer programmes, which is currently one of the main issues in the rehabilitation of patients with unstable pelvic ring injuries [53, 54].

During the verticalization phase, the patient should be trained to practice the self-care features. Physiotherapeutic treatment, therapeutic exercise aimed at gradually increasing the physical load on the musculoskeletal system are carried out. After consolidation of pelvic fractures and capsulo-ligamentous apparatus of the pelvis, measures aimed at the patient's full physical recovery or impact on persistent residual phenomena (application of a special orthosis for pelvic stabilization, spa treatment) are implemented [55].

CONCLUSION

The possibility of recovery of the musculoskeletal apparatus functions in statics and walking after treatment of unstable pelvic ring injuries in the shortest possible time is a determining factor in the choice of rehabilitation measures. The postoperative period largely determines the final result of the performed treatment, influences the possible consequences and quality of life of the patient. Axial load on the lower extremities and verticalization should be performed immediately after pain relief, while considering the physiological characteristics of the patient's condition and the peculiarities of possible multi-organ injuries. Considering this theoretical study, the issues related to verticalization and axial load on the lower extremities depending on the type of pelvic ring injury have been insufficiently studied and require further research.

Conflict of interest

The authors of this article declare no conflicts of interest.

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