ГБУ «СПб НИИ СП им. И.И. Джанелидзе»

Современный взгляд на проблему принятия тактических решений при лечении пострадавших с ротационно-нестабильным повреждениями тазового кольца

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Санкт-Петербург
2025

Актуальность проблематики

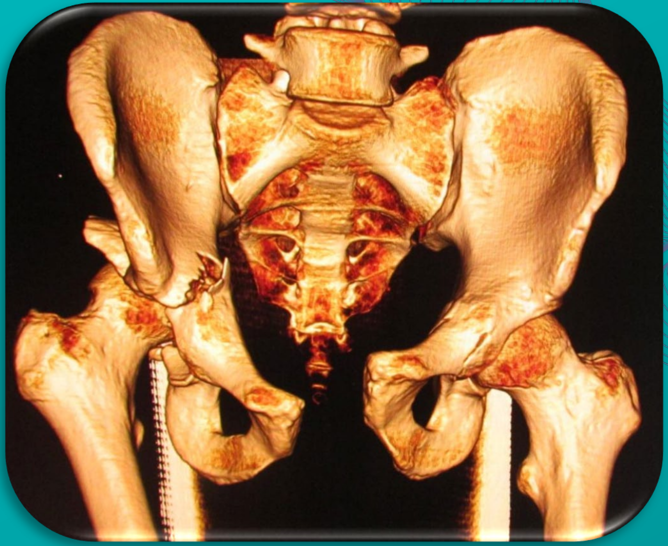
Летальность при нестабильных повреждениях таза составляет 27%, а при наличии нестабильной гемодинамики возрастает до 65% (Бондаренко А.В., 2014; Tesoriero R.B., 2017; Höch A., 2019; Bugaev N. et al., 2020, Анкин Н.Л., 2014; Tai D., 2011).

Высокая частота неудовлетворительных результатов при лечении ротационно-нестабильных повреждении таза (20 – 58% клинических наблюдений) во многом связана с неправильной оценкой поврежденных структур таза и неустраненной деформацией таза (Лазарев А.Ф., 2016; Lindahl J., 2005, Антониади Ю.В., 2002; Бабоша В.А., 1997; Захарова Ю.А.,. 2013; Каплан Л.В., 1979; Черкес-Заде Д.И., 1988, H. C. Sagi 2011 г).

АВФ не могут в полной мере выполнить задачу по восстановлению анатомии тазового кольца, поэтому в период полной компенсации жизненных функций организма необходим окончательная внутренняя фиксация таза. (Ананьин Д.А., 2015; Гуманенко Е.К., 2012; Hildebrand F, 2004; Herren C., 2016).

Вопрос об показаниях к оперативному лечению и применению способов окончательной фиксации таза, в том числе малоинвазивных, является до конца не решенным(Заднепровский Н.Н., 2018; Иванов П.А., 2014; Литвина Е.А., 2017; Файн А.М., 2013).

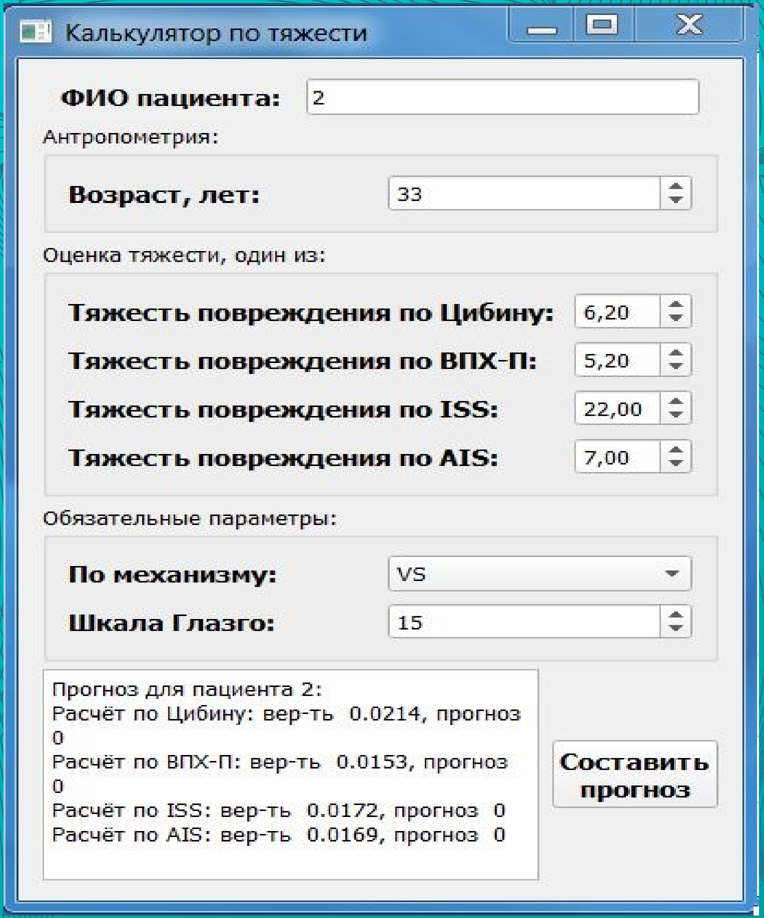
Таким образом, тема оптимального метода лечения ротационно-нестабильных повреждений таза в настоящий момент остается спорной и недостаточно изученной. До конца неизвестны биомеханические свойства систем фиксации в зависимости от анатомии повреждения. Имеется необходимость разработки и совершенствования оптимальных способов окончательной внутренней фиксации костей таза в острый период травмы, базирующегося на принципах малоинвазивного остеосинтеза.



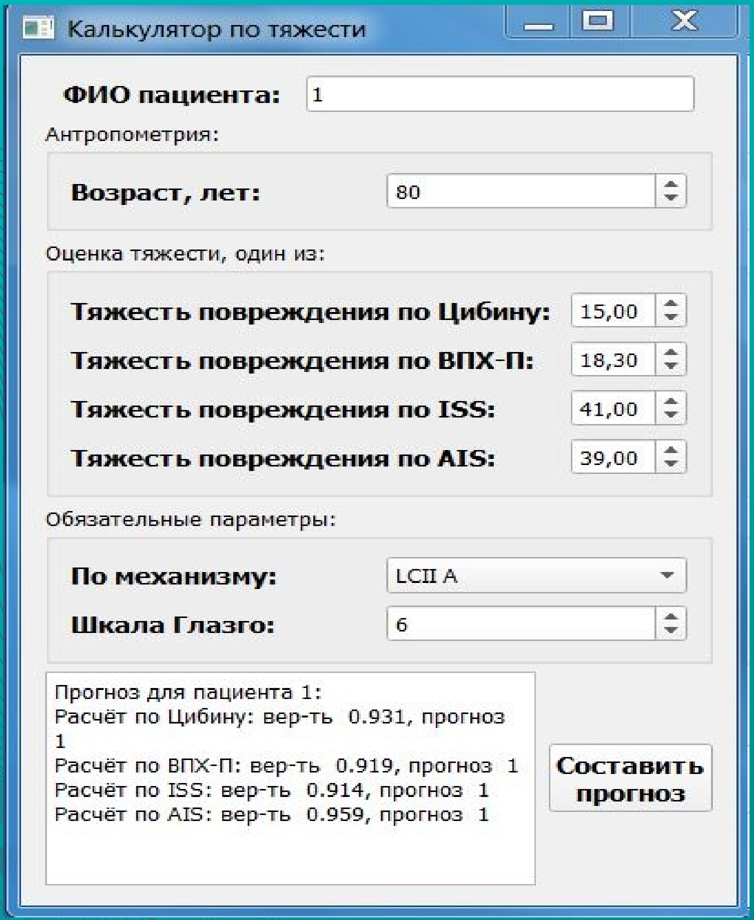
В НИИ Джанелидзе используется дифференцированная система хирургического лечения при нестабильных повреждениях таза, основанная на объективной оценке тяжести травмы и состояния пострадавшего, прогнозе для оперативного вмешательства, полноценной оценке поврежденных структур тазового кольца.

На основании этого формулируются показания к оперативному лечению, определяется наиболее оптимальный способ фиксации тазового кольца в различные сроки после получения травмы. Большую роль играют малоинвазивные способы фиксации таза у пострадавших в острый период травматической болезни.

Для прогноза оперативного вмешательства при нестабильном повреждении таза разработаны регрессионные логит-модели



Прогноз благоприятный (0)
Ранние реконструктивно-стабилизирующие оперативные вмешательства

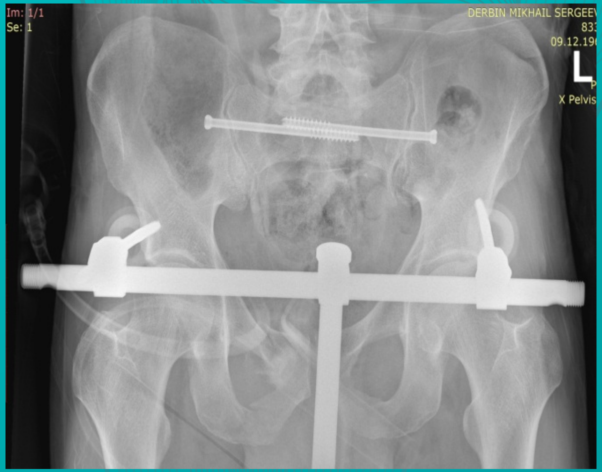


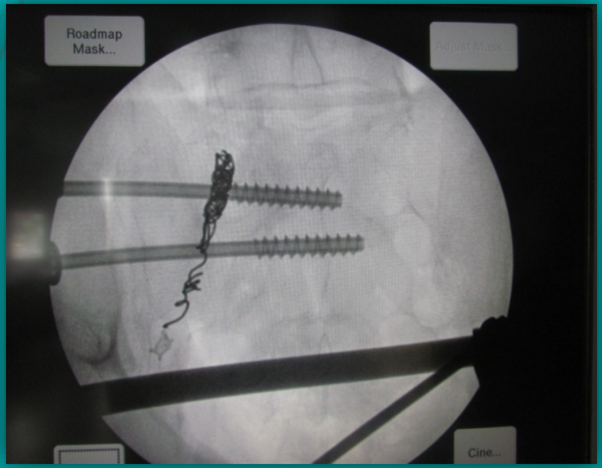
Прогноз неблагоприятный (1)
Неотложные стабилизирующие (противошоковые) оперативные вмешательства

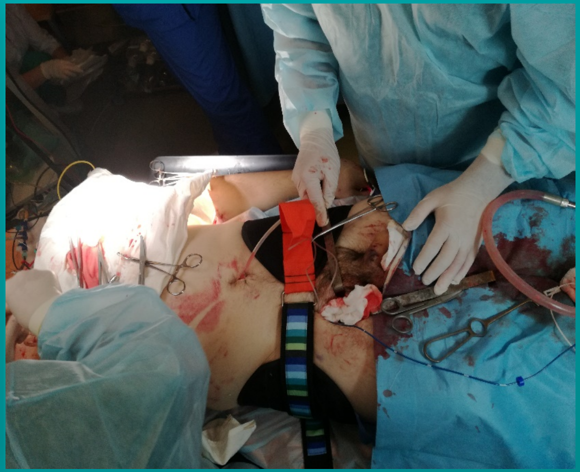
Нестабильная гемодинамика

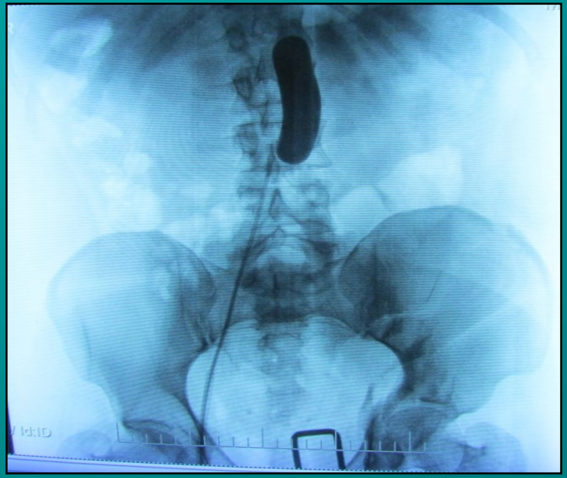
Тактика «orthopedic damage control»

1. Устранение жизнеугрожающих последствий травмы
2. Устранение внетазовых повреждений.
3. Остановка продолжающегося кровотечения, в том числе внутритазового, различными методами
4. Быстрая стабилизация переломов внешними устройствами
5. Вопрос об окончательном остеосинтезе таза решается после стабилизации гемодинамики



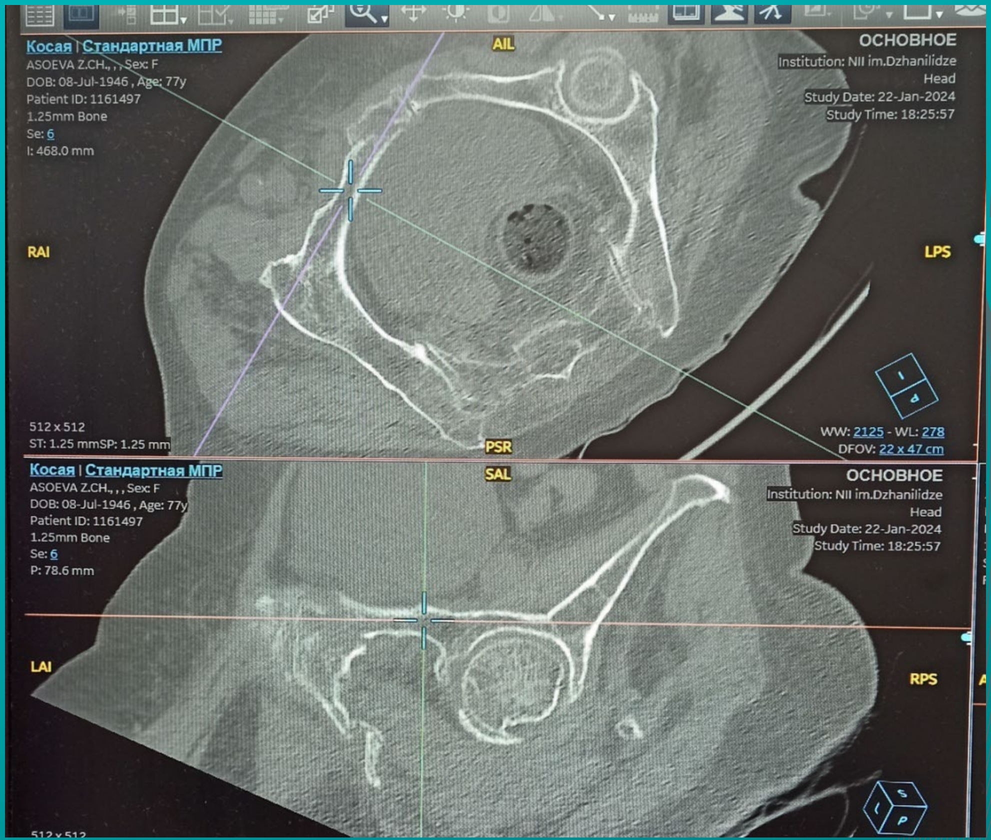






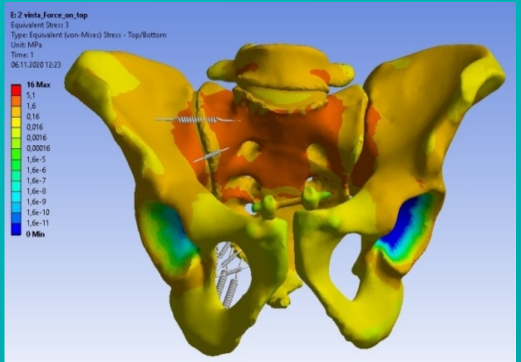
Диагностика

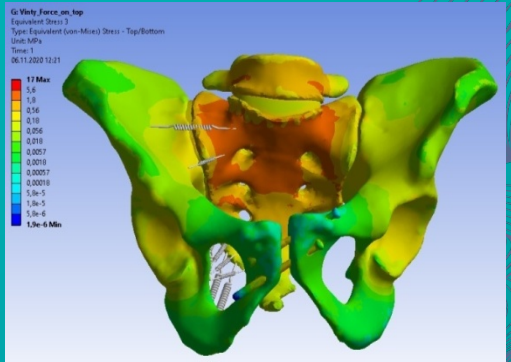
Основной метод – СКТ таза.
Позволяет надежно визуализировать повреждения тазового кольца, провести предоперационное планирование.

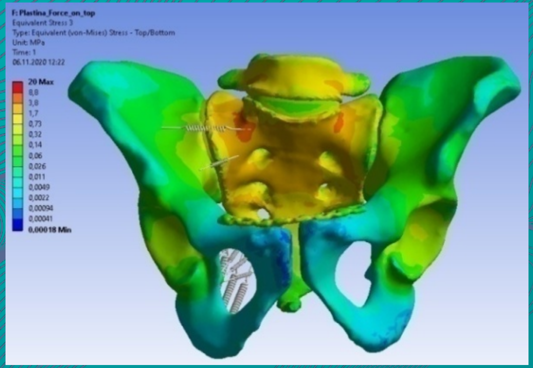


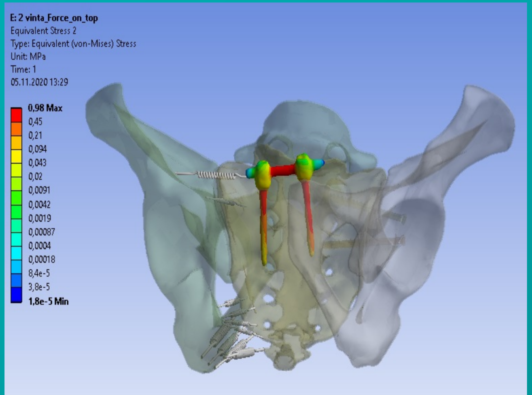
Биомеханическое моделирование

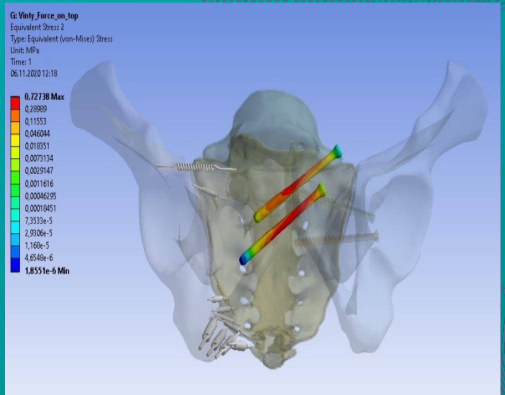
Произведена оценка биомеханических характеристик наиболее частых способов стабилизации тазового кольца (канюлированными винтами, пластинами, системами полиаксиальных винтов) отдельно и в различных комбинациях с помощью компьютерного моделирования.

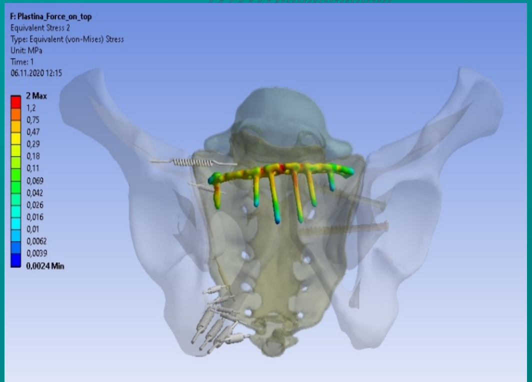






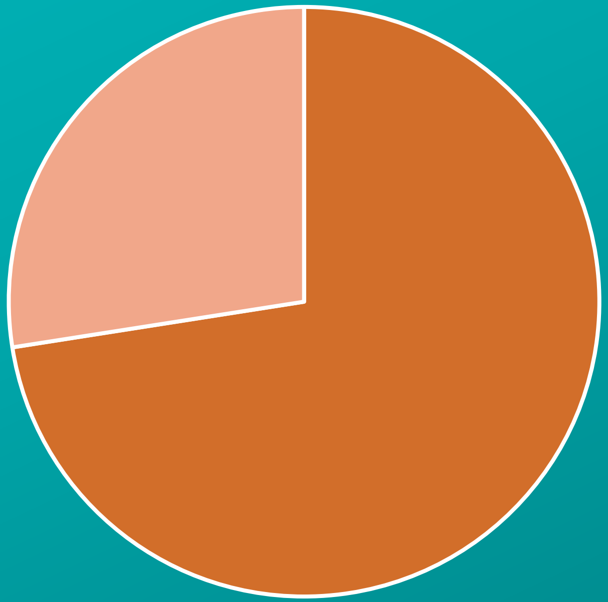






Проведено исследование результатов лечения 313 пострадавших с наличием ротационно-нестабильного повреждения тазового кольца, поступивших в НИИ Джанелидзе с 2020 по 2025 г.

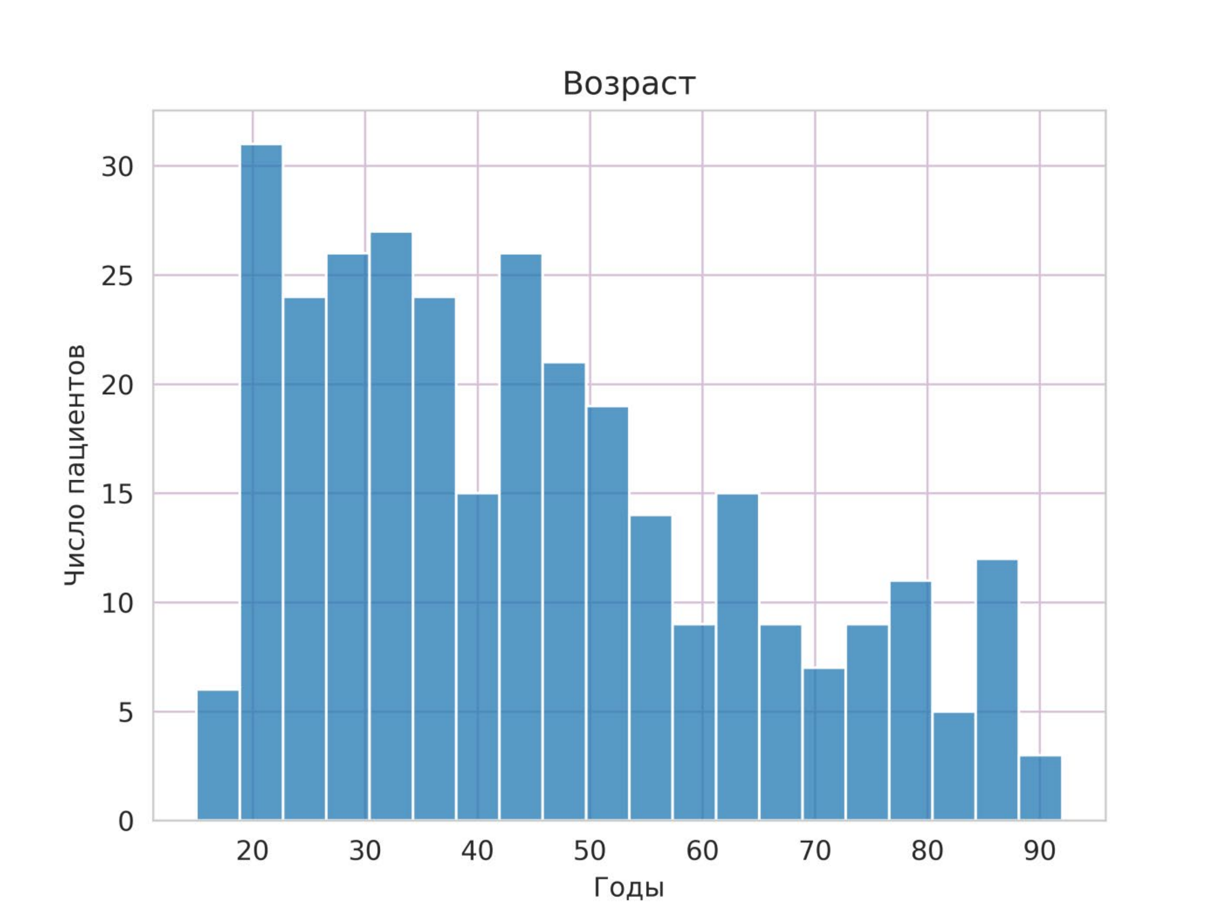
Распределение по варианту лечения

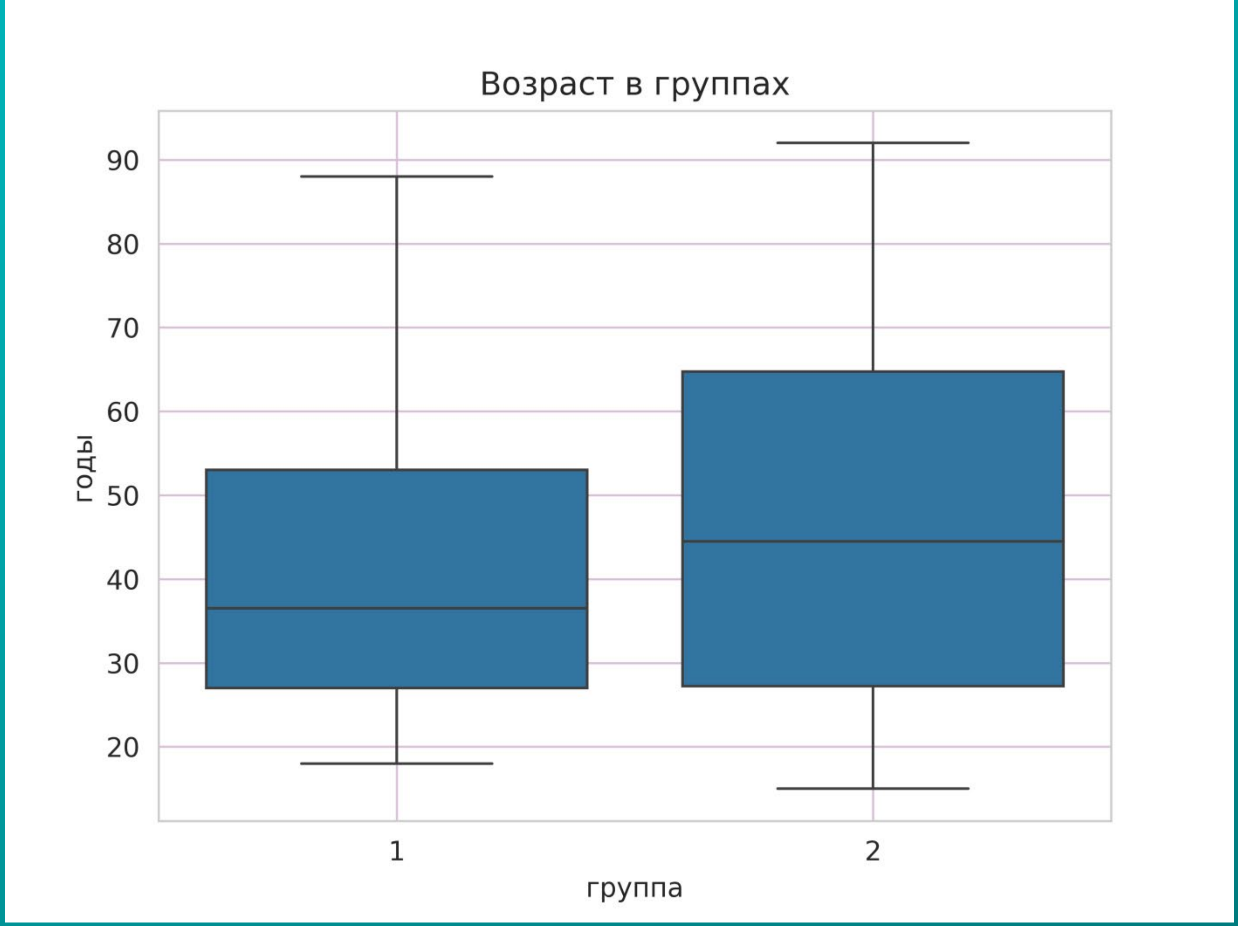


Группа 1. Оперативное лечение (72.5%)

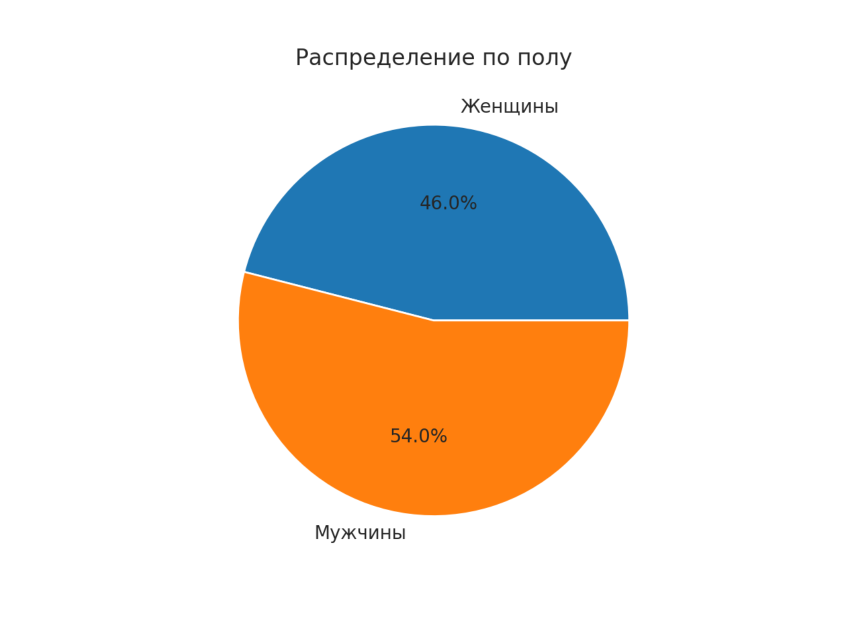
Группа 2. Консервативное лечение (27.5%)

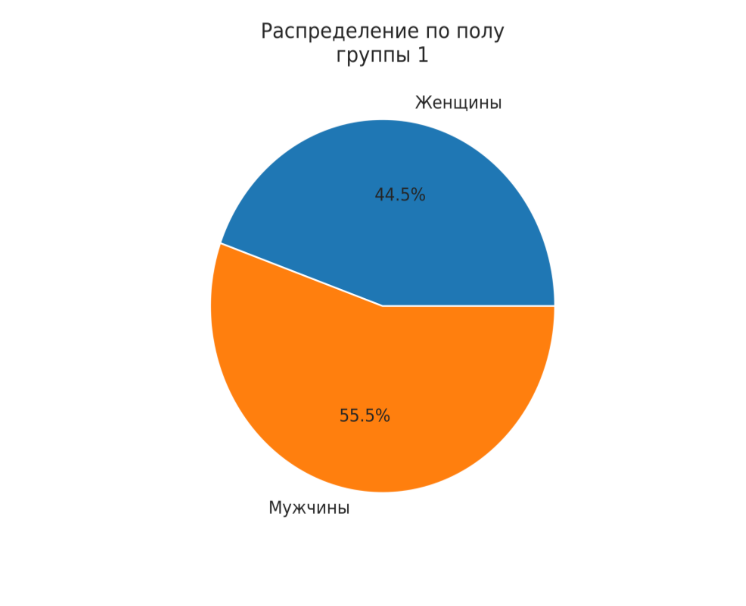
Основной заголовок (используйте шрифт Montserrat SemiBold)

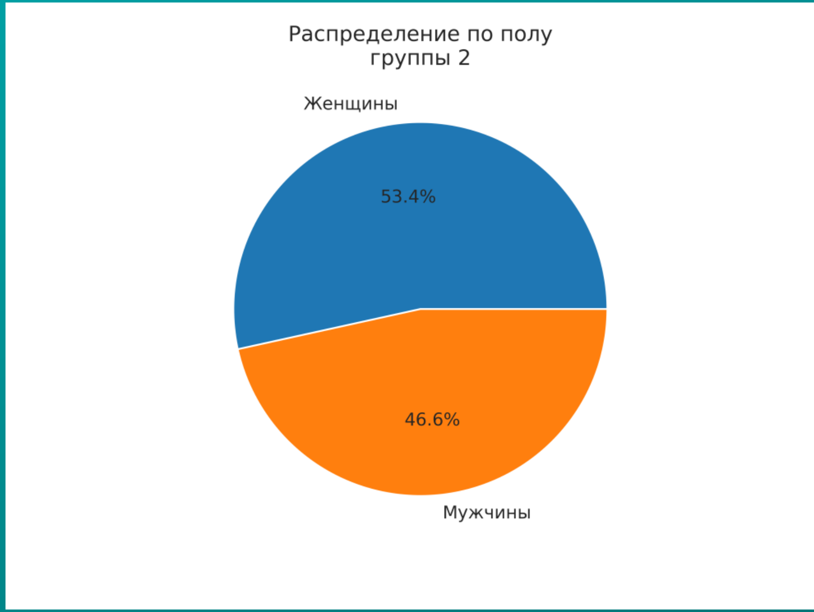




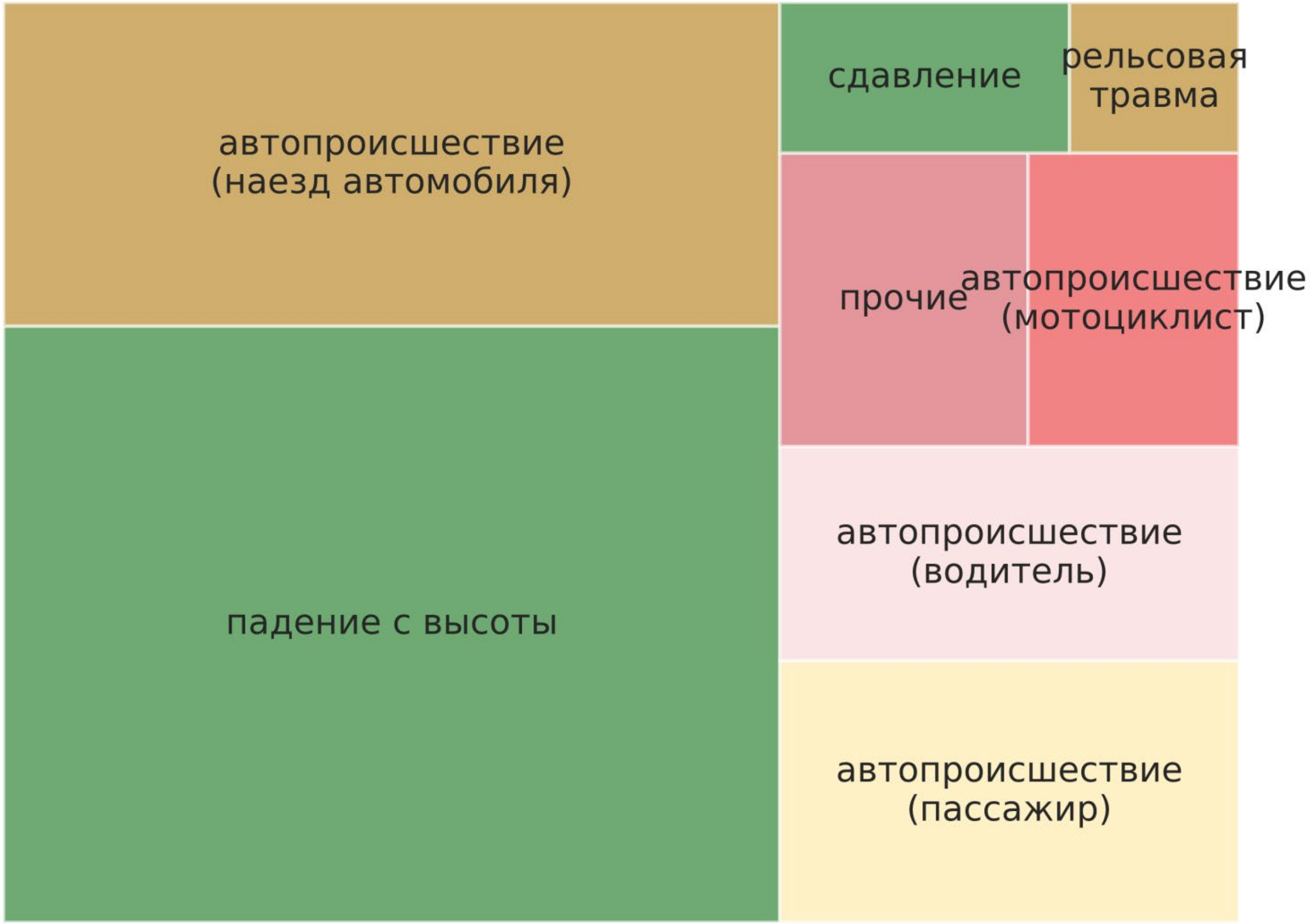
Основной заголовок (используйте шрифт Montserrat SemiBold)



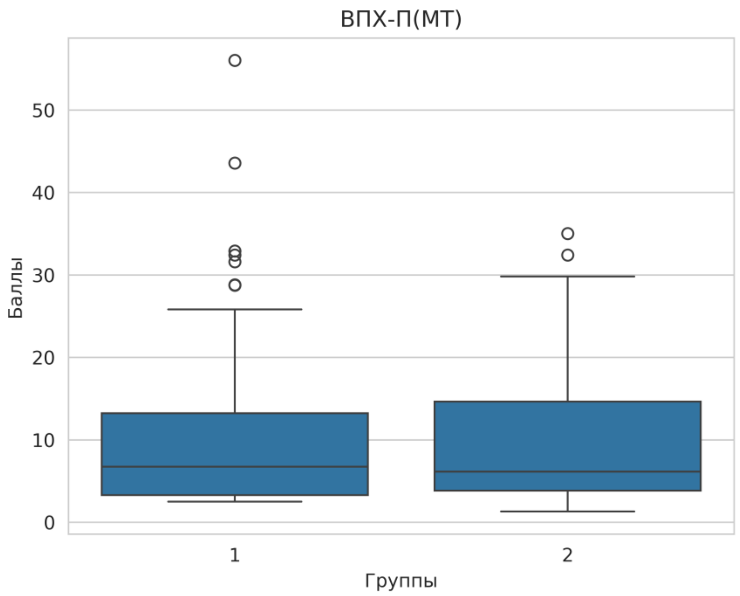


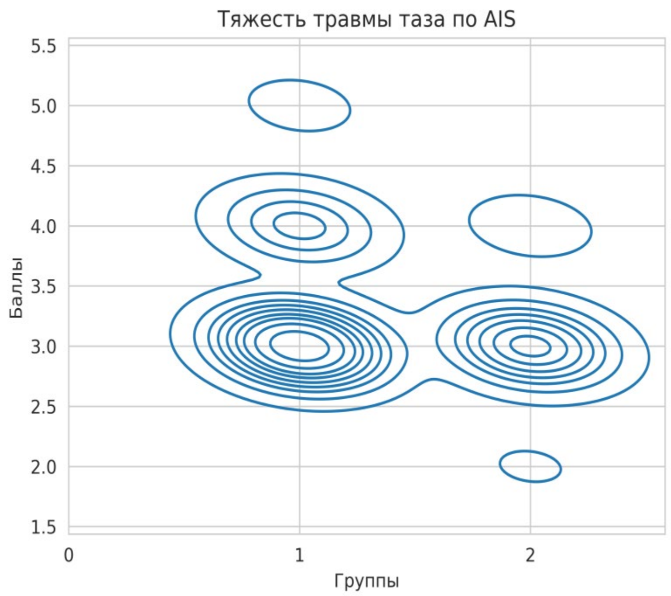


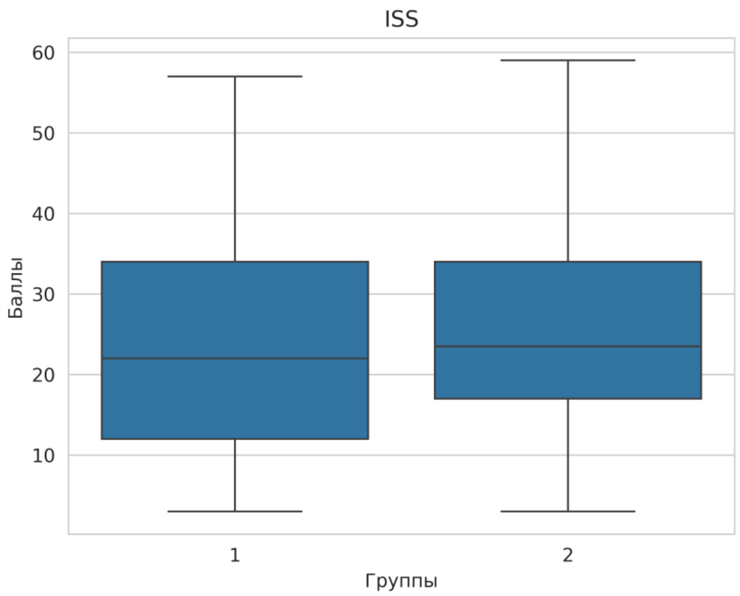
Механизм травмы



Пострадавшим проводили объективную оценку тяжести травмы

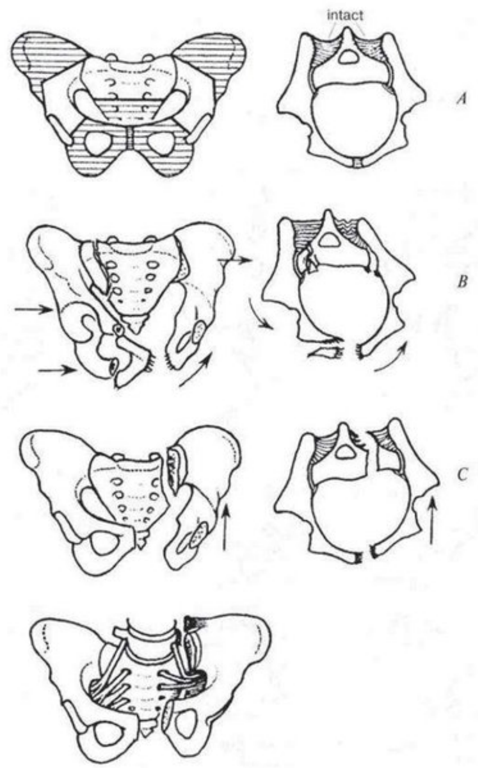




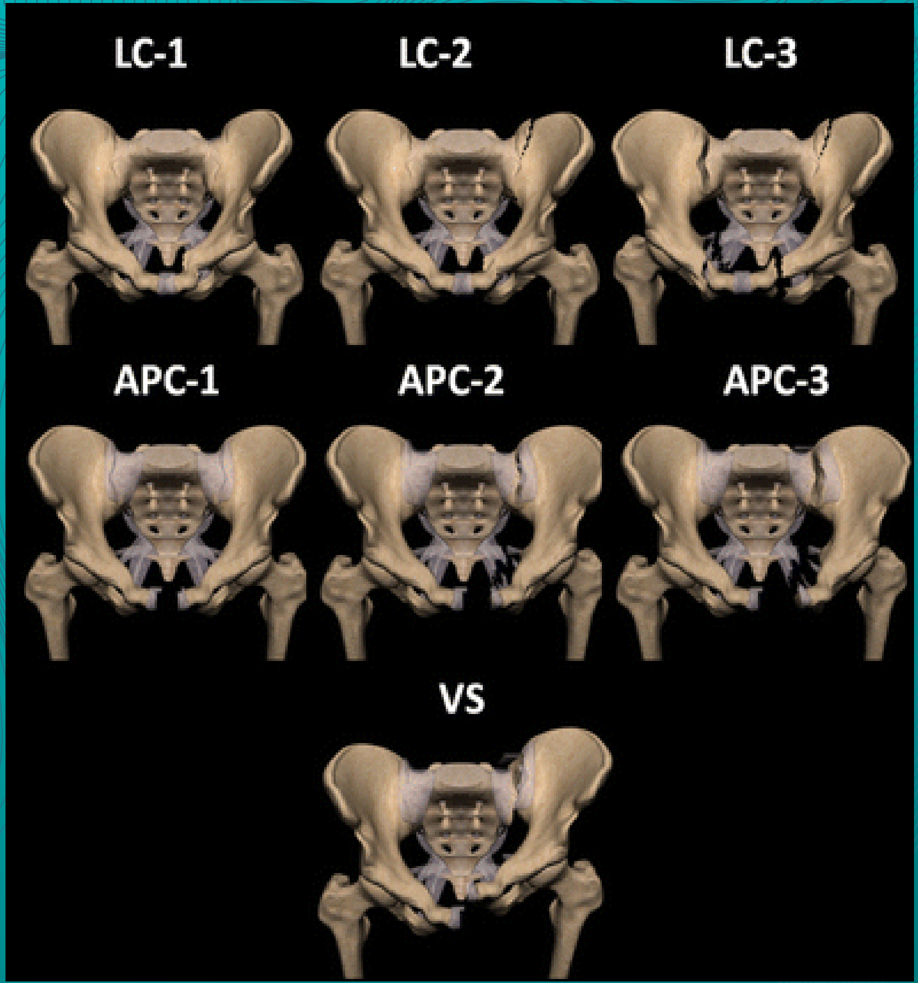


Для характеристики ротационно-нестабильных повреждений таза мы использовали классификацию Tile - AO/ASIF и Young-Burgess.

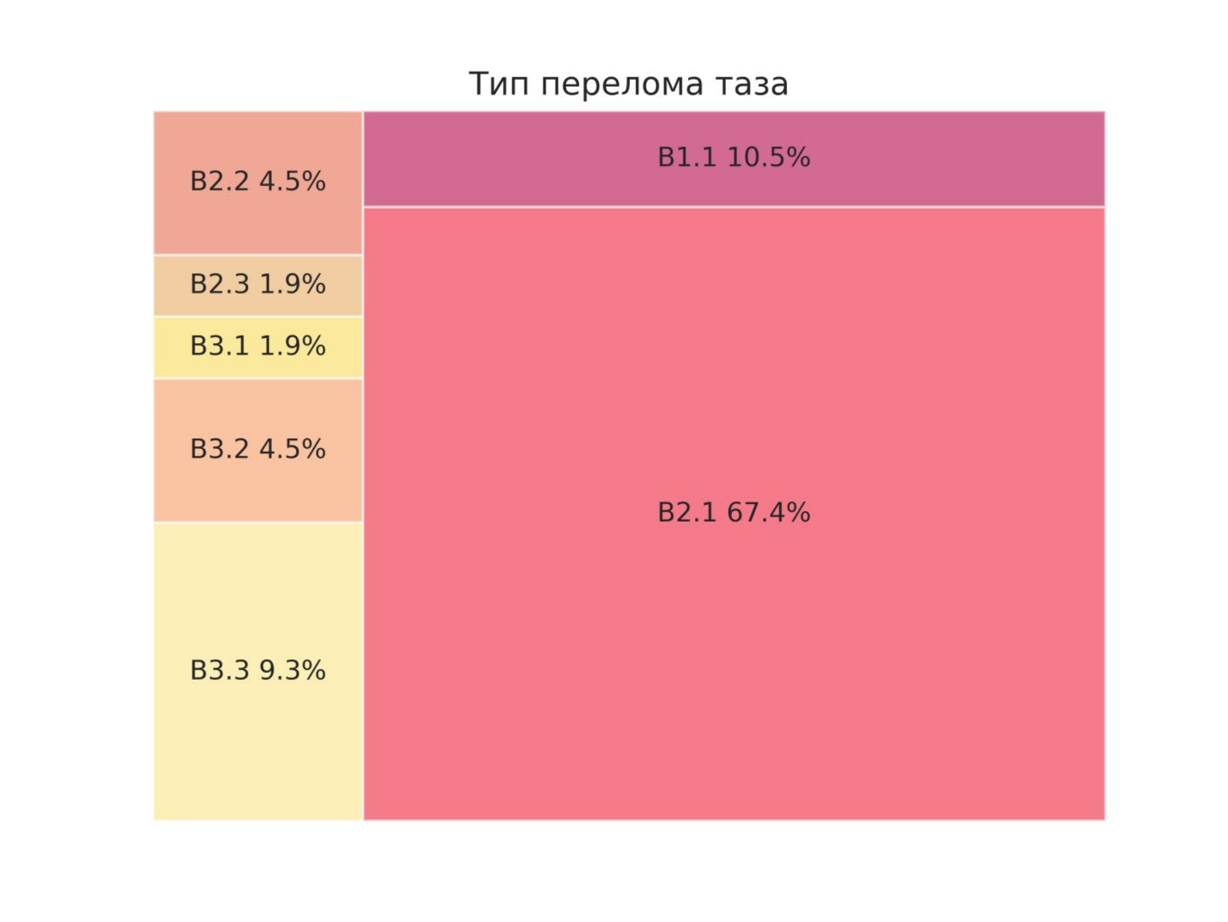
Классификация по УКП AO/ASIF

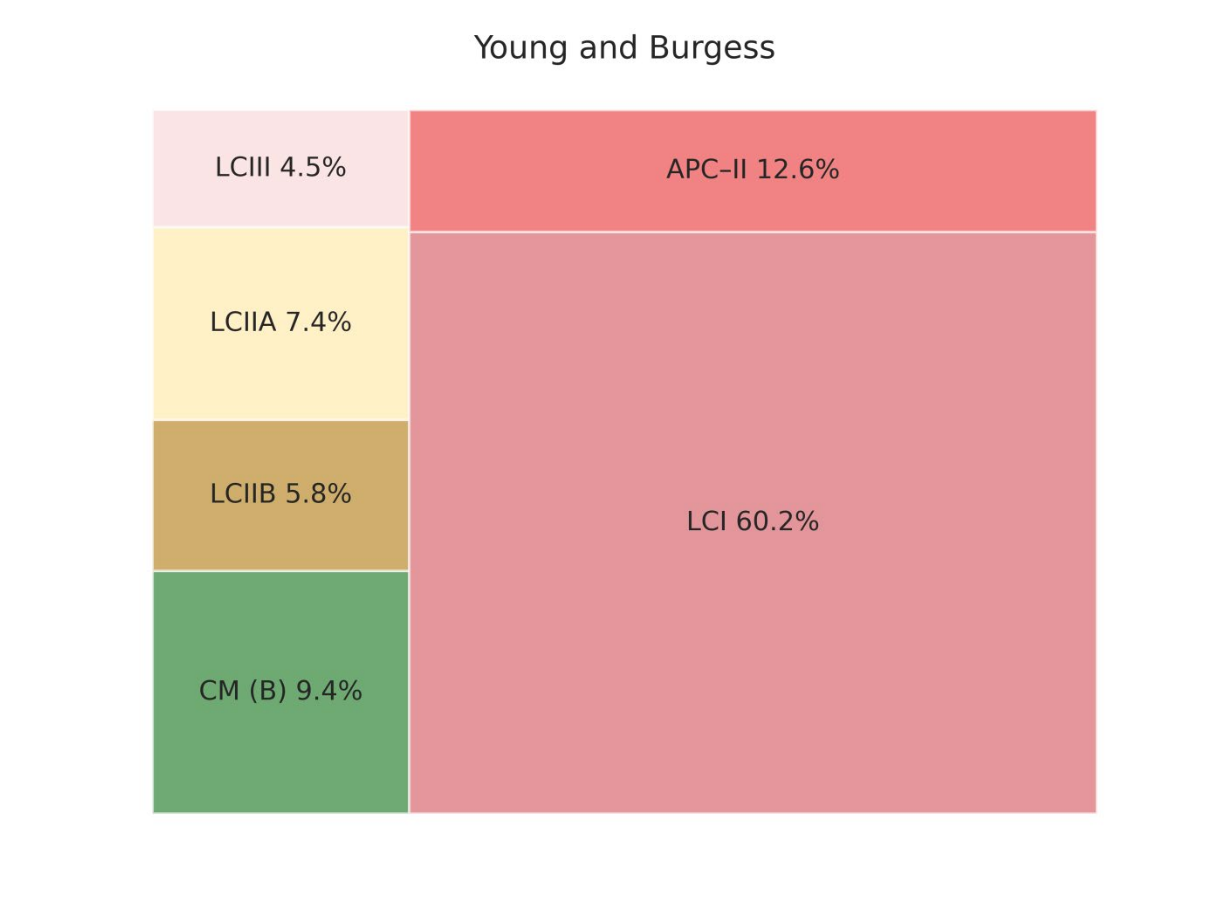


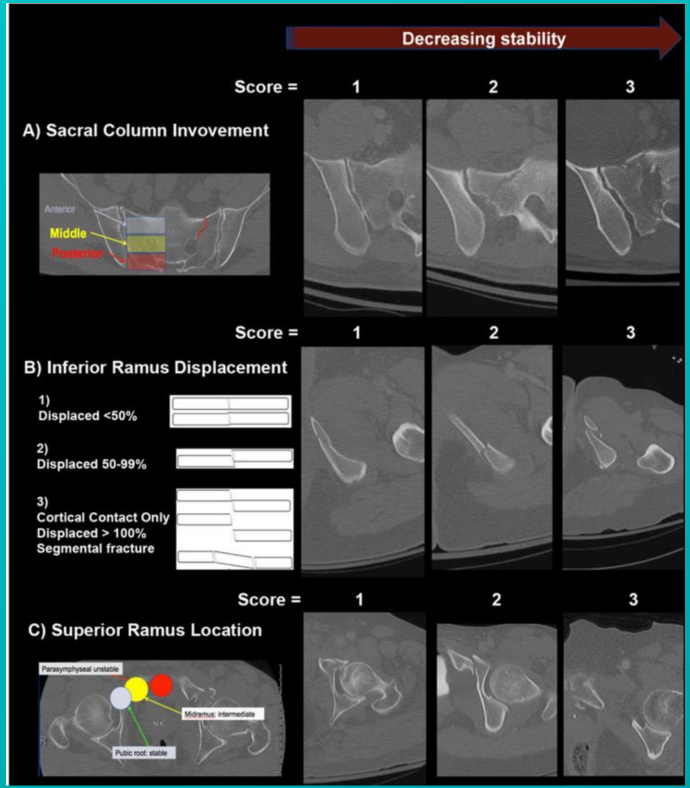
- **Тип А. Стабильные (заднее полукольцо интактно)**
- А1. Отрывные переломы
- А2. Поперечные переломы крестца
- **Тип В. Частично стабильные (неполное разрушение заднего полукольца)**
- В1. Переломы по типу «открытой книги» - наружно-ротационные
- В2. Переломы, вызванные боковой компрессией
- В2-1. Односторонние
- В2-2. Контралатеральные повреждения (по типу «ручки ведра»)
- В3. Билатеральные
- **Тип С. Нестабильные (полное разрушение заднего полукольца)**
- С1. Односторонние
- С1-1. Подвздошные переломы
- С1-2. Крестцово-подвздошные переломо-вывихи
- С1-3. Вертикальные переломы крестца
- С2. Двухсторонние повреждения (с одной стороны-по типу В, с другой-по типу С)
- С3. Двусторонние по типу С

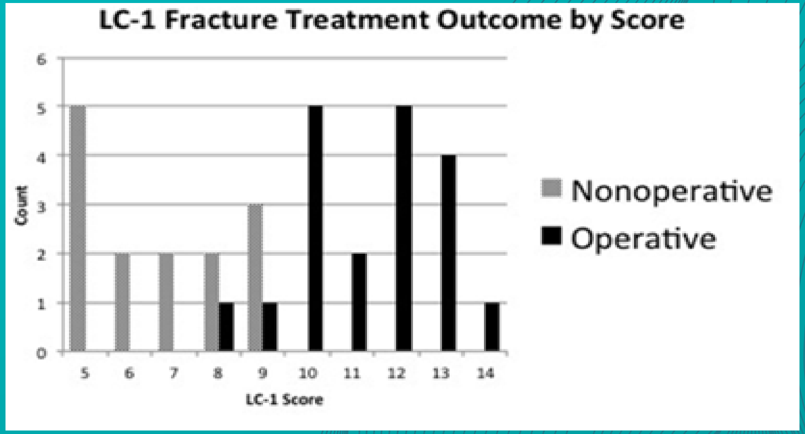


Распределение пострадавших по типам повреждений









(J. Beckmann и др, 2020 г.)

Рентгенологические критерии	Балл
Параметры	
Смещение при переломе крестца	
< 2 мм	1
> 2 мм	2
Тип перелома крестца по классификация Denis	
Зона 1	1
Зона 2	2
Зона 3	3
Колонны крестца (МСКТ аксиальная проекция)	
1 колонна	1
2 колонна	2
3 колонна	3
Перелом нижней ветви лонной кости со смещением	
минимальное	1
>50%	2
полное	3
Локализация перелома горизонтальной ветви лонной кости	
Основание	1
Средняя часть	2
Парасимфизельная зона	3

ORIGINAL ARTICLE

Examination Under Anesthetic for Occult Pelvic Ring Instability

H. Claude Sagi, MD,*† Franco M. Coniglione, DO,‡ and Jason H. Stanford, MD§

Objective: To describe the technique and results of stress examination with fluoroscopy under anesthesia (EUA) to determine stability and the need for operative stabilization of traumatic pelvic ring injuries.

Design: Retrospective chart and radiographic review.

Setting: Level I trauma center.

Subjects: Skeletally mature patients with traumatic incomplete posterior pelvic ring injuries.

Methods: Patients were consented for EUA if preoperative radiographs and computed tomographic scanning of the pelvis demonstrated an incomplete injury to the posterior pelvic ring (Orthopaedic Trauma Association [OTA] 61-B type injuries). Patients with nondisplaced anterior compression fractures of the sacral ala without internal rotation or a fracture line exiting the posterior cortex were excluded from this analysis. Similarly, skeletally immature patients or those with complete instability of the pelvic ring (OTA 61-C type injuries) were excluded. All patients meeting inclusion criteria were taken to the operating room, anesthetized, and placed in the supine position for stress examination (EUA) of the pelvic ring using intraoperative dynamic fluoroscopy. Examination consisted of a resting static film followed by internal rotation, external rotation, and push–pull maneuvers of both lower extremities. Each of these maneuvers was performed using the anteroposterior, inlet, and outlet projections, providing a total of 15 distinct images for each patient's examination. The preoperative classification of the pelvic ring injury was then accepted or redefined based on the amount of rotational and translational instability in the axial, coronal, and sagittal planes. The decision to proceed with anterior and/or posterior operative reduction and stabilization was subsequently based on the degree of pelvic ring instability noted during the EUA.

Results: A total of sixty-eight patients underwent an EUA of their pelvis by the senior author. Fifty males and 18 females with an average age of 35 years comprised the study group. In all, 37 anteroposterior compression (APC or OTA 61-B1) injuries and 31 lateral compression (LC or OTA 61-B2) injuries were evaluated. Of the 14 pelvic ring injuries initially classified as an APC-1, seven (50%) were deemed stable and treated nonsurgically, whereas seven (50%) were felt to have sufficient instability (an occult APC-2) to warrant treatment with anterior fixation based on EUA. Of the 23 injuries initially classified as an APC-2, all but one required surgical fixation: 13 (57%) were treated with anterior fixation alone (APC-2a), whereas nine (39%) were treated with anterior fixation and supplemental iliosacral screw placement (APC-2b) based on the degree of instability noted during the EUA. Of the 20 injuries initially classified as an LC-1, 13 (65%) were stable and treated nonsurgically (LC-1a), whereas seven (35%) were treated with anterior and/or posterior stabilization (LC-1b) based on the degree of instability noted during the EUA.

Conclusions: The reported incidence of poor functional outcomes associated with pelvic fracture may be attributable, in part, to inadequate treatment of misdiagnosed injuries and chronic instability and/or malunion. Performing an examination under anesthesia with dynamic stress fluoroscopy as described in this series revealed occult instability in 50% of presumed APC-1 injuries, 39% of APC-2 injuries, and 37% of LC-1 injuries. We propose a modification to the Young-Burgess Classification system to reflect the dynamic component of pelvic ring instability disclosed on EUA as follows: APC-2a for those injuries requiring anterior only fixation, APC-2b for those injuries that may require treatment with anterior and posterior fixation, LC-1a for those injuries that are stable and do not require internal fixation, and LC-1b for those lateral compression injuries that may require treatment with internal fixation. We conclude that pelvic EUA merits further analysis as an important diagnostic tool that may provide additional information regarding instability of the pelvic ring.

Key Words: pelvic fracture, instability, examination under anesthesia, dynamic stress view, fluoroscopy

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The results of this study were presented in part at the Annual Meeting of the Orthopaedic Trauma Association, Baltimore, MD, October 2010.

The authors declare no conflicts of interest.

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INTRODUCTION

Work by Pennal and Tile in 1980 introduced a systematic approach to classifying pelvic injuries by characterizing ring disruptions based on the injury force vector: lateral compression (LC), anteroposterior compression (APC), and vertical shear.[1] Later work by Tile included the presence or absence of presumed stability as an element of the classification scheme. Pelvic ring injuries were thus described as stable, rotationally unstable but vertically stable, or both rotationally and vertically unstable.[2] Young and Burgess later expanded the initial work of

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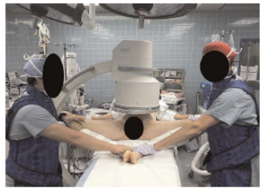

FIGURE 2. Method for external rotation/anteroposterior compression stress examination of the pelvis.

Fluoroscopic imaging using anteroposterior, inlet, and outlet projections for each manipulative maneuver was performed, providing a total of 15 distinct images for each patient's examination. The classification of the pelvic ring injury was then redefined by the amount of rotational instability around the vertical and horizontal axes and translational instability in the coronal and sagittal plane. The decision to proceed with anterior and/or posterior operative reduction and stabilization was based on the suspected degree of pelvic ring instability from the results of the EUA.

For APC-1 injuries, if greater than 2.5 cm of widening occurred (an occult APC-2) with external rotation stress examination, then some form of anterior fixation (external fixator or internal fixation) was applied. For APC-2 injuries, if any flexion or extension sagittal plane rotational instability (one pubic body displacing to greater than 1 cm above or below the contralateral pubic body) was noted on push–pull examination,

FIGURE 3. Method for push–pull stress examination of the pelvis. First one extremity is pushed cranially while the other is pulled caudally. These maneuvers are then repeated on the contralateral extremities.

then posterior fixation (an iliosacral screw) was added to augment the anterior fixation. For LC-1 injuries, if greater than 1 cm but less than 2 cm of ramus or symphyseal overlap occurred with internal rotation stress examination, then anterior only fixation was applied in the form of retrograde medullary ramus screws, reconstruction plates, or external fixators. If greater than 2 cm of ramus or symphyseal displacement occurred, then both anterior (as above) and posterior fixation (iliosacral screw) was applied. For LC-2 injuries, if no displacement occurred, then no fixation was applied; if any displacement from the initial static resting position occurred, then anterior and posterior internal fixation was applied. For LC-3 injuries, parameters for LC-1 and APC-2 injuries were both applied as outlined previously.

RESULTS

Sixty-eight patients underwent an EUA for an incomplete pelvic ring injury and met inclusion criteria for chart and radiographic analysis. Fifty males and 18 females with an average age of 35 years (range, 24–75 years) comprised the study group. In all, 37 anteroposterior compression (OTA 61-B1) injuries and 31 lateral compression (OTA 61-B2) injuries were evaluated. Mechanisms of injury included 23 motor vehicle collisions, 17 motorcycle collisions, 12 pedestrians struck, 10 falls, and six crush injuries.

Fourteen pelvic ring injuries were initially classified as an APC-1. Of these, seven (50%) were found to be stable and were treated without fixation, whereas seven (50%) were felt to have sufficient instability based on the EUA (greater than 2.5 cm symphyseal diastasis and hence an occult APC-2 injury) to warrant treatment with anterior internal fixation (Fig. 4). Three of these patients were felt to require supplemental posterior fixation with percutaneously placed iliosacral screws because of flexion/extension rotational instability noted on the push–pull stress views.

Twenty-three pelvic ring injuries were initially classified as an APC-2. Thirteen (57%) had anterior fixation (11 ORIF and two anterior external fixators) alone and were reclassified an APC-2a injury, whereas nine (39%) were felt to have sufficient flexion/extension and external rotational instability based on EUA to warrant treatment with anterior internal fixation and supplemental posterior fixation with iliosacral screws; these were reclassified as an APC-2b injury (Fig. 5). The notation "APC-2b" was used rather than "APC-3/Tile C" because it was felt that sufficient integrity of the posterior ligamentous complex was present to prohibit all degrees of translation (specifically vertical translation; ie, these were not vertically unstable injuries, just multiaxial rotationally unstable). One patient initially classified as an APC-2 was felt to have an APC-1 after stress examination because the symphysis did not diastase more than the original injury film suggesting approximately 2.5 cm of diastasis.

Nineteen injuries were initially classified as an LC-1. Twelve (63%) were stable, treated nonsurgically without fixation, and reclassified as an LC-1a injury. Seven (37%) were felt to warrant treatment with surgical stabilization based on instability noted during the EUA and were reclassified as an LC-1b injury. Surgical fixation included one patient with anterior internal fixation alone and six with combined anterior

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Pennal and Tile by subcategorizing the previously described force vectors of LC and APC into a continuum of injury and increasing instability. The remainder of pelvic ring injuries were classified as a vertical shear or combined mechanism.[3,4]

APC injuries are commonly described as an "open-book pelvis" with symphyseal diastasis; the extent of the posterior injury further subclassifies the injury. APC-1 injures represent slight widening of the symphysis and anterior sacroiliac joint with intact, sacrotuberous (ST), sacrospinous (SSp), and anterior sacroiliac ligaments (ASI). Early cadaveric biomechanical tests on the effects of ligament sectioning revealed that widening of the symphysis beyond 2.5 cm suggested failure of the ST, SSp, and ASI ligaments rendering the pelvis rotationally unstable in the axial plane, thus defining the "incomplete" APC-2 injury pattern.[4,5] The posterior sacroiliac (PSI) ligaments, as originally described with the APC-2 pattern, are not disrupted because they are in the completely unstable APC-3 pattern.[4,5]

(LC pelvic ring injuries were described as "implosions" caused by a lateral to medially directed force vector with internal rotation applied directly to the pelvis or indirectly through the proximal femur. Young and Burgess subdivided the LC injuries based on the extent of posterior ring injury with LC-1 and LC-2 representing the "incomplete" patterns: LC-1 patterns with sacral impaction and LC-2 patterns with a fracture of the iliac wing.[4]

Although there is little controversy or debate concerning the need for reduction and stabilization of pelvic ring injuries with complete instability (vertical shear, combined mechanism, APC-3, and LC-3 injury patterns), there is still considerable variability among pelvic trauma surgeons regarding the optimal or "required" treatment for many of the incomplete injury patterns. More specifically, which APC-1 injuries are actually occult APC-2 injuries that require anterior fixation; do some APC-2 injuries have intact but attenuated posterior sacroiliac ligaments that require supplemental posterior stabilization; and finally, which LC-1 injuries are stable (in other words, will not displace with mobilization and without internal fixation for stabilization) and which ones require anterior and/or posterior stabilization?

Initial static radiographs and computed tomography (CT) scans obtained in the emergency room setting only record a moment in time, often not displaying the total amount of displacement that may have occurred during the traumatic event. Additionally, radiographs taken after the application of a circumferential sheet or pelvic binder can mask the true injury pattern. For these reasons, it is reasonable to surmise that the true extent of pelvic instability will not be displayed on all pelvic radiographs and imaging in 100% of patients.

The purpose of this analysis is to report on a series of patients with incomplete traumatic pelvic ring injuries for whom pelvic examination under anesthetic was performed in an attempt to better characterize the degree of instability and the need for operative stabilization.

PATIENTS AND METHODS

Using a prospectively collected orthopedic trauma database, 283 patients with traumatic pelvic ring injuries were identified as having had operative treatment from 2007 to 2009 by the senior author. During this period of time, all patients with a preoperative diagnosis of a pelvic fracture with incomplete injury to the posterior pelvic ring (Orthopaedic Trauma Association [OTA] 61-B, Young-Burgess APC-1, APC-2, LC1, LC-2, and some LC-3) underwent an examination under anesthetic (EUA) in an attempt to disclose any occult pelvic ring instability and compare preoperative with postoperative diagnoses. Inclusion criteria included skeletally mature patients with incomplete (Tile B, OTA 61-B type) traumatic pelvic ring injuries without acetabular fracture. Exclusion criteria included skeletally immature patients, OTA 61-A and OTA 61-C type injuries (no disruption of the pelvic ring or complete instability of the posterior pelvic ring), pregnant patients, and those not evaluated with manipulation before operative fixation. Patients with nondisplaced anterior sacral alar impaction without a fracture line extending to the posterior cortex and without internal rotation deformity were presumed stable and not taken for EUA.

After Institutional Review Board approval, hospital charts, operative reports, and both preoperative and intraoperative radiographs and CT scans were reviewed to record the initial and final classification/diagnosis and analyze the results of the manipulation and its impact on the presumed need for surgical stabilization and internal fixation.

Method for Examination Under Anesthesia

All patients were anesthetized and placed in the supine position for stress examination of the pelvic ring. With the surgeon-examiner in a lead gown, stress examination under fluoroscopy consisted of adduction and internal rotation of the lower extremities with compression through the greater trochanters (Fig. 1), external rotation with frog-leg positioning and an abduction force applied to the knees (Fig. 2), and push–pull of both lower extremities with longitudinal traction on one limb and a simultaneous vertical loading on the contralateral limb (Fig. 3). Although there was no way of specifically quantifying the amount of force applied, the leaded examiners were essentially pulling and pushing with maximal force. The push–pull maneuvers were then repeated on the contralateral limb.

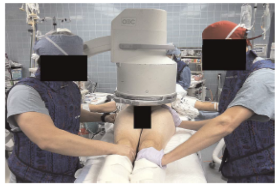

FIGURE 1. Method for internal rotation/lateral compression stress examination of the pelvis.

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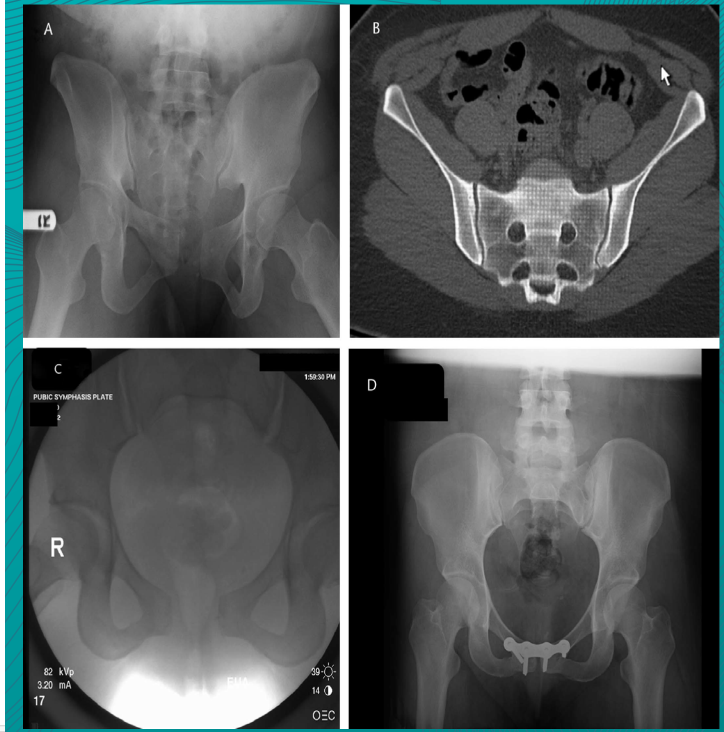
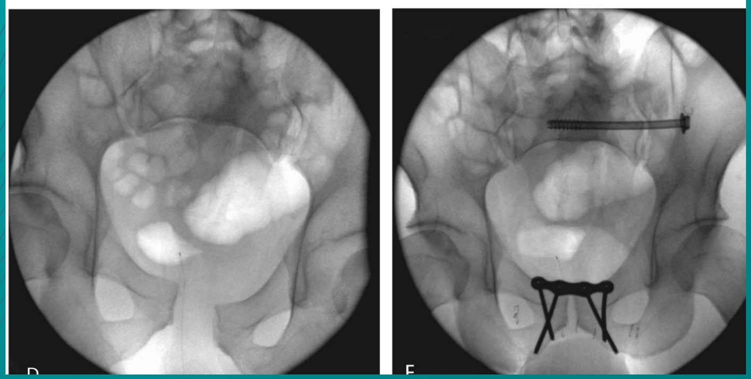
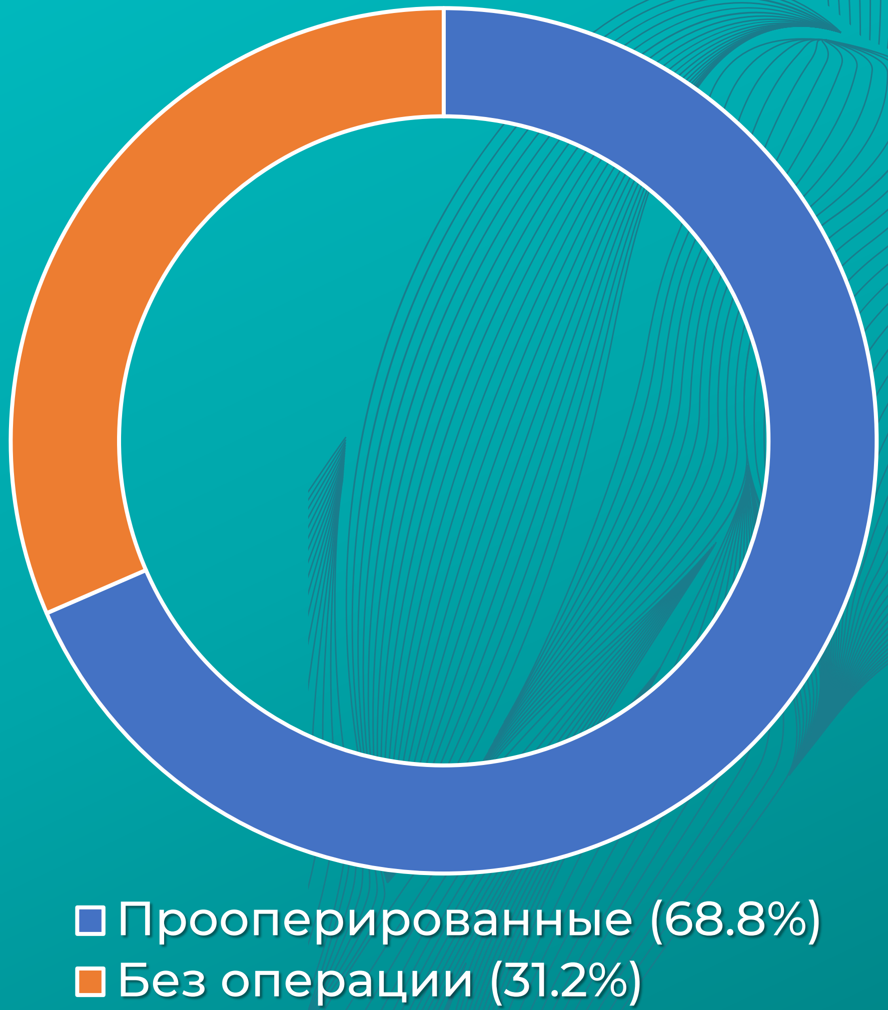
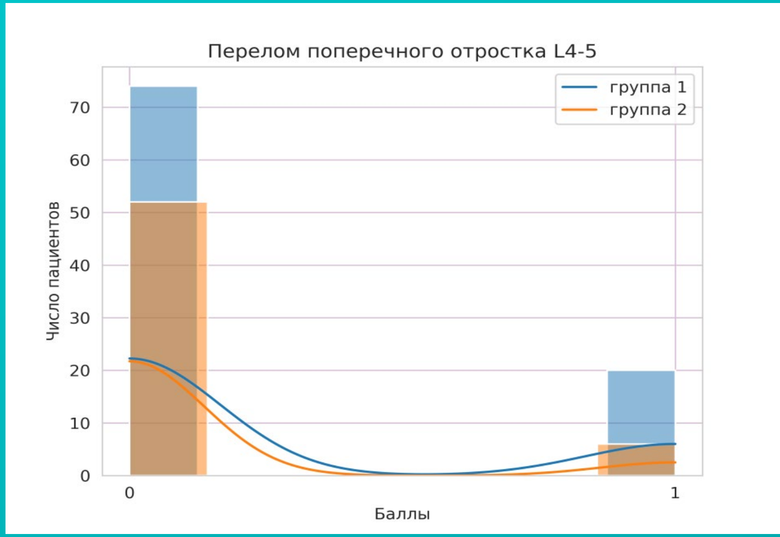




Группа LC1 – 186 пострадавших

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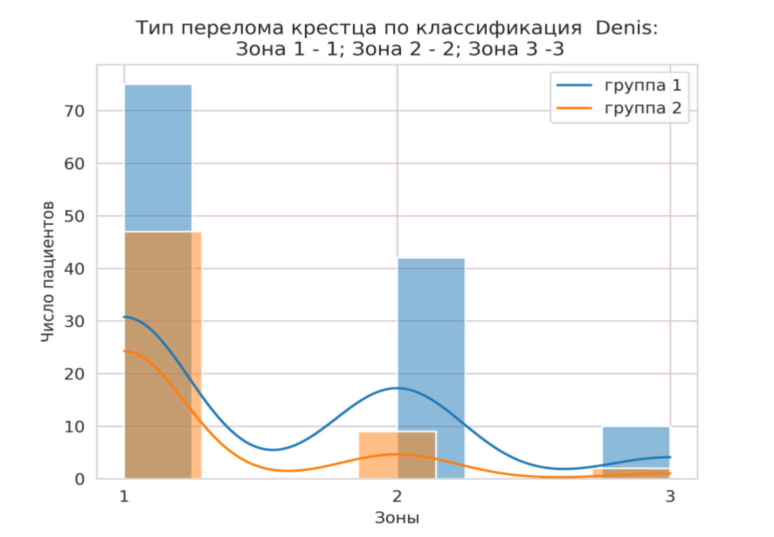
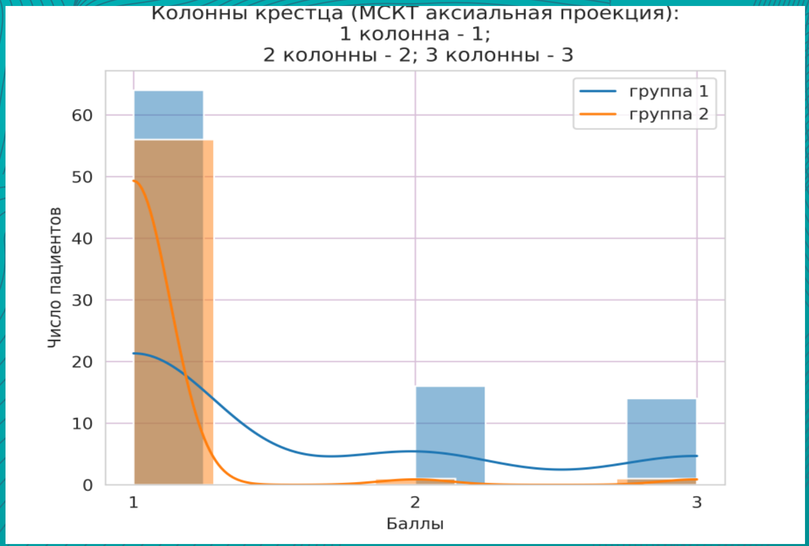
группа 1
группа 2
Число пациентов
Баллы


Тип перелома крестца по классификация Denis:
Зона 1 - 1; Зона 2 - 2; Зона 3 -3
группа 1
группа 2
Число пациентов
Зоны


Колонны крестца (МСКТ аксиальная проекция):
1 колонна - 1;
2 колонны - 2; 3 колонны - 3
группа 1
группа 2
Число пациентов
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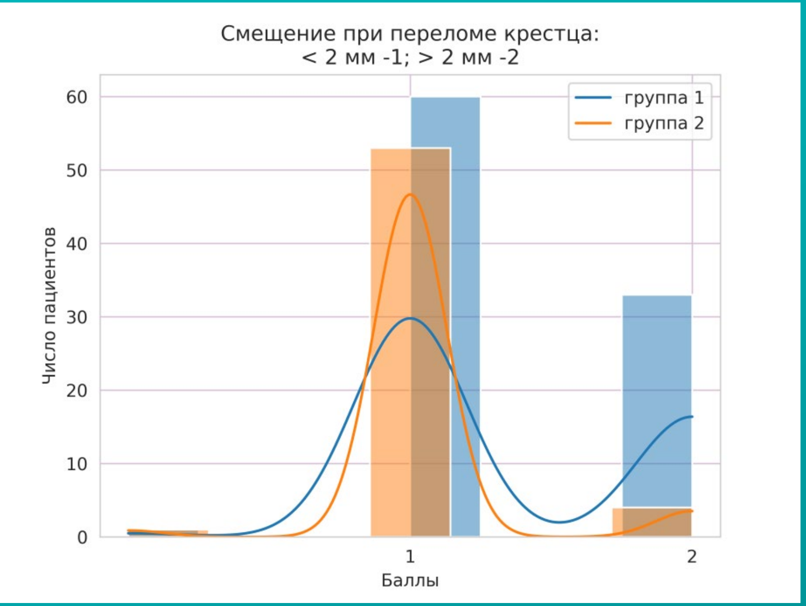
Смещение при переломе крестца:
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группа 1
группа 2
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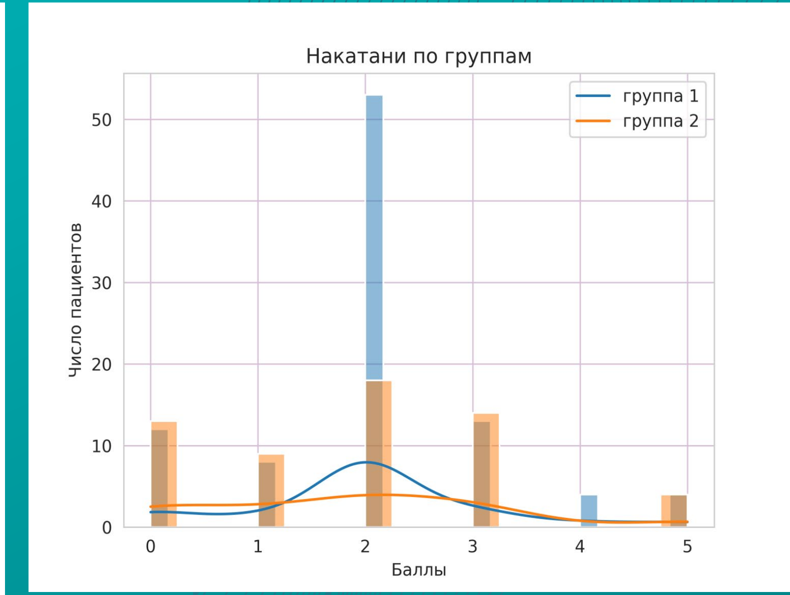
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группа 1
группа 2
Число пациентов
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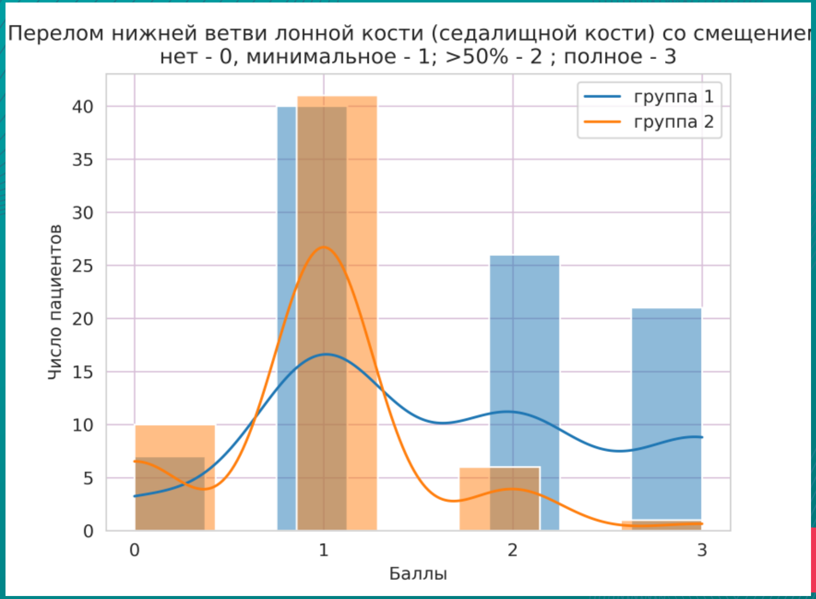
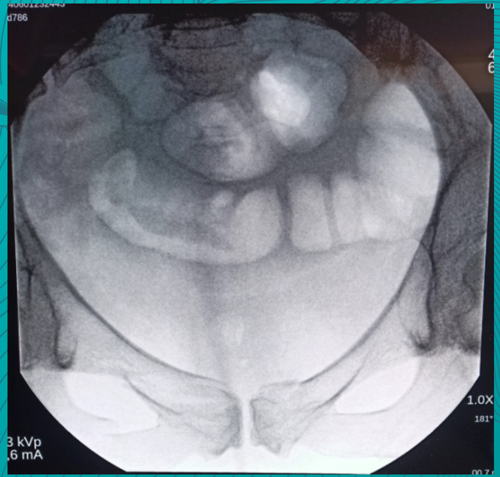
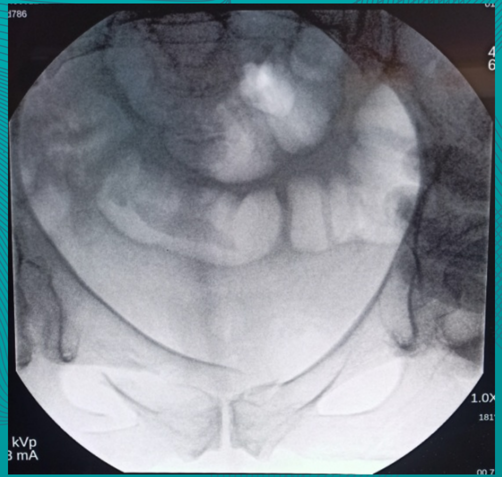
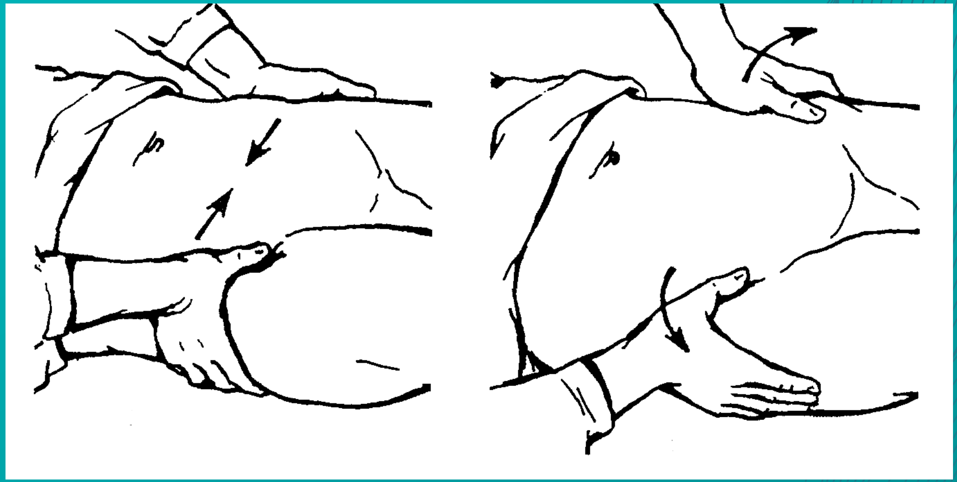
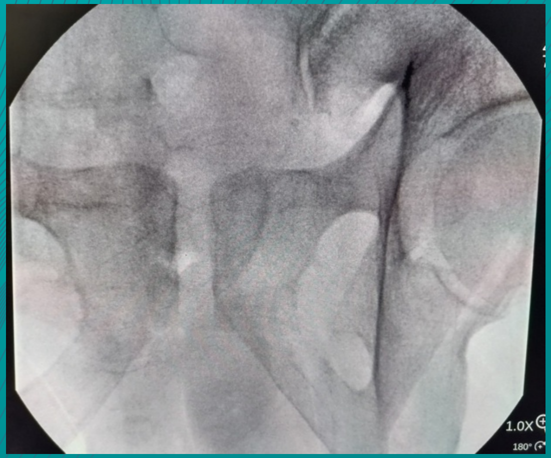

Перелом нижней ветви лонной кости (седалищной кости) со смещение
нет - 0, минимальное - 1; >50% - 2 ; полное - 3
группа 1
группа 2
Число пациентов
Баллы

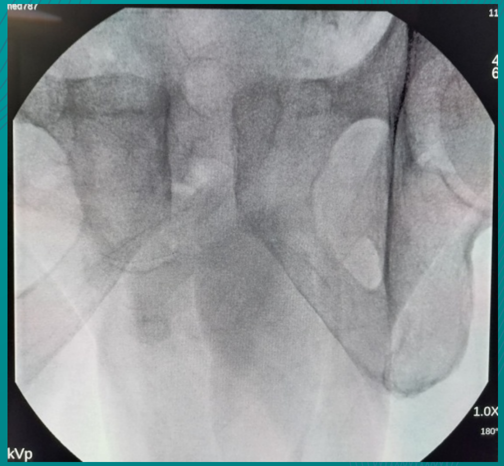
Стресс-исследование тазового кольца под рентгеноскопией











Спасибо за внимание!