SnapPelvis

International Prospective Observational Cohort Study of Traumatic Pelvic Ring Injuries

www.estesonline.org
ESTES
EUROPEAN SOCIETY FOR TRAUMA AND EMERGENCY SURGERY

CONTRIBUTOR MANUAL

An international non-randomized time-bound prospective observational cohort study addressing the epidemiology and management of Traumatic Pelvic Ring Injuries

Study period: January 1st 2025 – September 30th 2025

ClinicalTrials.gov Registration: NCT06540339

ESTES SnapPelvis Study Steering Committee

Name	Country	Center	Email
Univ.-Prof. Dr, med, Frank Hildebrand, MHBA ***Chair**	Germany	University Hospital RWTH Aachen, Aachen	fhildebrand@ukaachen.de
Univ.-Prof. Dr. med. Hans-Christoph Pape	Switzerland	University Hospital Zurich, Zurich	hans-christoph.pape@usz.ch
Prof. Dr. Inger B. Schipper, MD PhD FACS	Netherlands	Leiden University Medical Center,Leiden	I.B.Schipper@lumc.nl
PD Dr. med. habil. Andreas Höch	Germany	University Hospital Leipzig, Leipzig	Andreas.hoech@medizin.uni-leipzig.de
Gary Alan Bass, MD MBA PhD FEBS (Em Surg)	USA / Ireland	University of Pennsylvania, Philadelphia	Gary.bass@pennmedicine.upenn.edu
Shahin Mohseni, MD PhD FACS hFEBS(Em Surg)	Sweden	Orebro University Hospital, Orebro	mohsenishahin@yahoo.com
Dr. med. Eftychios Bolierakis	Germany	University Hospital RWTH Aachen, Aachen	ebolierakis@ukaachen.de

SnapPelvis

International Prospective Observational Cohort Study of Traumatic Pelvic Ring Injuries

What is a Snapshot Audit?

For some surgical conditions and scientific questions, the “real world” effectiveness of surgical patient care may be better explored using a multi-institutional time-bound observational cohort assessment approach (termed a “snapshot audit”) than by retrospective review of administrative datasets or by prospective randomized control trials. Multi-center, snapshot cohort studies or audits have the ability to gather large patient numbers in short time periods from many healthcare systems with different resources or practices of care concerning one specific surgical condition. They allow exploration of differences in patient populations and management across the sampled cohort to identify areas of practice variability that may result in apparent differences in outcome. As such, whilst not providing true evidence of efficacy or the impact of a single variable on overall outcome, they can be hypothesis-generating and identify areas warranting further study in future randomized controlled trials (1). Snapshots also shed light on the real world practice, rather than the presumed or guideline suggested patient care (2).

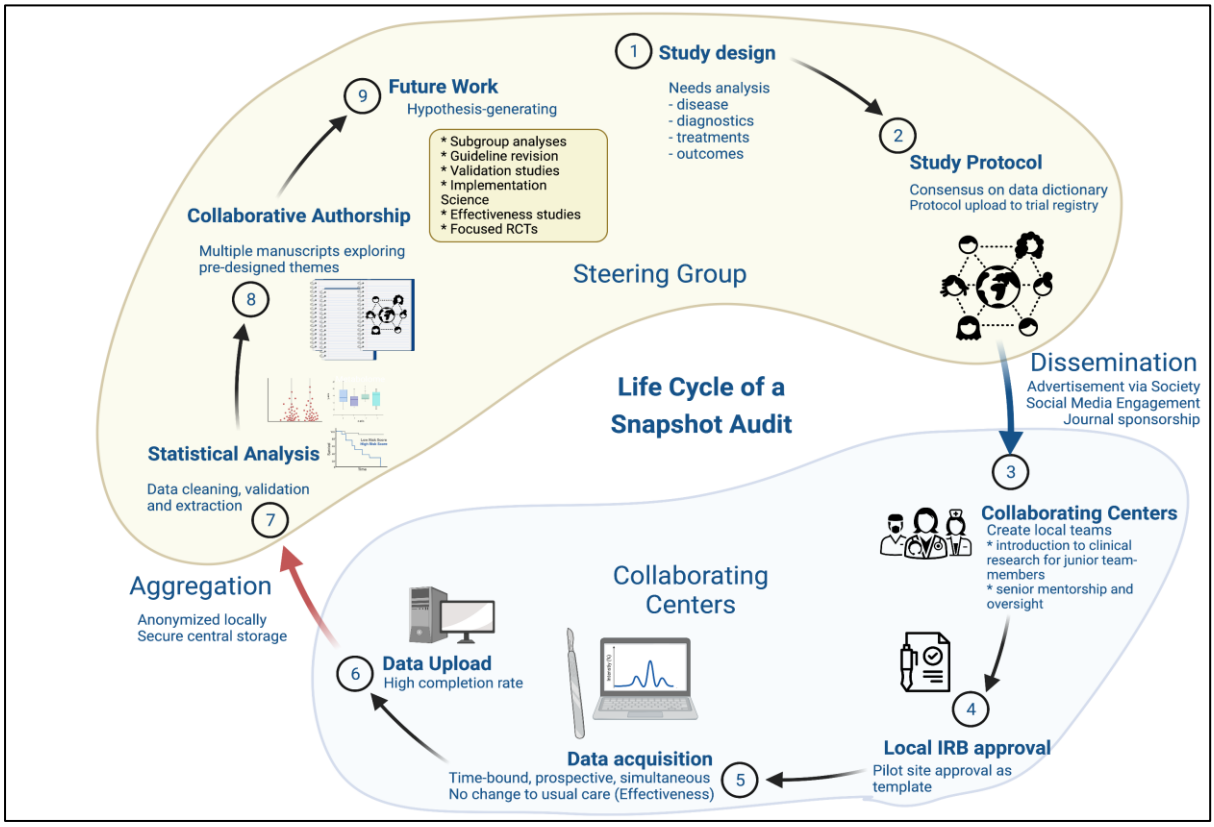


Figure 1 - Snapshot audit – process flow

The European Society for Trauma and Emergency Surgery (ESTES) has recognized the strengths of this form of research, as well as its power in bringing together surgeons and emergency surgical units across multiple regions or countries for a common research goal, thus strengthening an active network of research participation across Europe.

Scope

Traumatic Pelvic Ring Injuries (TPRI) represent a broad spectrum of trauma-associated pathologies with a distinct bimodal age distribution in patients admitted through the Emergency Departments of all acute care hospitals. In younger patients, this type of injury is often associated with high-energy trauma, hemodynamic instability, high mortality and morbidity rates (3-6). In the elderly population, pelvic fractures result from low energy trauma mechanisms (e.g. ground level fall) and can affect the long-term independency and life quality of geriatric patients (7).

There is substantial variation in the management of pelvic ring injuries among pelvic trauma surgeons; these variations include but are not limited to the timing of definitive fixation, the indications and protocols of conservative treatment, and the appropriate osteosynthesis of the anterior and/or posterior pelvic fractures (8).

This 'ESTES snapshot audit' -a prospective observational cohort study- has a dual purpose. Firstly, as an epidemiological study, it aims to report the burden of injury in specific hospitals, distributed widely throughout Europe. Secondly, it aims to demonstrate current strategies for both, younger (after high-energy trauma) and geriatric patients (after low-energy trauma) employed to assess and treat these patients. These twin aims will serve to provide a 'snapshot' of what we are doing now, but will also be hypothesis-generating while providing a rich source of patient-level data to allow further analysis of particular clinical questions. The acquired study data can be subsequently evaluated and compared to patient data of established pelvic trauma registries across Europe.

Key Study Dates

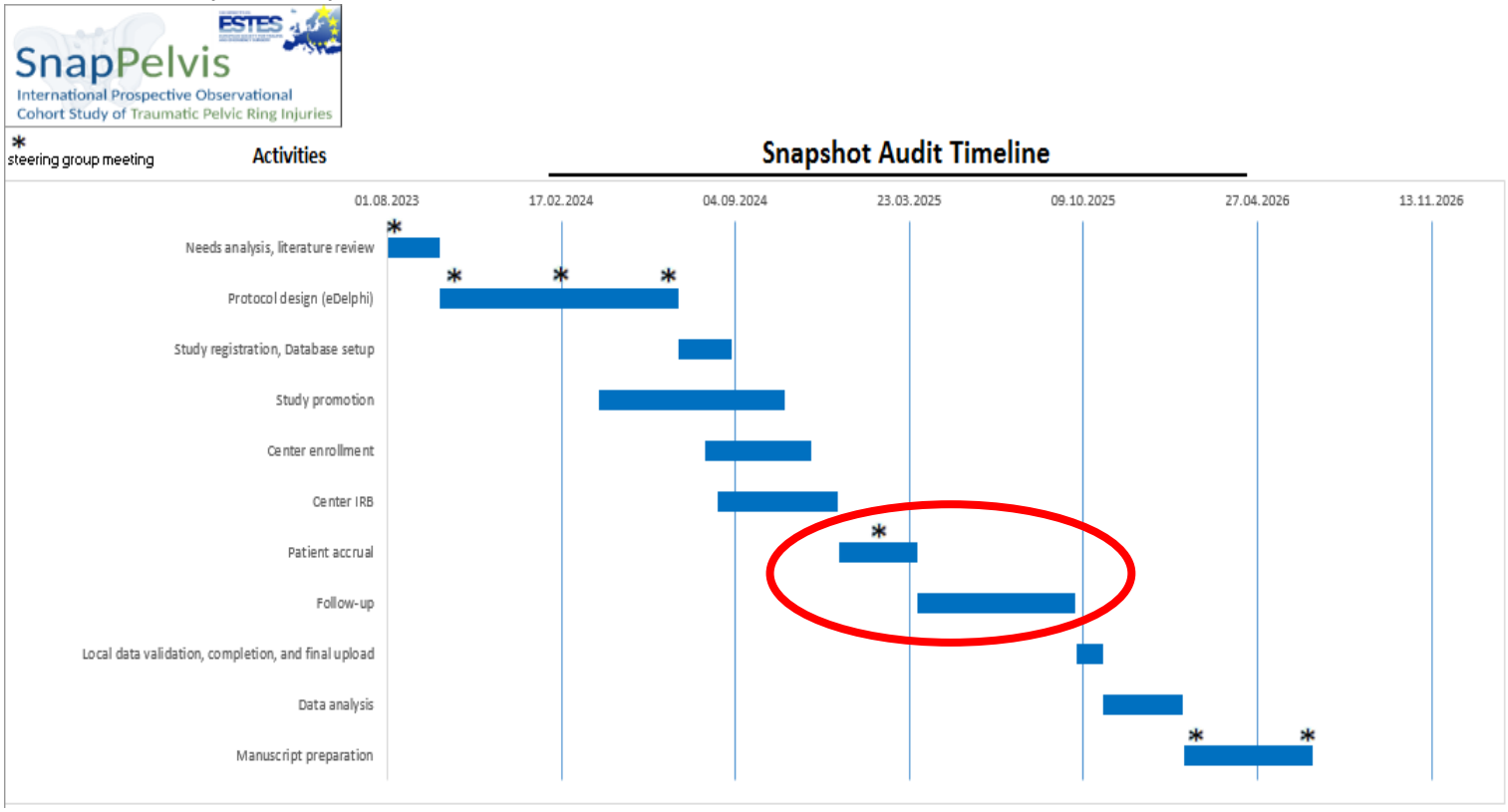


Figure 2 - Timeline for snapshot audit

01AUGUST2024	Center enrolment and local IRB submission
01JANUARY2025-31MARCH2025	Ninety (90) consecutive day patient enrolment
31MARCH2025	Final day for new patient enrolment
30SEPTEMBER2025	Final day of patient follow-up (180 days since last admission)
01OCTOBER2025-31OCTOBER2025	Local data validation, completion, and final upload
01NOVEMBER2025	REDCap® database locked; this is the deadline for data submission and center inclusion.

Definitions

-Traumatic pelvic ring injury (TPRI): Any injury to the bony or supporting ligamentous structures of the pelvis after trauma (9).

-Anterior pelvic ring: Os pubis, Os ischium, pubic symphysis, anterior part of Os ilium (8).

-Posterior pelvic ring: Posterior part of Os ilium, sacroiliac joints, Os sacrum (9).

-Complex pelvic trauma: Traumatic pelvic ring injuries associated with open fractures and/or injury to the urethra, bladder, vagina, penis or scrotum, pelvic soft tissue (e.g. Morel-Lavallée-lesion) rectum, sigmoid, nerves from the lumbosacral plexus, venous and arterial structures of the retroperitoneum (10).

-AO/OTA classification: The AO/OTA classification is one of the most up-to-date systems for classifying pelvic ring injuries. Like other injured anatomical regions, they are divided into three groups based on the severity of the respective injury (Appendix A) (11):

- Type A: intact posterior pelvic ring (A1: pubic or innominate bone avulsion fracture, A2: pubic or innominate bone fracture, A3: transverse sacral fracture without involvement of the sacroiliac joint)
- Type B: incomplete posterior pelvic ring disruption (B1: incomplete posterior arch injury with no rotational instability, B2: unilateral posterior arch injury with rotational instability, B3: bilateral posterior arch injury with rotational instability)
- Type C: complete posterior pelvic ring disruption (C1: complete unilateral posterior arch disruption or vertical shear injury, C2: bilateral posterior arch injury with complete disruption of one side and incomplete disruption of the other, C3: complete bilateral posterior arch disruption)

-Mechanism of injury classification (Young and Burgess): The most widely used classification that is based on the mechanism of injury is that of Young and Burgess, which subgroups the pelvic ring injuries into four major categories (Appendix B) (9, 12-13):

- *LC (Lateral Compression) mechanism*: This injury pattern results from a force directly applied to the iliac bone or the greater trochanter, causing internal rotation of the injured hemipelvis. A pure LC force vector causes compression of the posterior sacroiliac complex. Although the bone (e.g., sacrum or posterior ilium) may fracture, the surrounding soft tissues usually remain intact. The associated anterior ring injury may be ipsilateral or contralateral to the posterior injury, fracture all four (bilateral superior and inferior) pubic rami, disrupt the pubic symphysis, or include any combination thereof.

1. LC I: sacral compression fracture on the side of impact
2. LC II: fracture of the ilium (crescent fracture) as posterior ring injury
3. LC III: LC I or LC II injury with contralateral open book injury pattern (windswept pattern)

- *APC (Anterior Posterior Compression) mechanism*: This injury pattern results from a direct back-to-front blow to the posterior-superior iliac spines, a direct front-to-back blow to the anterior-superior iliac spines, and an indirect force through external rotation of the femur. APC forces initially disrupt the anterior pelvic ring structure (e.g., pubic symphysis) followed by the anterior sacroiliac and the sacrospinous ligaments, creating a rotationally unstable pelvis.

1. APC I: open book injury pattern with anterior pelvic ring injury, usually symphysis diastasis (>1cm, <2,5cm), and intact sacroiliac ligaments
2. APC II: open book injury pattern with anterior pelvic ring injury, usually symphysis diastasis (>2,5cm), and ruptured anterior but intact posterior sacroiliac ligaments
3. APC III: complete separation of the hemipelvis with anterior pelvic ring injury, usually symphysis diastasis (>2,5cm), and complete disruption of the sacroiliac ligaments

- *VS (Vertical Shear) mechanism*: This injury pattern results from a shearing force, which is one that courses in the vertical plane perpendicular to the main posterior bony trabecular pattern, as in a fall from a height. The posterior injury can occur through the sacrum, sacroiliac joint, ilium, or any combination thereof. Similarly, the anterior lesion can occur through any of the anterior structures. With complete disruption of the posterior sacroiliac complex, the hemipelvis becomes globally unstable and can translate in any plane.
- *Combined mechanism*: combination of the above mentioned injury patterns.

-Fragility fractures of the pelvis (FFP): Low-energy pelvic fractures in osteoporotic patients (14). The comprehensive classification of the FFP is based on the degree of instability, which is the critical aspect for the decision-making process about the indication, type and extent of surgical treatment. A FFP Type I lesion corresponds to an isolated anterior pelvic ring fracture. In FFP

Type II lesions, moderate instability results from an undisplaced unilateral sacral fracture with or without an anterior pelvic ring injury. FFP Type III lesions have a high degree of instability after displaced unilateral posterior injury running through the iliac bone, through the sacroiliac joint and/or through the sacrum with a concomitant anterior pelvic ring fracture. FFP Type IV lesions have the highest instability because of a complete spinopelvic dissociation after displaced bilateral dorsal injuries, which may be combined with different types of uni- or bilateral anterior injury (Appendix C) (14).

Proposed Study Questions

For any given surgical condition, there are broad variations in care approaches, delivery methods, and outcomes that merits investigation. These variations are important to recognize and explore as those differences in care may disclose the question that further study, such as a prospective randomized control trial, may ideally be suited to answer.

Primary Research Questions

- What is the incidence of

    1. High-energy pelvic ring injuries (group A)
    2. Complex pelvic trauma (group B)
    3. Low-energy fragility fractures of the pelvis (group C)

    in specific treating hospitals, distributed widely throughout Europe?

- What are the treatment algorithms currently employed in the acute and definitive management for these groups?
- What is the proportion of non-operatively managed patients for these groups?
- What are the proportion and type of fixation of patients treated surgically for these groups?
- What is the mortality rate for these groups?
- What is the rate of systemic complications for these groups?
- What is the re-admission rate for fracture-related implant failure, infections and re-operations within 6 months for these groups?

Secondary Research Questions

- What are the common patterns of traumatic pelvic ring injuries for these groups?
- What is the prevalence of complications in the non-operative management of traumatic pelvic ring injuries for these groups?
- What are the radiological and clinical outcomes of the operative management depending on the type of fixation for these groups?
- What are the pelvic outcome score (15) and rate of social reintegration after traumatic pelvic ring injuries for these groups?

Methods

Summary

Prospective audit of consecutive patients diagnosed in the Emergency Department with traumatic pelvic ring injuries over a 3-month period. The audit shall include unscheduled patient admissions from January 2025 until March 2025 as outlined in ``Key Study Dates``.

As this is an observational cohort audit, no change to normal patient management is required.

Primary Objective

To uncover the burden of traumatic pelvic ring injuries in participating hospitals throughout Europe. To explore differences in patients, management strategies and outcomes for both, younger (after high-energy trauma) and geriatric patients (after low-energy trauma) to identify areas of practice variability resulting in apparent differences in outcome warranting further study.

The outcomes that the study will examine in the entire patient cohort are:

- Incidence of traumatic pelvic injuries in specific treating hospitals, distributed widely throughout Europe, subdivided into
    1. High-energy pelvic ring injuries (group A)
    2. Complex pelvic trauma (group B)
    3. Low-energy fragility fractures of the pelvis (group

    .
- Investigation of specific aspects for these 3 groups focusing on
    - Acute care.
    - Diagnostic work-up.
    - Surgical strategies in the management of polytraumatised patients (e.g. Early Total Care (ETC), Damage Control Orthopedics (DCO), Safe Definitive Orthopedic Surgery (SDS))
    - Non-operative and operative management strategies
    - Postoperative care.

- Time to surgery and postoperative functional/radiological outcomes.
- Complications related to injury and/or related therapies within 180 post-operative days.
- Length of Emergency Department, Intensive Care Unit and Hospital stay.
- Re-admission within 6 months for fracture-related implant failure, infections and re-operations.

Methods for identifying patients

Multiple methods may be used according to local circumstances/staffing:

1. Daily review of emergency department (non-operative) and operating room lists.
2. Daily review of team handover sheets / emergency admission lists / ward lists.
3. Review of operating room logbooks.
4. Use of electronic systems to flag any readmissions of patients identified and treated.

Inclusion and Exclusion Criteria

Inclusion Criteria:

Adult patients (≥18 years of age) admitted for traumatic pelvic ring injuries (AO/FFP-Classification).

Exclusion criteria:

Concomitant acetabular fractures

Center eligibility

All hospitals/units performing orthopedic pelvic trauma surgery in Europe are eligible to join this audit. No unit size or case throughput stipulations are made. Any clinical center is welcome to participate so long as the protocol is adhered to.

All participating centers will be required to register their details with the ESTES cohort study office and will be responsible for their own local approvals process prior to the start of the data collection period. Inclusion of data sets will be subject to local approval from participating clinical Centers.

Centers should ensure that they have appropriate pathways and staffing to include all consecutive eligible patients during the study period and provide the required data entry before locking of the study REDCap® database on the November 1st 2025.

Patient follow-up

The audit is designed so that normal patient follow-up pathways can be used to obtain outcome data. No additional visits or changes to normal follow-up should be made. However, local investigators should be proactive in identifying post-diagnosis events (or lack thereof), within the limits of normal follow-up. These may include reviewing the patient notes (paper and electronic) during admission and before discharge to note in-hospital complications, reviewing hospital systems to check for re-attendances or re-admissions, and reviewing post-operative radiology reports.

Data acquisition

This research is an observational and non-interventional audit that collects data along the usual course of management pathway. The Data Collection Instrument (DCI; Appendix E) has been designed to reflect common parameters. We envisage that participating clinical centers will identify a team of 4-5 members; one Consultant (clinical 'lead' of the study), trainee surgeons or data administrators who will undertake the logistical roles as well as co-ordinate data entry.

Missing data and retrospective patient entry

The online database has been designed to allow sites to securely access an individual patient's data throughout the study period. This means that any missing or erroneous data can be altered by the local investigators whilst the data collection period is ongoing.

The study design means that sites may retrospectively identify eligible patients that were missed primarily and for whom contemporaneous patient and operation data was not entered.

Local approvals

All data collected will measure current practice, with no changes made to normal treatment. As such, this study should be registered as an audit of current practice at each participating Center. It is the responsibility of the local team at each site to ensure that local audit approval (or equivalent) is completed for their Center. Participating Centers will be asked to confirm that they have gained formal approval at their site.

Authorship

Investigators from each individual site will be included as formal co-investigators in this research and will be PubMed searchable and citable. The output from this research will be published by the steering group on behalf of a single corporate authorship – e.g "ESTES SnapPelvis Group."

Data collection system, information governance and protection of personal data

Data will be recorded on a dedicated, secure server running on the REDCap® web application. REDCap® allows for secure upload and storage of data, in compliance with European Union General Data Protection Regulation 2018 (GDPR) and the Health Insurance Portability and Accountability Act of 1996 (HIPAA) legislation. Participating study centers will declare their primary investigators, who have to belong to the responsible medical team for the local study population. Contractual obligation of compliance with the aforementioned guidelines must be declared on the basis of a data sharing agreement between the ESTES SnapPelvis Study Steering Committee and the local study centers. Following data sharing agreement and local institutional review board approval, the registered local investigators will receive their login credentials for the REDCap® study platform over encrypted Netscaler-protected browser. The personal patient data must be pseudonymised prior to transmission to the study platform in the end of the follow-up period. The corresponding look-up-table will only be accessible to the local investigators, who need to already have access to the relevant patient data as members of the responsible medical team for the local study population irrespective of the study purpose. Patient data, which are not routinely processed during medical care of the local study population, will not be collected. Following data transmission, the patient data will be further processed only as cumulative data sets and not as separate patient records. Individual patient identification will not be possible after retrospective data transmission. Registered local investigators will have individual password-protected access only to their unit's data entered

on to REDCap®. Other sites' data will not be accessible. It is the responsibility of each participating center to ensure their own records comply with local data governance legislation, GDPR or HIPAA, as applicable ('accountability'). The registered local investigators have to ensure through appropriate technical and organizational measures in cooperation with the local data protection supervising authority that patient data will be processed lawfully, fairly and in a transparent manner in relation to the data subject and study purpose ('lawfulness, fairness and transparency'). Patient data will be collected for the aforementioned specified, explicit and legitimate study purposes and not further processed in a manner that is incompatible with those purposes; further processing for archiving purposes in the public interest, scientific or historical research purposes or statistical purposes is not considered to be incompatible with the initial purposes ('purpose limitation'). Data management will be relevant and limited to what is necessary in relation to the study purposes for which they are processed ('data minimization'). The registered local investigators must ensure that patient data are accurate and, where necessary, kept up to date; every reasonable step must be taken to ensure that personal data that are inaccurate, having regard to the purposes for which they are processed, are erased or rectified without delay ('accuracy'). Furthermore, data processing must be conducted in a manner that ensures appropriate security of the personal data, including protection against unauthorized or unlawful processing and against accidental loss, destruction or damage, using appropriate technical or organizational measures ('integrity and confidentiality'). The patient data will be archived for 10 years and then deleted ('storage limitation'). In case of incompliance with the aforementioned principles, the concerned study center will be excluded from the study and the transmitted data, if applicable, will be deleted from the study platform.

Data governance

A data sharing agreement with specification of data governance must be signed between the ESTES SnapPelvis Study Steering Committee and each of the participating local study centers prior to enrolment.

The primary patient data stay under the governance of the respective local study centers throughout the duration of the study and are transmitted via REDCap in a processed pseudonymised form to the ESTES Research Committee.

The ESTES Research Committee welcomes the use of the processed data for further research that increases the knowledge in the field, highlights areas where more research is needed for

the benefit of future patients . Requests can be submitted to the ESTES Research Committee. Data sharing is subject to ESTES approval and the appropriate safeguarding as determined by the ESTES. Any future sub-projects should also comply with our policy of a single corporate authorship e.g. “ESTES SnapPelvis Group” or similar. However, authors’ contributions will be highlighted in accordance with the recommendations for the conduct, reporting, editing, and publication of scholarly work in medical journals.

Publication of data

The report of this audit will be prepared in accordance with guidelines set by the STROBE (strengthening the reporting of observational studies in epidemiology) statement for observational studies (Appendix D). Data will be published as a pool from all participating units. Subgroup analyses by injury pattern and severity, treatment technique or outcome variables may be presented, but no hospital-level or surgeon-level data will be published whereby an individual patient, unit or surgeon could be identified. If local investigators would like a breakdown of their own unit’s data for benchmarking purposes and local presentation/discussion, this can be made available after the end of the study; however, it will not be possible or permissible to de-anonymize patient data stored in REDCap®, in strict compliance with GDPR and HIPAA.

Financial arrangements

This study is undertaken voluntarily by participating institutions under the co-ordination of the Emergency Surgery Cohort Study Steering Committee. It is not anticipated that participating Centers would bear any costs. Similarly, no financial reimbursement will be made to units or investigators.

Key steps for successful inclusion of your Center

- Contact a member of the **ESTES SnapPelvis Study Steering Committee** (see contact details earlier in this Protocol Document) about participation in the study at the Center of your choice. They will connect you to any other interested medical students and doctors at your Center or country.

- Form a **team** of **up to six collaborators**. The **Principal Investigator** (PI) should co-ordinate the team and lead audit registration/data collection. This can be a doctor of any grade but should preferably be a consultant/attending surgeon. Ideally, trainee/residents should be involved at each Center. You will need to submit an ORCID number for each collaborator; this is free and easy to set up (www.orcid.org), and is the most reliable way for the journal publishers to link each collaborator with a manuscript in PubMed.

- The data collection period will be **01st January 2025 – 30th September 2025**. Your team must ensure its availability to collect 9 months consecutive data during the study period.

- Ensure that you secure **formal ethics committee** (or similar entity) **approval** from your hospital according to local regulations. This must be done prior to commencing data collection. **If you have any difficulties or are unsure what is required contact the ESTES SnapPelvis Study Steering Committee or your supervising surgeon, or your local ethics committee chairperson.**

- Once the local ethics committee approval is received, please forward evidence of this to the **ESTES SnapPelvis Study Steering Committee Chair (contact details at the beginning of this Manual).** REDCap® accounts will not be issued until proof of approval is received.

- Arrange to **meet** with the other members of your team, including the trainee/resident and supervising consultant/attending. Agree in advance, who will

be responsible for each stage of the project, e.g. identifying patients, collecting baseline data, completing follow-up, data entry to REDCap®. Talk through how you will identify patients and collect required data; it will be particularly helpful if the consultant/attending is present to offer guidance regarding this.

- **Identify** all patients meeting **inclusion criteria** within the study window.

- Regularly **follow-up** for information on complications over the designated **180-day period.** This study is **prospective,** so you should not wait until the end of the post-operative period to follow-up patients. Discuss the best way to follow up patients with the consultant/attending supervising your audit, as this will vary from Center to Center.

- Ensure all data has been uploaded to the REDCap® system and you have completed all fields, avoiding **missing data points**.

Reference list

1. Bass, G. A., Kaplan, L. J., Ryan, É. J., Cao, Y., Lane-Fall, M., Duffy, C. C., ... & Mohseni, S. (2023). The snapshot audit methodology: design, implementation and analysis of prospective observational cohort studies in surgery. European Journal of Trauma and Emergency Surgery, 49(1), 5-15.
2. Bass, G. A., Gillis, A., Cao, Y., & Mohseni, S. (2022). Patterns of prevalence and contemporary clinical management strategies in complicated acute biliary calculous disease: an ESTES 'snapshot audit'of practice. European Journal of Trauma and Emergency Surgery, 1-13.
3. Enninghorst, N., Toth, L., King, K. L., McDougall, D., Mackenzie, S., & Balogh, Z. J. (2010). Acute definitive internal fixation of pelvic ring fractures in polytrauma patients: a feasible option. Journal of Trauma and Acute Care Surgery, 68(4), 935-941.
4. Ertel, W., Keel, M., Eid, K., Platz, A., & Trentz, O. (2001). Control of severe hemorrhage using C-clamp and pelvic packing in multiply injured patients with pelvic ring disruption. Journal of orthopaedic trauma, 15(7), 468-474.
5. Lögters, T., Lefering, R., Schneppendahl, J., Alldinger, I., Witte, I., Windolf, J., ... & TraumaRegister der DGU. (2010). Interruption of the diagnostic algorithm and immediate surgical intervention after major trauma–incidence and clinical relevance: Analysis of the trauma register of the German Society for Trauma Surgery. Der Unfallchirurg, 113, 832-838.
6. Timmer, R. A., Mostert, C. Q., Krijnen, P., Meylaerts, S. A., & Schipper, I. B. (2023). The relation between surgical approaches for pelvic ring and acetabular fractures and postoperative complications: a systematic review. European Journal of Trauma and Emergency Surgery, 49(2), 709-722.
7. Küper, M. A., Trulson, A., Stuby, F. M., & Stöckle, U. (2019). Pelvic ring fractures in the elderly. EFORT open reviews, 4(6), 313-320.
8. Parry, J. A., Funk, A., Heare, A., Stacey, S., Mauffrey, C., Starr, A., ... & Trikha, V. (2021). An international survey of pelvic trauma surgeons on the management of pelvic ring injuries. Injury, 52(10), 2685-2692.
9. Moed, B. R., & Bieneman, B. K. (2012). Musculoskeletal trauma, pelvic angioembolization. Encyclopedia of Intensive Care Medicine. Vincent JL., Hall JB.

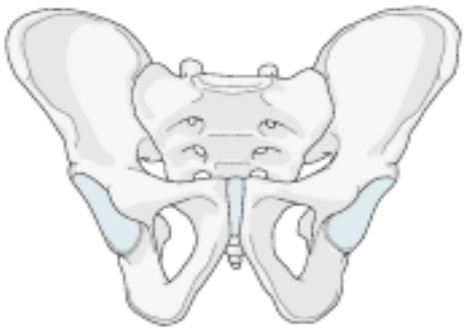
10. Schmal, H., Markmiller, M., Mehlhorn, A. T., & Sudkamp, N. P. (2005). Epidemiology and outcome of complex pelvic injury. Acta Orthop Belg, 71(1), 41-7.
11. Meinberg, E. G., Agel, J., Roberts, C. S., Karam, M. D., & Kellam, J. F. (2018). Fracture and dislocation classification compendium—2018. Journal of orthopaedic trauma, 32, S1-S10.
12. Young, J. W., Burgess, A. R., Brumback, R. J., & Poka, A. (1986). Pelvic fractures: value of plain radiography in early assessment and management. Radiology, 160(2), 445-451.
13. Burgess, A. R., Eastridge, B. J., Young, J. W., Ellison, T. S., Ellison Jr, P. S., Poka, A., ... & Brumback, R. J. (1990). Pelvic ring disruptions: effective classification system and treatment protocols. Journal of Trauma and Acute Care Surgery, 30(7), 848-856.
14. Rommens, P. M., & Hofmann, A. (2013). Comprehensive classification of fragility fractures of the pelvic ring: recommendations for surgical treatment. Injury, 44(12), 1733-1744.
15. Pohlemann, T., Gänsslen, A., Schellwald, O., Culemann, U., & Tscherne, H. (1996). Outcome after pelvic ring injuries. Injury, 27, 31-38.

Appendix A

AO/OTA classification of pelvic ring injuries (11)

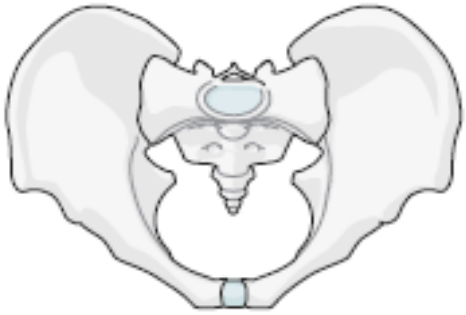
Pelvic ring

Bone: Pelvis 6



61

Location: Pelvis, **pelvic ring** 61



Types:

Pelvis, pelvic ring, **intact posterior arch**
61A

Pelvis, pelvic ring, **incomplete disruption of posterior arch**
61B

Pelvis, pelvic ring, **complete disruption of posterior arch**
61C

Qualifications *are optional and applied to the fracture code where the asterisk is located as a lower-case letter within rounded brackets. More than one qualification can be applied for a given fracture classification, separated by a comma. For a more detailed explanation, see the compendium introduction.*

DOI: 10.1097/BOT.0000000000001066

61A

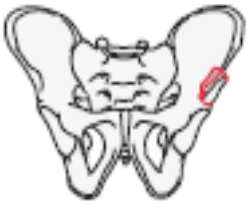
Type: Pelvis, pelvic ring, **intact posterior arch** 61A

Group: Pelvis, pelvic ring, intact posterior arch, **innominate bone avulsion fracture** 61A1

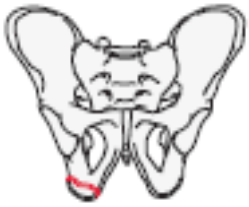
Subgroups:

Anterior superior iliac spine fracture
61A1.1

Anterior inferior iliac spine fracture
61A1.2



Ischial tuberosity fracture
61A1.3

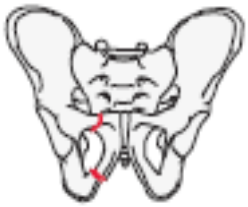


Group: Pelvis, pelvic ring, intact posterior arch, **innominate bone fracture** 61A2

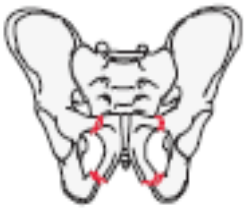
Subgroups:

Iliac wing fracture
61A2.1

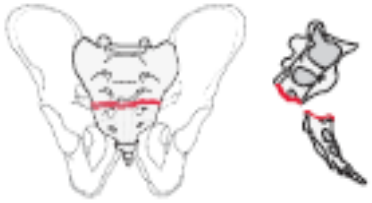
Unilateral fracture of the anterior arch
61A2.2



Bilateral fractures of the anterior arch
61A2.3



Group[1]: Pelvis, pelvic ring, **transverse fracture of sacrum (S3, S4, S5) and coccyx** 61A3



[1]*Fracture of the upper sacral segments attached to sacroiliac joints (S1, S2) are classified as part of the pelvic ring injury. If a more detailed classification is required refer to sacral classification (54) in the Spine classification.*

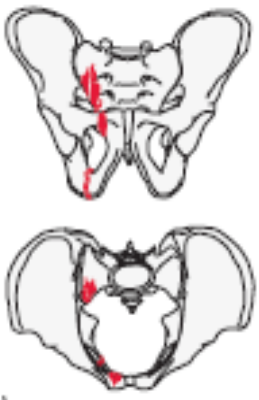
61B

Type: Pelvis, pelvic ring, **incomplete disruption of posterior arch** 61B

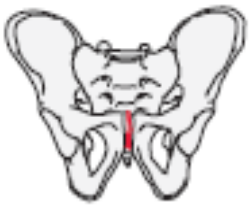
Group: Pelvis, pelvic ring, incomplete disruption of posterior arch, **no rotational instability** 61B1

Subgroups:

Lateral compression fracture (LC1)
61B1.1*



Open book fracture (APC1)
61B1.2

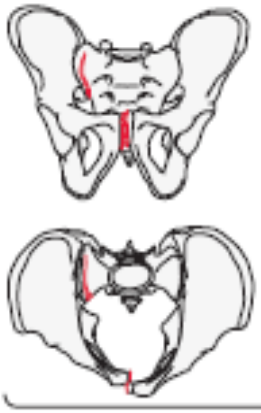


*Qualifications:
- a **Ipsilateral or unilateral pubic ramus fracture**
- b Bilateral pubic rami fracture
- c Contralateral pubic ramus fracture
- e Paresymphyseal fracture
- f Tilt fracture
- g Locked symphysis

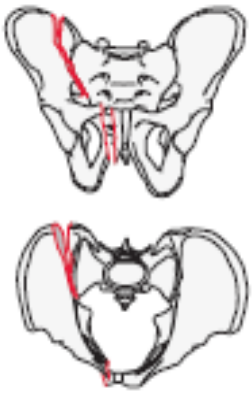
Group: Pelvis, pelvic ring, incomplete disruption of posterior arch, **rotationally unstable, unilateral posterior injury** 61B2

Subgroups:

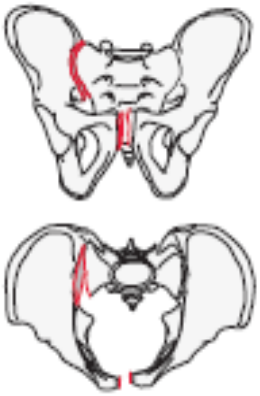
Lateral compression fracture of the sacrum with internal rotation instability (LC1)
61B2.1*



Lateral compression fracture of the ilium (crescent) with internal rotation instability (LC2)
61B2.2*



Open book or external rotation instability (APC2)
61B2.3*

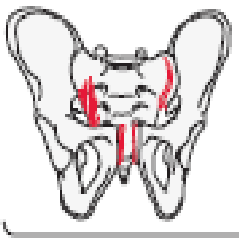


*Qualifications:
- a Ipsilateral or unilateral pubic ramus fractures
- b Bilateral pubic rami fractures
- c Contralateral pubic ramus fractures
- d Symphysis disruption
- e Paresymphyseal fracture
- f Tilt fracture
- g Locked symphysis

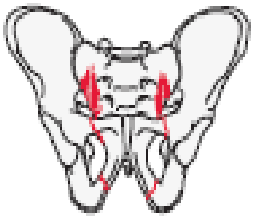
Group: Pelvis, pelvic ring, incomplete disruption of posterior arch, rotationally unstable, **bilateral posterior injury** 61B3

Subgroups:

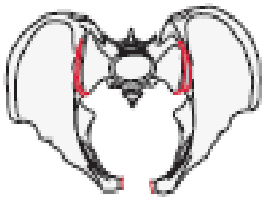
Internal rotationally unstable on one side and external rotationally unstable on the contralateral side (LC3)
61B3.1*



Bilateral lateral compression sacral fracture
61B3.2*



Open book or external rotation instability (bilateral APC2)
61B3.3*



*Qualifications:

a Ipsilateral or unilateral pubic ramus fractures
b Bilateral pubic rami fractures
d Symphysis disruption
e Parasymphyseal fracture
f Tilt fracture
g Locked symphysis

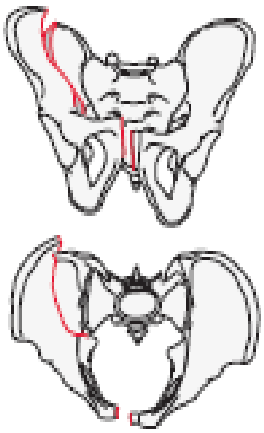
61C

Type: Pelvis, pelvic ring, **complete disruption of posterior arch** 61C

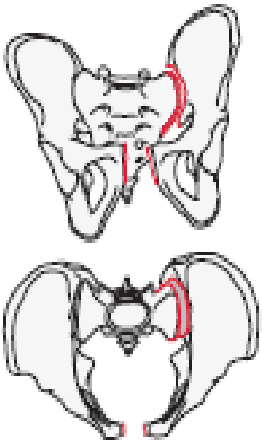
Group: Pelvis, pelvic ring, complete disruption of posterior arch, **unilateral posterior injury (APC3, vertical shear)** 61C1

Subgroups:

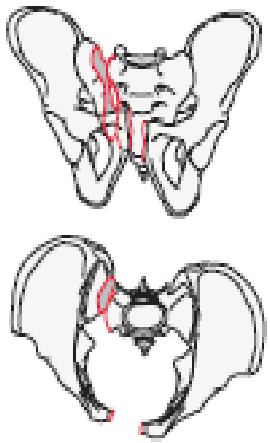
With iliac fracture
61C1.1*



Through the sacroiliac joint
61C1.2*



With a sacral fracture
61C1.3*



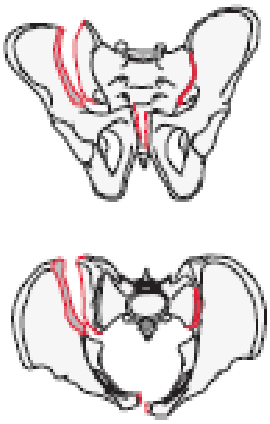
*Qualifications:

a Ipsilateral or unilateral pubic ramus fracture
b Bilateral pubic rami fracture
c Contralateral pubic ramus fracture
d **Symphysis disruption**
e Parasymphyseal fracture
f Tilt fracture
g Locked symphysis
j Sacroiliac joint fracture dislocation

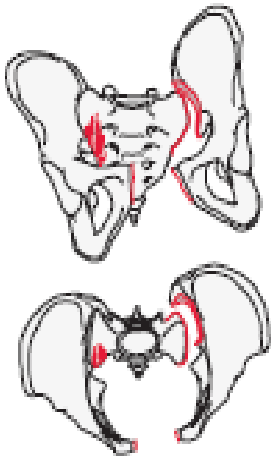
Group: Pelvis, pelvic ring, complete disruption of posterior arch, **bilateral posterior injury, one hemipelvis injury complete disruption, contralateral hemipelvis injury incomplete disruption (LC3)** 61-C2

Subgroups:

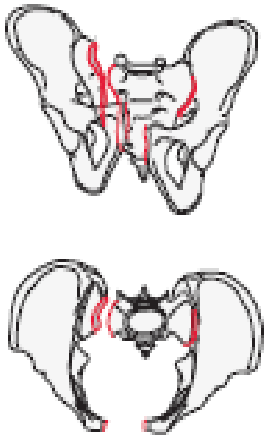
Complete disruption through ilium
61-C2.1*



Complete disruption through sacroiliac joint
61-C2.2*



Through the sacrum
61-C2.3*



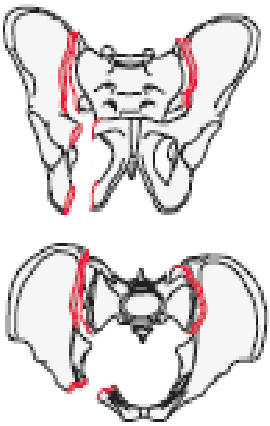
*Qualifications:

- a Ipsilateral or unilateral pubic ramus fracture
- b Bilateral pubic rami fracture
- c Contralateral pubic ramus fracture
- d **Symphysis disruption**
- e Parasymphyseal fracture
- f Tilt fracture
- g Locked symphysis
- k Contralateral posterior lateral compression lesion: sacrum
- l Contralateral posterior lateral compression lesion: ilium (crescent)
- m Contralateral posterior external rotation lesion: sacroiliac joint
- n Contralateral posterior external rotation lesion: fracture dislocation

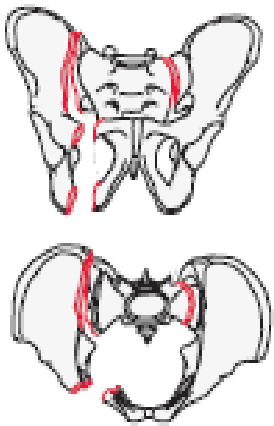
Group: Pelvis, pelvic ring, complete disruption of posterior arch, **bilateral posterior injury, both sides complete disruption (APC3, vertical shear)** 61-C3

Subgroups:

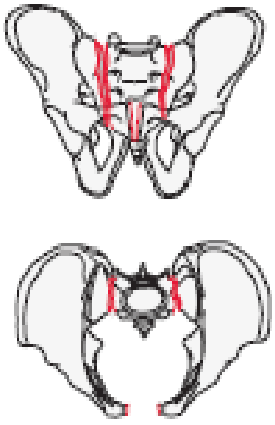
Extra-sacral on both sides
61-C3.1*



Sacral one side, extra sacral other side
61-C3.2*



Sacral both sides
61-C3.3*



*Qualifications:

- a Ipsilateral or unilateral pubic ramus fracture
- b Bilateral pubic rami fracture
- c Contralateral pubic ramus fracture
- d Symphysis disruption
- e Parasymphyseal fracture
- f Tilt fracture
- g Locked symphysis
- h Iliac wing fracture
- j Sacroiliac joint disruption

Qualifications *are optional and applied to the fracture code where the asterisk is located as a lower-case letter within rounded brackets. More than one qualification can be applied for a given fracture classification, separated by a comma. For a more detailed explanation, see the compendium introduction.*

Appendix B

Mechanism of injury classification (Young and Burgess) (13)

TABLE I
Injury classification keys

Category	Common Characteristic	Differentiating Characteristic
LC-I	Anterior transverse Fx (pubic rami)	Sacral compression on side of impact
LC-II	Anterior transverse Fx (pubic rami)	Crescent (iliac wing) Fx
LC-III	Anterior transverse Fx (pubic rami)	Contralateral open-book (APC) injury
APC-I	Symphyseal diastasis	*Slight* widening of pubic symphysis and/or SI joint; stretched but intact anterior and posterior ligaments
APC-II	Symphyseal diastasis or anterior vertical Fx	Widened SI joint; disrupted anterior ligaments; intact posterior ligaments
APC-III	Symphyseal diastasis or anterior vertical Fx	Complete hemipelvis separation, but no vertical displacement; complete SI joint disruption; complete anterior and posterior ligament disruption
VS	Symphyseal diastasis or anterior vertical Fx	Vertical displacement anteriorly and posteriorly, usually through SI joint, occasionally through iliac wing and/or sacrum
CM	Anterior and/or posterior, vertical and/or transverse components	Combination of other injury patterns: LC/VS or LC/APC

Appendix C

Fragility fractures of the pelvis (FFP) (14)

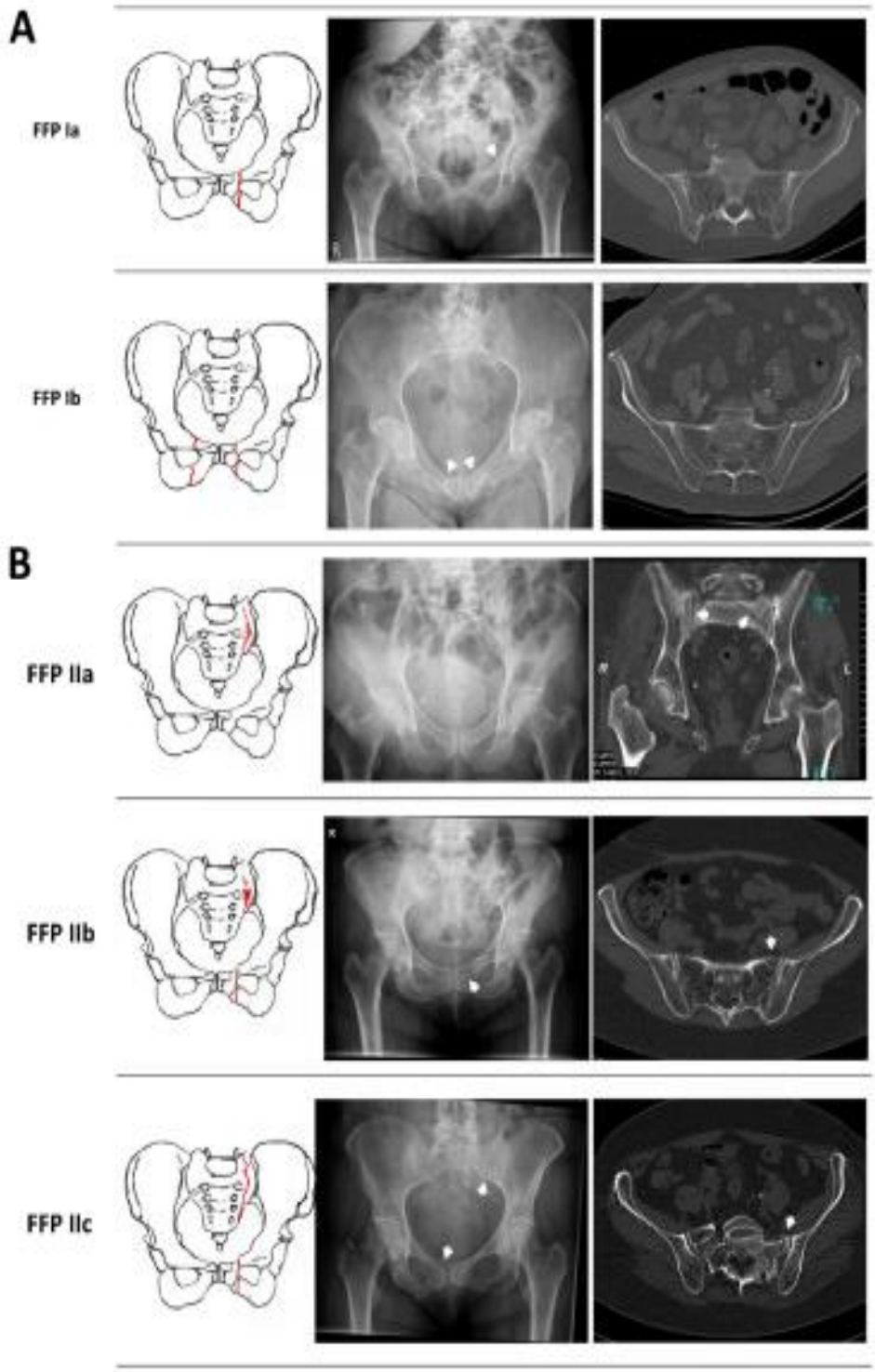


Fig. 3. Classification of fragility fractures of the pelvis (FFP). (A) FFP Type I – Anterior injury only. Type Ia: isolated unilateral anterior disruption. Type Ib: isolated bilateral anterior disruption. (B) FFP Type II – non-displaced posterior injury. Type IIa: isolated, non-displaced sacral fracture without involvement of the anterior pelvic ring. Type IIb: non-displaced sacral crush with anterior disruption. Type IIc: non-displaced sacral, iliosacral or ilium fracture with anterior disruption. (C) FFP Type III – displaced unilateral posterior injury. Type IIIa: displaced unilateral iliac fracture. Type IIIb: displaced unilateral iliosacral disruption. Type IIIc: displaced unilateral displaced sacral fracture. (D) FFP Type IV – displaced bilateral posterior injury. Type IVa: bilateral iliac fracture or bilateral iliosacral disruption. Type IVb: bilateral sacral fracture, spinopelvic dissociation. Type IVc: combination of different dorsal instabilities.

Appendix D

STROBE Statement Checklist items included in cohort studies reports

	Item No	Recommendation
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found
Introduction		
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported
Objectives	3	State specific objectives, including any prespecified hypotheses
Methods		
Study design	4	Present key elements of study design early in the paper
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up
		(*b*) For matched studies, give matching criteria and number of exposed and unexposed
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group
Bias	9	Describe any efforts to address potential sources of bias
Study size	10	Explain how the study size was arrived at
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding
		(*b*) Describe any methods used to examine subgroups and interactions
		(*c*) Explain how missing data were addressed
		(*d*) If applicable, explain how loss to follow-up was addressed
		(*e*) Describe any sensitivity analyses
Results		

Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed
		(b) Give reasons for non-participation at each stage
		(c) Consider use of a flow diagram
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders
		(b) Indicate number of participants with missing data for each variable of interest
		(c) Summarise follow-up time (eg, average and total amount)
Outcome data	15*	Report numbers of outcome events or summary measures over time
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included
		(*b*) Report category boundaries when continuous variables were categorized
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses
Discussion		
Key results	18	Summarise key results with reference to study objectives
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence
Generalisabilty	21	Discuss the generalisability (external validity) of the study results
Other information		
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based

*Give information separately for exposed and unexposed groups.

1. **Note:** An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at http://www.strobe-statement.or

Appendix E

REDCap® Data Collection Instruments

Hospital Details*	Key Name	Data
Primary, secondary or tertiary hospital	PSTERT	List
Trauma center level	TCLEV	Integer
Number of beds	NOB	Integer
Number of ICU beds	NOICUB	Integer
Number of general/orthopaedic trauma cosultants	GOTC	Integer
Number of pelvic trauma surgeons	POTC	Integer
Number of polytraumatized patients/month	NOPM	Integer
Medical specialty of the trauma leader	MSTL	List
Other medical specialty of the trauma leader	OMSTL	Chain
Possibility for emergent angioembolization	PEMANG	Binary
Is a hybrid operating room available for trauma patients?	HOTP	Binary

Data Collection Instrument 1 – Medical Center Demographics
*will be filled once for each center

Demographics	Key Name	Data Type
Country Code	CC	List
Center ID	CID	List
Patient ID	PID	Chain
Mode of admission	ADM	Binary
Age (years)	AGE	Integer
Sex	SEX	List
Body mass index	BMI	Calc
Trauma mechanism	TME	List
Working accident	WAC	Binary
Patient working (not pensioned) before accident	PATWO	Binary
Trauma energy	TRAUMEN	Binary
Trauma type	TTY	List
Injury Severity Score (ISS)	ISS	Integer
Maximum Abbreviated Injury Scale (MAIS)-head and neck	MHE	Integer
Maximum Abbreviated Injury Scale (MAIS)-face	MFA	Integer
Maximum Abbreviated Injury Scale (MAIS)-thorax	MTH	Integer
Maximum Abbreviated Injury Scale (MAIS)-abdomen	MAB	Integer
Maximum Abbreviated Injury Scale (MAIS)-extremities	MEX	Integer
Maximum Abbreviated Injury Scale (MAIS)-external	MXT	Integer

Data Collection Instrument 2 - Patient Demographics

Pre-injury Status	Key Name	Data Type
ASA-score	ASA	Integer
Charlson Comorbidity Index	CCI	Calc
Osteoporosis known before fracture	OSTEO	Binary

Medication for osteoporosis before facture	OSMED	List
Pelvic implants	PIM	List
Living conditions before injury	LCO	List
Pre-injury mobility	PIM	List
Clinical Frailty Scale	FRAIL	List

Data Collection Instrument 3 - Patient Pre-injury Status

Type of Injury	**Key Name**	**Data Type**
Type of TPRI	TOP	List
Anatomical injury classification	AID	List
Denis classification of sacral fractures	DENTRANSS	List
Young and Burgess classification	YBC	List
AO/OTA (2018) classification	AO	Chain
Fragility Fracture of the Pelvis	FFP	Binary
FFP-classification	FFPC	List
Complex pelvic trauma	CPET	Binary
Complex pelvic trauma : injured organ	CPEO	List
Dislocation of the anterior pelvic ring (mm)	DISAP	Decimal
Dislocation of the posterior pelvic ring (mm)	DISPP	Decimal

Data Collection Instrument 4- Type of TPRI

Primary In-hospital Management	**Key Name**	**Data Type**
Date of accident	DACC	Date
Date of admission	DADM	Date
Date of discharge (or confirmed death)	DDIS	Date
Death during primary in-hospital treatment	MORT	Binary
Cause of death during primary in-hospital treatment	RMORT	List
Source of fatal hemorrhage	SFHEM	List
Length of stay (days)	LOS	Calc
Length of ICU stay (days)	LOS	Integer
Duration of mechanical ventilation (hours)	DVENT	Integer
Activation of resuscitation trauma room	RTR	Binary
Type of preclinical pelvic immobilisation	PIMM	List
Preclinical pelvic immobilisation effective?	PBEFF	Binary
Hemorrhagic shock upon admission	HEMAD	Binary
Source of hemorrhagic shock upon admission	SHEMAD	List
First laboratory results- hemoglobin	LABHB	Decimal
First laboratory results - thrombocytes	LABTHR	Integer
First laboratory results - INR	LABINR	Decimal
First laboratory values - aPTT	LABPTT	Decimal
First laboratory values – base excess	LABBE	Decimal
First laboratory values – lactate	LABLAC	Decimal
Other measured prognostic biomarkers during first laboratory assessment	LABBIO	Chain
Number of packed red blood cells (pRBC) units in the first 24h	URBC	Integer
Number of fresh frozen plasma (FFP) units in the first 24h	UFFP	Integer
Number of concentrated thrombocyte units in the first 24h	UPLAT	Integer
Adminstration of tranexamic acid (g) in the first 24h	GTXA	Binary

Administration of adrenaline during the first 24h	ADADR	Binary
Administration of noradrenaline during the first 24h	ADNOR	Binary
Administration of dobutamine during the first 24h	ADDOB	Binary
Antibiotic prophylaxis	PXATB	Binary
Antibiotic treatment (if >1 day)	TTATB	Binary
Implementation of ROTEM/ROTEG	ROTE	Binary
Pelvic diagnostics	PDIAG	List
Preferred radiological projections	XRPDIAG	List
Emergent mechanical pelvic stabilisation in trauma room	EMPET	Binary
Type of EMPET	TEMPET	List
Was EMPET effective ?	EFEM	Binary
Emergent hemostasis in case of pelvic bleeding	EMHEM	Binary
Type of EMHEM	TEMHEM	List
Was EMHEM effective?	EFEMHEM	Binary
Surgical strategies in the management of polytraumatised patients	SURGSTR	List
Emergent mechanical pelvic stabilisation in the operation room?	EMPSOR	Binary
Type of EMPSOR	TEMPSOR	List
Was EMPSOR effective?	EFEMPS	Binary
Other emergent interventions	OEINT	Chain
Definitive TPRI treatment	DEFTPRI	Binary
Reasons for conservative DEFTPRI	RECON	List
Operative symphysis stabilisation	OPSYMP	Binary
Date of OPSYMP	DOPSYMP	Date
Type of OPSYMP	TOPSYMP	List
Osteosynthesis complication of OPSYMP	COPSYMP	Binary
Operative stabilisation of os pubis	OPPUB	Binary
Date of OPPUB	DOPPUB	Date
(per side) Type of OPPUB	TOPPUB	List
Osteosynthesis complication of OPPUB	COPPUB	Binary
Operative stabilisation of the sacroiliac joint	OPSI	Binary
Date of OPSI	DOPSI	Date
(per side) Type of OPSI	TOPSI	List
Osteosynthesis complication of OPSI	COPSI	Binary
Operative stabilisation of os sacrum	OPSAC	Binary
Date of OPSAC	DOPSAC	Date
(per side) Type of OPSAC	TOPSAC	List
Osteosynthesis complication of OPSAC	COPSAC	Binary
Duration (min) of operative definitive TPRI trearment	DDTPRI	Integer
Postoperative pelvic diagnostics	PPDIAG	List
(in case of x-ray as PPDIAG) Preferred projections	XRPPDIAG	List
Postoperative dislocation of the anterior pelvic ring (mm)	PDISAP	Decimal
Postoperative dislocation of the posterior pelvic ring (mm)	PDISPP	Decimal
Medication for osteoporosis after facture	POSMED	List
General complications	GCOMP	Binary
(in case of GCOMP) Type of GCOMP	TGCOPMP	List
(in case of thrombosis and/or pulmonary embolism) Venous thromboembolism prophylaxis before event	ATHPCO	Binary
Implant-associated or other surgical complications	IMCOPM	Binary

(in case of IMCOMP) Type of IMCOMP	TIMPCOMP	List
Operative revision?	OPREV	Binary
Number of OPREV	NOPREV	Integer
Date of first OPREV	DFOPREV	Date
Type of OPREV	TOPREV	List
Venous thromboembolism prophylaxis upon discharge	VTEDIS	List
Pain level upon discharge (verbal numerical scale 0-10)	PALDIS	List
WHO step of pain management upon discharge	WHOPAIN	List
Weight bearing upon discharge	WBDIS	List
Mobility/ walking aids upon discharge	WADIS	List
Routine calculation of Barthel-ADL-Index upon discharge	CALCBART	Binary
Barthel-ADL-Index score upon discharge	BARTIND	Integer
Place of discharge	PDIS	List

Data Collection Instrument 5- Course of Primary In-hospital Management

Follow-up and Final Outcome	**Key Name**	**Data Type**
Duration of follow-up (days)	DURFOL	Integer
Death during follow-up period	MORTFU	List
Readmission during follow-up	READFOL	Binary
Readmission related to TPRI	READPE	Binary
Reason for readmission related to TPRI	RREPE	List
Pelvic revision surgery during follow-up	PRSURG	Binary
Type of PRSURG	TPRSURG	List
Number of pelvic operative revisions during follow-up	NPRSURG	Integer
Date of first pelvic operative revision during follow-up	DPRSURG	Date
Pelvic diagnostics during follow-up	PDIAGFU	List
(in case of x-ray as PDIAGFU) Preferred projections	XRPDIAGFU	List
Osseous healing of TPRI	OSHETRP	Binary
Weight bearing at the end of the follow-up period	WBFU	List
Mobility/ walking aids at the end of the follow-up period	WAFU	List
(in case of patients not pensioned before accident) Return to work during follow-up period	RETWO	Binary
Pelvic Outcome at the end of the follow-up period : radiological result	POSRAD	List
Pelvic Outcome at the end of the follow-up period : clinical result-pain	POSPAIN	List
Pelvic Outcome at the end of the follow-up period : clinical result- functional deficiencies	POSFUNCT	List
Pelvic Outcome at the end of the follow-up period : clinical result- neurological deficiencies	POSNEURO	List
Pelvic Outcome at the end of the follow-up period : clinical result- urological deficiencies	POSURO	List
Pelvic Outcome at the end of the follow-up period : clinical result- sexual deficiencies	POSSE	List
Pelvic Outcome at the end of the follow-up period : clinical result- bowel incontinence	POSBOW	Binary
Pelvic Outcome at the end of the follow-up period : social reintegration	POSSOC	List

Pelvic Outcome Score	POS	Calc

Data Collection Instrument 6- Follow-up Period and Final Outcome