

RESEARCH

Open Access



# Developing a core outcome set for acetabular fractures: a systematic review (part I)

Denise Schulz<sup>1,2\*†</sup>, Catharina Gaeth<sup>2,3†</sup>, Martin C. Jordan<sup>2,4</sup>, Steven C. Herath<sup>5</sup>, Christopher Spering<sup>6</sup>, Dan Bieler<sup>3</sup>, Joachim Windolf<sup>1,2</sup> and Anne Neubert<sup>1,2</sup>

## Abstract

**Background** There are indications that clinical studies investigating the surgical treatment of acetabular fractures assess different outcomes. This heterogeneity reduces the comparability of study results and, thus, limits the knowledge generated from research. Core outcome sets (COS) contain a minimum set of outcomes that should be measured in studies investigating a specific disease or injury. A COS for surgically treated acetabular fractures does not yet exist. Therefore, the aim of this study is to identify the reported outcomes in studies investigating the surgical treatment of acetabular fractures.

**Methods** Studies including skeletally mature individuals ( $\geq 16$  years) with isolated acetabular fractures treated surgically were included. Studies with polytrauma patients, pathological fractures, additional pelvic fractures, exclusively non-surgical treatment, or juvenile individuals were excluded. Three databases and two clinical trial registries were searched on 15 November 2022. The identified outcomes were grouped and subsequently categorized according to the Core Outcome Measures in Effectiveness Trials Guidelines.

**Results** A total of 193 studies were included, which reported a cumulative total of 2581 outcomes. After grouping, 266 unique outcomes were identified. No outcome was examined in all studies. *Pain, ability to walk independently, range of motion, quality of reduction, and heterotopic ossification* were the most reported unique outcomes and assessed in at least 60% of included studies. A total of 105 outcomes were only assessed in one of the included studies. Outcomes of all five core areas and 25 outcome domains of the Core Outcome Measures in Effectiveness Trials taxonomy were examined. Furthermore, outcomes were named and defined differently, measured at different time points, and assessed using a variety of measurement instruments.

**Conclusion** Overall, this systematic review shows that a wide range of outcomes are measured in studies examining surgical treatment of acetabular fractures. The results of this systematic review will be used in a subsequent study to develop the COS for surgically treated acetabular fractures by using the Delphi method.

**Systematic review registration** PROSPERO: CRD42022357644; COMET: 2123.

**Keywords** Core outcome set, Outcome reporting, Acetabular fractures, Systematic review

<sup>†</sup>Denise Schulz and Catharina Gaeth contributed equally to this work.

\*Correspondence:

Denise Schulz

Denise.Schulz@med.uni-duesseldorf.de

Full list of author information is available at the end of the article



© The Author(s) 2025. **Open Access** This article is licensed under a Creative Commons Attribution 4.0 International License, which permits use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons licence, and indicate if changes were made. The images or other third party material in this article are included in the article's Creative Commons licence, unless indicated otherwise in a credit line to the material. If material is not included in the article's Creative Commons licence and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder. To view a copy of this licence, visit <http://creativecommons.org/licenses/by/4.0/>.

## Background

Acetabular fractures, although relatively rare, with an incidence of 3 to 40 per 100,000 persons per year, represent a complex injury pattern characterized by a bimodal distribution in the population [1–3]. The younger demographic, predominantly male individuals typically experience these injuries due to high-velocity trauma such as motor vehicle accidents or falls from significant heights. In contrast, older adults often sustain these fractures from low-energy mechanisms such as falls from a standing position, which can lead to fragility fractures associated with diminished bone quality [2, 4]. Notably, data from the German Pelvic Registry indicates that over 50% of acetabular fractures occur in individuals aged 60 years and older, with an increasing incidence due to demographic shifts toward an aging population [2, 5, 6]. In elderly, acetabular fractures are associated with higher complication rates and increased mortality compared to other orthopedic injuries, including hip fractures [7, 8]. Khoshbin et al. (2020) emphasize that the risk of mortality following acetabular fractures exceeds that of hip fractures, underscoring the severity and clinical significance of these injuries in older adults [9].

Clinical research on acetabular fractures is essential to advance the understanding of injury mechanisms, optimize treatment strategies, and improve patient outcomes and quality of life. Although there is a substantial body of research literature reporting outcomes of surgically treated acetabular fractures, there is considerable variability in the results and outcomes reported among these studies [10, 11]. These discrepancies can arise from differences in study design, research objectives, and the specific outcomes assessed, ranging from surgical techniques and complication rates to rehabilitation protocols and functional recovery [12, 13]. This heterogeneity significantly impedes the ability to compare, contrast, and synthesize findings, thereby limiting the development of evidence-based clinical guidelines and the identification of superior treatment modalities [14]. The rarity of acetabular fractures exacerbates this problem; individual studies often have small sample sizes that reduce statistical power and the generalizability of findings [1–3]. To address these challenges, the Core Outcome Measures in Effectiveness Trials (COMET) initiative established methods to develop core outcome sets (COS) that can reduce heterogeneity and inconsistency in outcome assessment and reporting. COS are standardized, research-based sets of key outcomes that should be measured and reported in all clinical trials investigating a specific disease or injury, such as acetabular fractures. The implementation of COS allows more study results to be included in the evidence synthesis, resulting in more valuable findings and comparability of studies, thereby

improving scientific findings [15, 16]. Currently, there is no COS for surgically treated acetabular fractures, which represents a significant gap in research standardization.

The aim of this systematic review is to analyze the outcomes reported in studies of surgically treated acetabular fractures in skeletally mature individuals. In a subsequent study, the identified outcomes will be used to develop the COS for surgically treated acetabular fractures. The establishment of a COS for acetabular fractures will reduce heterogeneity in outcome reporting, improve evidence synthesis, and ultimately enhance clinical decision-making and patient care.

## Methods

This systematic review is reported according to Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) and the Core Outcome Set-STAndards for Reporting (COS-STAR) guidelines [16, 17]. The completed checklists can be found in Additional file 1 and 2. The systematic review was registered via PROSPERO (registration nr. CRD42022357644) and the entire COS for acetabulum fractures project was registered with the COMET database (<https://www.comet-initiative.org/Studies/Details/2123>). The methodological procedure of the systematic review is based on the COMET Handbook [12]. A detailed version of the methodology is reported in the published protocol by Schulz et al. [18]. There are no amendments to the protocol.

## Eligibility criteria

All studies investigating the surgical treatment of isolated acetabular fractures in patients aged  $\geq 16$  years were eligible for inclusion. Studies including patients with polytrauma, pathological fractures, additional pelvic fractures (e.g., pelvic ring fractures), sole non-surgical treatment, or skeletally immature patients ( $< 16$  years) were excluded. Furthermore, studies that did not examine outcomes in relation to the surgical treatment of acetabular fractures were not included (e.g., studies of risk factors or diagnostics). Systematic reviews, case reports, biomechanical, cadaveric, animal studies, and studies involving fewer than ten individuals were excluded.

## Search strategy and selection process

The databases MEDLINE via PubMed, Cochrane Central Register of Controlled Trials (CENTRAL), and Web of Science Core Collection were searched from inception to 15. November 2022. For the identification of ongoing or unpublished studies, ClinicalTrials.gov and World Health Organization International Clinical Trials Registry Platform were searched. Furthermore, the references of relevant systematic reviews were searched manually. Only studies published in English or German were eligible, but

there were no restrictions regarding the publication date. The search strategies are provided in Additional file 3.

Two authors screened the titles and abstracts and, subsequently, the full texts of the search hits using the Covidence® software [19]. Disagreements were resolved via discussion or if necessary, by a third reviewer.

### Data extraction

Data were extracted with a pre-developed form that was piloted. The data from the included studies were extracted by two authors independently using the Covidence® software [12, 19]. Disagreements were resolved through discussion. Reported outcomes, their definition, time point(s), and measurement instrument(s) were extracted in verbatim.

Outcomes were defined as results reported in the methods or results separately from study and participants characteristics. In many studies, complications were only summarized as one outcome under the term “complications” without specifying the term in more detail. If reported complications were extracted as individual outcomes, and if a measurement instrument contained more than one item, each individual item was extracted as an outcome [20].

As stated in the protocol, the risk for outcome reporting bias was assessed using the Outcome Reporting Bias In Trials (ORBIT) study classification system [18, 21]. However, the entire study to develop a COS for surgically treated acetabular fractures is still ongoing. The results of the outcome reporting bias assessment and the Delphi study will be presented in a subsequent manuscript.

### Data synthesis

In a first step, outcomes that measure the same concept but have different names or definitions were grouped to identify the number of unique outcomes. Afterwards, unique outcomes were categorized using the taxonomy of the COMET initiative [22]. Outcome grouping and categorization were carried out by two authors with methodological or clinical expertise independently using Microsoft Excel. Conflicts were solved via discussion.

A subgroup analysis that illustrated reported outcomes by year of publication (before and after 2000) was conducted.

## Results

The search resulted in 11,800 hits. After deduplication, 8159 records were screened by title and abstract, resulting in 673 full texts that were reviewed for inclusion. The manual search did not identify any additional studies for inclusion. Finally, 184 published studies with 186 records [23–208] and 9 ongoing studies [209–217] were included in this systematic review. The search and selection

process were documented in a PRISMA flow diagram (Fig. 1) [17].

### Study characteristics

The 184 studies were published in the years 1975 to 2023 and involved a total of 11,321 participants [23–59, 61–82, 84–208]. The 193 included studies are nine randomized controlled trials (RCT) (4.66%), one mixed methods study (RCT & observational study) (0.52%), 66 observational studies with control group (34.20%), and 117 observational studies without control group (60.62%). The studies have been or are being conducted in 36 different countries, most frequently in China ( $n=35$ ; 18.13%), the USA ( $n=28$ ; 14.51%), India ( $n=20$ ; 10.36%), Germany ( $n=13$ ; 6.74%), and Switzerland ( $n=9$ ; 4.66%) (Table 1). More detailed study characteristics are provided in Additional file 4.

### Outcomes

Overall, 2581 outcomes were measured cumulatively in 193 studies. The studies measured on average 13.37 outcomes (range 1–36). Grouping of outcomes with diverse names that measured the same concept resulted in a total of 266 unique outcomes. No outcome was assessed in all studies. *Pain* was the most frequently reported outcome ( $n=158$ ; 81.86%). Other often reported outcomes were *ability to walk independently* ( $n=140$ ; 72.54%), *range of motion* ( $n=139$ ; 72.02%), *quality of reduction* ( $n=127$ ; 65.80%), and *heterotopic ossification* ( $n=117$ ; 60.62%). In total, 39.47% of the outcomes ( $n=105$ ) were measured in only one study (e.g., *wounds healing time*, *iatrogenic obturator artery injury*, *screw irritation*, and *erectile dysfunction*).

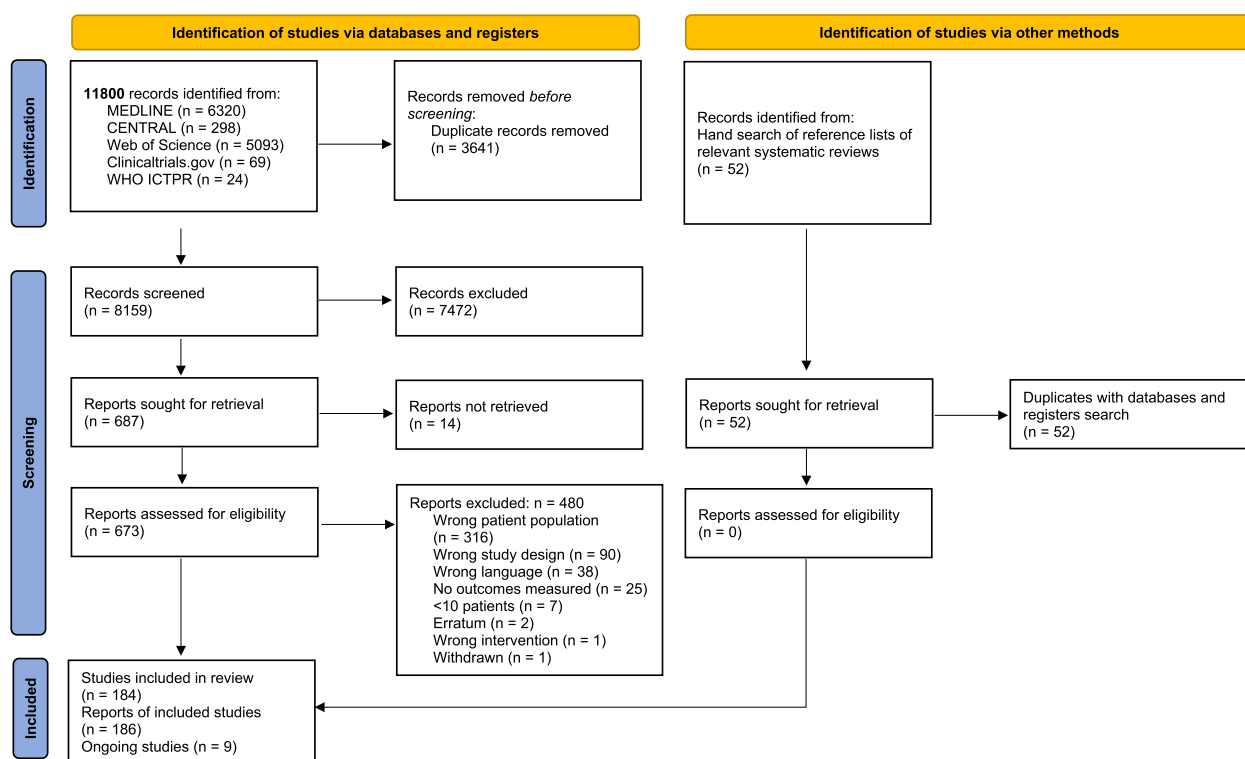
### Subgroup analysis

Of the 193 studies included, twelve were conducted before the year 2000. Overall, 49 unique outcomes were measured in studies before 2000. In particular, the outcomes *thrombophlebitis*, *the acetabulum*, or *the weight-bearing dome* as well as *skin problems* were exclusively investigated in studies conducted before 2000.

*Heterotopic ossification*, which was investigated in eleven studies, and *quality of reduction*, which was investigated in nine studies, are the most frequently investigated outcomes in studies before the year 2000.

### Outcome names and definitions

There was a high variance in the terms used to name the same outcome. For example, for *heterotopic ossification*, the outcome terms varied enormously: “periarticular ossification,” “periarticular calcifications,” “paraarticular ossification,” “ectopic bone formation,” “ectopic ossification,” “heterotopic calcification,” “heterotopic bone



**Fig. 1** PRISMA flow diagram. Legend: from Page et al. [17]

**Table 1** Study characteristics

Characteristics	Number of studies (%)
<b>Study design</b>	
RCT	9 (4.66)
Mixed methods	1 (0.52)
Observational studies with a control group	66 (34.20)
Observational studies without a control group	117 (60.62)
<b>Publication year</b>	
1975–1999	12 (6.22)
2000–2023	172 (89.12)
Ongoing	9 (4.66)
<b>Country</b>	
China	35 (18.13)
USA	28 (14.51)
India	20 (10.36)
Germany	13 (6.74)
Switzerland	9 (4.66)
Other	88 (45.60)

Legend: RCT randomized controlled trial, USA United States of America

formation,” “heterotrophic bone,” “ossifying myositis,” and “myositis ossificans.” Additionally, outcomes were defined heterogeneously or not at all. For example, *operation time*

was assessed in 39 studies but defined in only eight studies (20.51%). Definitions ranged from “skin-to-skin” [27, 64, 71, 80, 163, 170, 191] to “[...] from reduction of the bone fragment to optimal placement of the internal fixation device” [204].

### Measurement time points

Measurement time points were often reported inconsistently. For example, in 48.57% of 70 studies that investigated the outcome *arthritis*, no measurement time points were given. Similarly, 50.00% of the 44 studies that examined *bone union* and 27.66% of the 47 studies that examined *radiologic outcomes* did not report time points.

In addition, many studies only reported “last follow-up” without providing further information on the exact time point. These included 18 studies investigating *radiologic outcomes*, five studies examining *bone union*, and eight studies reporting *arthritis*. Some studies described “postoperative” without further specification, including two studies on *radiologic outcomes*, two studies on *bone union*, and six studies on *arthritis*.

Additionally, several studies reported heterogeneous time points. In seven studies, *radiologic outcome* was examined at several time points; for example, follow-up was reported to be carried out at 6 and 12 weeks, 6 months, and annually postoperatively [141], while

another study reported the follow-up at 45 days, 3, 6, and 12 months postoperative [26].

### Categorization

The included studies reported outcomes of all five core areas of the COMET taxonomy (*Death, Physiological/clinical, Life Impact, Resource use, Adverse events*) [22]. Overall, the studies assessed outcomes from 25 outcome domains (Table 2).

The most categorized outcome domains belong to the core area *Physiological/clinical* ( $n=13$ ; 52.00%). Most of outcomes were related to the *Musculoskeletal and connective tissue* ( $n=78$ ; 29.32%), *Physical functioning* ( $n=30$ ; 11.28%), or *Nervous system* ( $n=25$ ; 9.40%) outcome domains. Only one outcome (0.38%) was categorized to the *Mortality/survival, Cardiac, Immune system, Cognitive functioning, and Delivery of care* outcome domains (Fig. 2).

The number of studies that reported outcomes in the individual outcome domain is shown in Fig. 3. No outcome domain was considered in all 193 studies included. Most studies examined outcomes related

to the *Musculoskeletal and connective tissue* ( $n=186$ ; 96.37%) outcome domain. Although only 16 of the 266 unique outcomes were assigned to the *General* outcome domain, it is still the second most frequently reported outcome domain ( $n=162$ ; 83.94%). Outcomes related to the *Immune system, Cognitive functioning, and Delivery of care* outcome domains were assessed by only one study. A complete table showing the categorization of all 266 unique outcomes is provided in Additional file 5.

### Measurement instruments

Overall, 17 different measurement instruments were used in 156 (80.83%) studies. The most frequently reported measurement instrument was the Merle d'Aubigné Method, which was used in 91 studies (58.33%). Five individual measurement instruments were utilized only in one study each. Figure 4 ranks the applied measurement instruments and displays the numbers of studies utilizing them.

Of the 156 studies, 28 (17.31%) used two measurement instruments, while 12 (7.69%) used a combination of three scores, such as the Harris Hip Score, the Merle

**Table 2** Outcome categorization

Core area	Outcome domain	Number of unique outcomes	Example for unique outcomes
<b>Death</b>	Mortality/survival	1	Mortality
<b>Physiological/clinical</b>	Cardiac	1	Cardiovascular complications
	Gastrointestinal	6	Hernia
	General	16	pain
	Immune system	1	Inflammatory response
	Infection and infestation	7	Infection
	Injury and poisoning	3	Iatrogenic neurovascular injury
	Musculoskeletal and connective tissue	78	Range of motion
	Nervous system	25	Iatrogenic sciatic nerve injury
	Renal and urinary	5	Urinary tract infection
	Psychiatric	2	Mental status
	Respiratory, thoracic and mediastinal	3	Pneumonia
	Skin and subcutaneous tissue	13	Decubitus
	Vascular	23	Deep vein thrombosis
<b>Life impact</b>	Physical functioning	30	Ability to walk independently
	Social functioning	2	Social functioning
	Role functioning	4	Ability to work
	Emotional functioning/wellbeing	5	Arousal
	Cognitive functioning	1	Cognitive dysfunction
	Delivery of care	1	Satisfaction with medical care
<b>Resource use</b>	Economic	16	Operation time
	Hospital	5	Length of hospital stay
	Need for further intervention	12	Conversion to total hip arthroplasty
	Societal/carer burden	2	Return to their home
<b>Adverse events</b>	Adverse events/effects	4	Surgical complication



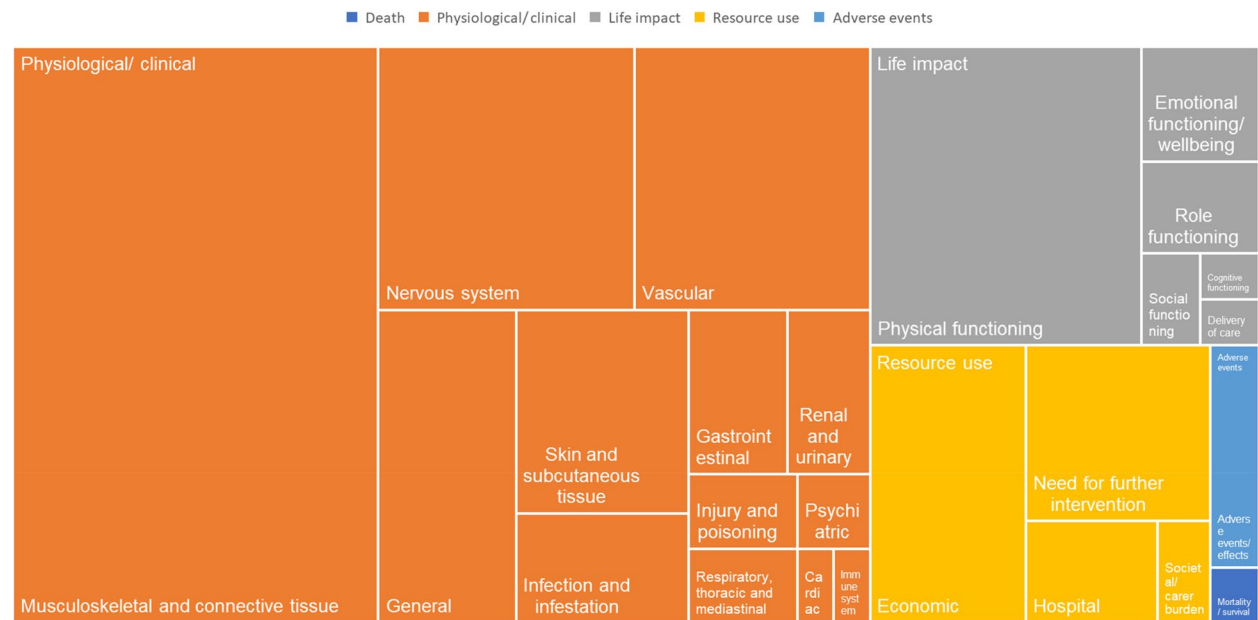


Fig. 2 Proportion of outcomes in core domains

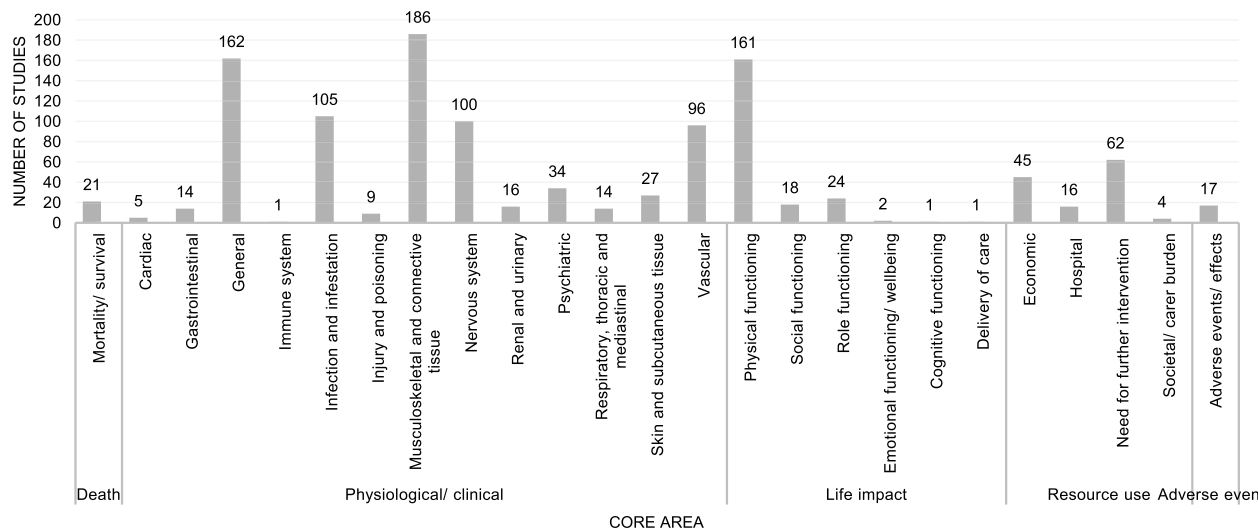
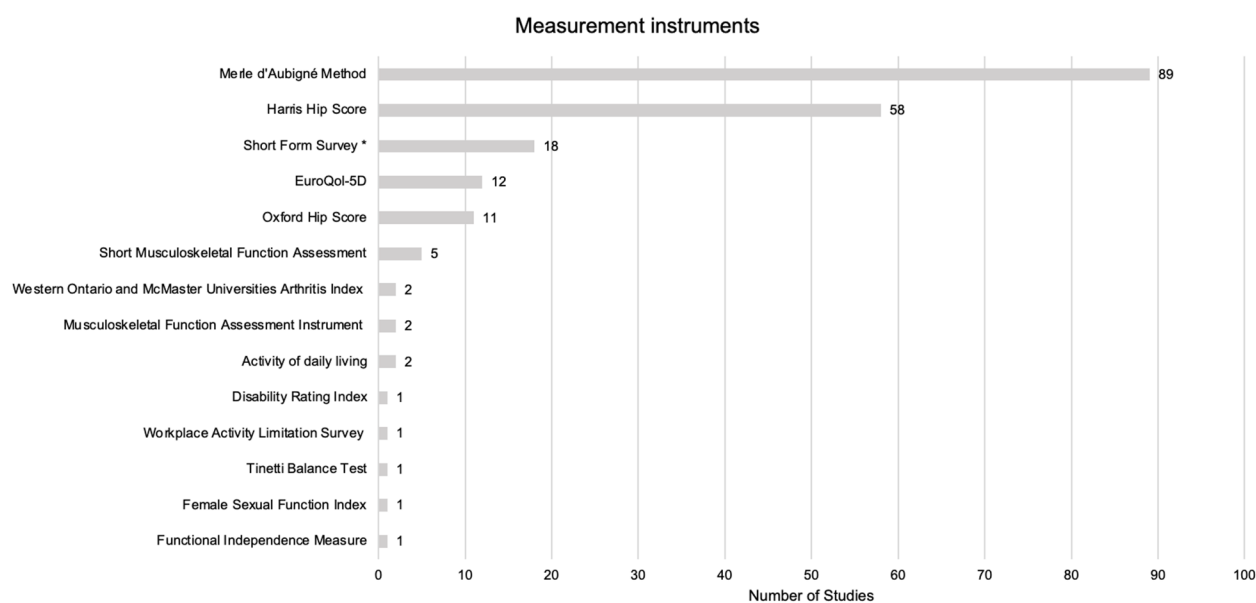


Fig. 3 Number of studies reported outcomes from individual outcome domains

d'Aubigné Method, and the Short Form Survey, to assess outcomes.

The 17 measurement instruments cover a spectrum of 50 unique outcomes. *Pain* was the most frequently assessed outcome. This outcome was reported in 153 studies (98.08%) and was assessed with nine different measurement instruments, including EuroQol-5D, Female Sexual Function Index, Harris Hip Score, Merle d'Aubigné Method, Oxford Hip Score, Short Form Survey, and Western Ontario and McMaster Universities

Arthritis Index. Some of the studies utilized different measurement instruments, which partly included the same unique outcomes. For example, in 33 studies, two different measurement instruments, such as Merle d'Aubigné Method and Harris Hip Score [36, 47] or Oxford Hip Score and EuroQol-5D [70, 209, 214], were used which assessed *Pain*. This outcome was examined in 6 studies with three different measurement instruments. *Ability to walk independently* was the second most frequently assessed outcome and was measured in



**Fig. 4** Measurement instruments. Legend: \* Short Form Survey includes 8-Item Short Form Survey (SF-8), 12-Item Short Form Survey (SF-12), and 36-Item Short Form Survey (SF-36)

136 studies (87.18%). Of these, 13 studies assessed this outcome using both the Merle d'Aubigné method and the Harris Hip Score.

*Range of motion* was reported in 134 studies (85.9%), with 55 studies using only the Harris Hip score and 85 studies using only the Merle d'Aubigné method. Eleven studies assessed *range of motion* with both instruments. A table of all measurement instruments including the number of studies that utilized them is provided in Additional file 6.

## Discussion

This systematic review shows that many different outcomes are measured in studies examining surgical treatment of acetabular fractures. None of the 266 unique outcomes were assessed in all 193 included studies. Five unique outcomes were measured in at least 60% of the studies, consisting of *pain*, *ability to walk independently*, *range of motion*, *quality of reduction*, and *heterotopic ossification*. Furthermore, almost 40% of the unique outcomes were measured in one study only. Many studies investigated specific aspects regarding the surgical treatment of acetabular fractures such as the effects on sexual function [119, 184]. The assessment of specific outcomes should not be hindered by a COS. Instead, studies should examine the most important outcomes defined in the future COS in addition to specific outcomes to reduce heterogeneity [12, 218]. Consequently, more study results could be included in evidence synthesis like in systematic reviews or clinical guidelines, which would increase

statistical power and lead to more precise findings and, thus, improve the knowledge generated from research [15, 219]. This is particularly important in studies investigating the surgical treatment of acetabular fractures as this is a rare fracture, and studies can therefore only investigate a small number of individuals [1–3].

In addition, this systematic review highlights significant inconsistencies in the reporting of measurement time points across studies assessing surgical treatment of acetabular fractures. Frequently, measurement time points were not specified and vague time points, such as “last follow-up” or “postoperative” given without further specification. Moreover, the studies showed considerable variability of time points with some studies reporting outcomes at multiple heterogeneous time points. This is comparable with the systematic review by Copley et al. (2022), in which only 56.7% of the included studies on cervical spine fractures reported a precise measurement time point [220]. Moreover, the vast variability in measurement instruments used across studies also presents a challenge for synthesizing study results as the different measurement instruments contain various scales and items. Other systematic reviews examining outcomes assessed in studies on traumatology also identified a high number of heterogeneous measurement instruments used [221–225]. Overall, there is a need for predefined, standardized measurement time points and the use of measurement instruments in future research to ensure consistency and to improve the comparability of findings across studies.

Outcomes on the *musculoskeletal and connective tissue* outcome domain were reported in the majority (96.37%) of included studies. This is comparable with other systematic reviews in traumatological research; for example, a systematic review for the development of a COS for traumatic brachial plexus injuries showed that outcomes from this domain were reported most often with 86% of included studies [222]. Similarly, Aquilina et al. (2023) showed that most of the outcomes reported in studies on open lower limb fractures related to the *musculoskeletal and connective tissue* outcome domain [221].

This study was characterized by a clear and reproducible approach based on published guidelines and the classification of outcomes according to the COMET taxonomy [12, 22]. In addition, this systematic review was conducted by reviewers with methodological or clinical expertise which enabled multidisciplinary approaches. The consideration of published and ongoing studies made it possible to identify contemporary outcomes. No publication date restrictions were defined in the inclusion criteria which made it possible to analyze a high number of studies and outcomes as well as the differences between studies published before and after 2000; however, the analysis showed no differences in the reported outcomes in studies conducted before and after the year 2000.

In consideration of these advantages, some limitations are noted. Only studies in German and English were included. Nevertheless, the comprehensive and sensitive literature search on three databases and two study registries without temporal or geographical restrictions reduced the risk of missing relevant studies. Also, broad inclusion criteria were defined to identify a high number of relevant outcomes for studies examining surgical treatment of acetabular fractures. Therefore, with 193 included studies, this systematic review is the most comprehensive examination of outcome reporting in studies examining acetabular fractures.

## Conclusion

This systematic review highlights the absence of standardized methodologies for assessing and reporting outcomes in studies that investigate surgical treatment of acetabular fractures. This significantly limits the ability to synthesize and compare the results of these studies.

This systematic review provides the basis for the development of a COS which can reduce the heterogeneity of outcomes in and between future studies. In a subsequent study, the Delphi method will be used to develop the COS for surgically treated acetabular fractures. This will help to ensure standardized outcome assessment in future studies, reduce heterogeneity between studies, and thereby enhance more study results to be included in evidence synthesis, and thus improve knowledge generated from research.

## Abbreviations

CENTRAL	Cochrane Central Register of Controlled Trials
COMET	Core Outcome Measures in Effectiveness Trials
COS	Core outcome set
COS-STAR	Core Outcome Set-STAndards for Reporting
ORBIT	Outcome reporting bias in trials
PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-Analyses
RCT	Randomized controlled trial

## Supplementary Information

The online version contains supplementary material available at <https://doi.org/10.1186/s13643-025-02824-0>.

Additional file 1. PRISMA checklist.  
Additional file 2. COS-STAR checklist.  
Additional file 3. Search strategies.  
Additional file 4. Study characteristics.  
Additional file 5. Outcome categorization.  
Additional file 6. Measurement instruments.

## Acknowledgements

We would like to thank Adrian Deichsel for his contribution to the title/abstract screening.

## Authors' contributions

DS: conceptualization, (1) reviewer (screening, data extraction, and data synthesis), writing and revision manuscript. CG: conceptualization, (2) reviewer (screening, data extraction, and data synthesis), writing and revision manuscript. MCJ: clinical expertise, manuscript editing. SCH: clinical expertise, manuscript editing. CS: clinical expertise, manuscript editing. DB: clinical expertise, manuscript editing. JW: clinical expertise, manuscript editing. AN: design, supervision, (3) reviewer (screening), revision of manuscript. All authors read and approved the final manuscript.

## Funding

Open Access funding enabled and organized by Projekt DEAL. This review is part of the project TraumaEvidence by the German Society of Traumatology and the University Hospital Duesseldorf, Germany. The authors received no specific funding for this work. The funders had no role in study design, data collection and analysis, decision to publish, or preparation of the manuscript.

## Data availability

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

## Declarations

### Ethics approval and consent to participate

Not applicable.

### Consent for publication

Not applicable.

### Competing interests

The authors declare no competing interests.

## Author details

<sup>1</sup>Department of Orthopaedics and Traumatology, Medical Faculty and University Hospital Düsseldorf, Heinrich-Heine-University Düsseldorf, Düsseldorf, Germany. <sup>2</sup>TraumaEvidence @ German Society of Trauma Surgery, Berlin, Germany. <sup>3</sup>Department for Trauma Surgery and Orthopaedics, Reconstructive and Hand Surgery, Burn Medicine, German Armed Forces Central Hospital, Koblenz, Germany. <sup>4</sup>Centre of Orthopaedics, Trauma Surgery and Rehabilitative Medicine, University Medicine Greifswald, Greifswald, Germany. <sup>5</sup>Department of Trauma and Reconstructive Surgery, Eberhard Karls University Tuebingen, BG Trauma Center Tuebingen, Tübingen, Germany. <sup>6</sup>Department



for Trauma Surgery, Orthopaedics and Plastic Surgery, University Medical Center Göttingen, Göttingen, Germany.

Received: 8 November 2024 Accepted: 17 March 2025

Published online: 09 April 2025

## References

- Laird A, Keating JF. Acetabular fractures: a 16-year prospective epidemiological study. *J Bone Joint Surg Br.* 2005;87:969–73.
- Alvarez-Nebreda ML, Weaver MJ, Uribe-Leitz T, Heng M, McTague MF, Harris MB. Epidemiology of pelvic and acetabular fractures in the USA from 2007 to 2014. *Osteoporos Int.* 2023;34:527–37.
- Rupp M, Walter N, Pfeifer C, Lang S, Kerschbaum M, Krusch W, et al. The incidence of fractures among the adult population of Germany—an analysis from 2009 through 2019. *Dtsch Arztebl Int.* 2021;118:665–9.
- Rinne PP, Laitinen MK, Huttunen T, Kannus P, Mattila VM. The incidence and trauma mechanisms of acetabular fractures: a nationwide study in Finland between 1997 and 2014. *Injury.* 2017;48:2157–61.
- Yang Z, Röhl SM, Nordsletten L. Verschobene Fraktur der Hüftgelenkpfanne bei älteren Patienten: Ist die akute Arthroplastik eine gute Option? *Z Orthop Unfallchir.* 2019;157:676–83.
- Herath SC, Pott H, Rollmann MFR, Braun BJ, Holstein JH, Höch A, et al. Geriatric acetabular surgery: Letournel's contraindications then and now—data from the German Pelvic Registry. *J Orthop Trauma.* 2019;33(Suppl 2):S8–13.
- McCormick BP, Serino J, Orman S, Webb AR, Wang DX, Mohamadi A, et al. Treatment modalities and outcomes following acetabular fractures in the elderly: a systematic review. *Eur J Orthop Surg Traumatol.* 2022;32:649–59.
- Gary JL, Paryavi E, Gibbons SD, Weaver MJ, Morgan JH, Ryan SP, et al. Effect of surgical treatment on mortality after acetabular fracture in the elderly: a multicenter study of 454 patients. *J Orthop Trauma.* 2015;29:202–8.
- Krappinger D, Freude T, Stuby F, Lindtner RA. Acetabular fractures in geriatric patients: epidemiology, pathomechanism, classification and treatment options. *Arch Orthop Trauma Surg.* 2024;144:4515–24.
- Dodd A, Osterhoff G, Guy P, Lefavre KA. Assessment of functional outcomes of surgically managed acetabular fractures: a systematic review. *Bone Joint J.* 2016;98-B:690–5.
- Dodd A, Osterhoff G, Guy P, Lefavre KA. Radiographic measurement of displacement in acetabular fractures: a systematic review of the literature. *J Orthop Trauma.* 2016;30:285–93.
- Williamson PR, Altman DG, Bagley H, Barnes KL, Blazeby JM, Brookes ST, et al. The COMET Handbook: version 10. *Trials.* 2017;18:280.
- Bellucci C, Hughes K, Toomey E, Williamson PR, Matvienko-Sikar K. A survey of knowledge, perceptions and use of core outcome sets among clinical trialists. *Trials.* 2021;22:937.
- Gargon E, Gurung B, Medley N, Altman DG, Blazeby JM, Clarke M, et al. Choosing important health outcomes for comparative effectiveness research: a systematic review. *PLoS ONE.* 2014;9:e99111.
- Clarke M, Williamson PR. Core outcome sets and systematic reviews. *Syst Rev.* 2016;5:11.
- Kirkham JJ, Gorst S, Altman DG, Blazeby JM, Clarke M, Devane D, et al. Core Outcome Set-STAndards for Reporting: The COS-STAR Statement. *PLoS Med.* 2016;13:e1002148.
- Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. *BMJ.* 2021;372:n71.
- Schulz D, Deichsel A, Jordan MC, Windolf J, Raschke MJ, Neubert A. Developing a core outcome set for acetabular fractures: a systematic review protocol. *Syst Rev.* 2024;13:150.
- Veritas Health Innovation M Australia. Covidence systematic review software. 2022. Available from: [www.covidence.org](http://www.covidence.org). Accessed 08 Aug 2024.
- Macefield RC, Jacobs M, Korfage IJ, Nicklin J, Whistance RN, Brookes ST, et al. Developing core outcomes sets: methods for identifying and including patient-reported outcomes (PROs). *Trials.* 2014;15:49.
- Kirkham JJ, Dwan KM, Altman DG, Gamble C, Dodd S, Smyth R, et al. The impact of outcome reporting bias in randomised controlled trials on a cohort of systematic reviews. *BMJ.* 2010;340:c365.
- Dodd S, Clarke M, Becker L, Mavergames C, Fish R, Williamson PR. A taxonomy has been developed for outcomes in medical research to help improve knowledge discovery. *J Clin Epidemiol.* 2018;96:84–92.
- Aigner R, Hellige R, Knippel S, Oberkircher L, Ruchholtz S, Buecking B. Internal fixation of acetabular fractures in an older population using the TIMI approach - midterm results of a prospective study. *Injury.* 2017;48:890–6.
- Al Adawy AS, Aziz AHA, El Sherief FA, Mahmoud WS, Mabrook M, Hassan YE-S. Modified Stoppa as an alternative surgical approach for fixation of anterior fracture acetabulum: a randomized control clinical trial. *J Orthop Surg Res.* 2020;15:154.
- Amoretti N, Huwart L, Hauger O, Marcy P-Y, Nouri Y, Ibba C, et al. Percutaneous screw fixation of acetabular roof fractures by radiologists under CT and fluoroscopy guidance. *AJR Am J Roentgenol.* 2013;200:447–50.
- Alexa O, Pertea M, Malancea RI, Puha B, Veliceasa B. Our experience in the surgical treatment of acetabular fractures using "spring plate" TECHNIQUE. *Rev Med Chir Soc Med Nat Iasi.* 2019;123:275–81.
- Ansari S, Barik S, Singh SK, Sarkar B, Goyal T, Kalia RB. Role of 3D printing in the management of complex acetabular fractures: a comparative study. *Eur J Trauma Emerg Surg.* 2021;47:1291–6.
- Askam B, Sims S. Supplemental superior buttress plating for the treatment of posterosuperior wall acetabulum fractures. *J Orthop Trauma.* 2019;33(Suppl 2):S27–31.
- Baba T, Shitoto K. Cable fixation of acetabular fracture utilizing an anchor screw for reduction and fixation. *Eur J Orthop Surg Traumatol.* 2010;20:75–9.
- Bogdan Y, Tornetta P, Jones C, Gilde AK, Schemitsch E, Vicente M, et al. Neurologic injury in operatively treated acetabular fractures. *J Orthop Trauma.* 2015;29:475–8.
- Borens O, Wettstein M, Garofalo R, Blanc CH, Kombot C, Leyvraz P-F, et al. Die Behandlung von Acetabulumfrakturen bei geriatrischen Patienten mittels modifizierter Kabelcerclage und primärer Hüfttotalprothese. *Erste Ergebnisse Unfallchirurg.* 2004;107:1050–6.
- Bouabdellah M, Bensalah M, Kamoun C, Bellil M, Kooli M, Hadhri K. Advantages of three-dimensional printing in the management of acetabular fracture fixed by the Kocher-Langenbeck approach: randomised controlled trial. *Int Orthop.* 2022;46:1155–63.
- Butler BA, Hannan ZD, Ghulam QM, DeLeon GA, O'Hara N, Nascone JW, et al. The effect of surgeon experience on short- to medium-term complication rate following operative fixation of acetabular fractures. *J Orthop Trauma.* 2022;36:509–14.
- Cano-Luís P, García-Mendoza A, Giráldez-Sánchez M, Andrés-Cano P. Pararectus approach in acetabular fractures in patients older than 65 years. Is it possible to improve the technique? *J Orthop Trauma.* 2023;37:109–15.
- Caterini R, Farsetti P, Potenza V, Mancini F, Monteleone G. Immediate passive mobilization of the hip after internal fixation of acetabular fractures. *Chir Organi Mov.* 2000;85:243–9.
- Cavalié G, Boudissa M, Kerschbaumer G, Seurat O, Ruatti S, Tonetti J. Clinical and radiological outcomes of antegrade posterior column screw fixation of the acetabulum. *Orthop Traumatol Surg Res.* 2022;108:103288.
- Chen CM, Chiu FY, Chuang TY, Lo WH. Treatment of acetabular fractures: 10-year experience. *Zhonghua Yi Xue Za Zhi (Taipei).* 2000;63:384–90.
- Ceylan H, Selek O, Inanir M, Yonga O, Odabas Ozgur B, Sarlak AY. External rotator sparing with posterior acetabular fracture surgery: does it change outcome? *Adv Orthop.* 2014;2014:520196.
- Chen J, Zheng Y, Fang Z, Zhou W, Xu D, Wang G, et al. One-stop computerized virtual planning system for the surgical management of posterior wall acetabular fractures. *J Orthop Surg Res.* 2022;17:439.
- Chen MJ, Wadhwa H, Tigchelaar SS, Frey CS, Gardner MJ, Bellino MJ. Trochanteric osteotomy for acetabular fracture fixation: a case series and literature review. *Eur J Orthop Surg Traumatol.* 2021;31:161–5.
- Chen Z, Wu Z-X, Chen G, Ou Y, Wen H-J. Oblique-ilioischial plate technique: a novel method for acetabular fractures involving low posterior column. *BMC Musculoskelet Disord.* 2022;23:540.
- Chen Z, Yang H, Wu Z, Chen G, Ou Y, Bi X, et al. A combination of the modified Stoppa approach and the iliac fossa approach in treating

- compound acetabular fractures by using an anterior ilioischial plate. *Acta Orthop Belg.* 2019;85:182–91.
43. Chiu FY, Chen CM, Lo WH. Surgical treatment of displaced acetabular fractures - 72 cases followed for 10 (6–14) years. *Injury.* 2000;31:181–5.
  44. Chiu FY, Lo WH, Chen TH, Chen CM, Huang CK, Ma HL. Fractures of posterior wall of acetabulum. *Arch Orthop Trauma Surg.* 1996;115:273–5.
  45. Ciolli G, Mauro D, Rovere G, Smakaj A, Marino S, Are L, et al. Anterior intrapelvic approach and suprapectineal quadrilateral surface plate for acetabular fractures with anterior involvement: a retrospective study of 34 patients. *BMC Musculoskelet Disord.* 2021;22:1060.
  46. Crowl AC, Kahler DM. Closed reduction and percutaneous fixation of anterior column acetabular fractures. *Comput Aided Surg.* 2002;7:169–78.
  47. Dadura E, Truszczynska-Baszak A, Szydłowski D. Radiological and functional assessment of treatment outcomes in patients after open reduction with internal fixation (ORIF) of acetabular fractures. *Int J Environ Res Public Health.* 2022;19:1277.
  48. Ebraheim NA, Patil V, Liu J, Haman SP. Sliding trochanteric osteotomy in acetabular fractures: a review of 30 cases. *Injury.* 2007;38:1177–82.
  49. Dickinson WH, Duwelius PJ, Colville MR. Muscle strength testing following surgery for acetabular fractures. *J Orthop Trauma.* 1993;7:39–46.
  50. Eckardt H, Lind D, Toendevold E. Open reduction and internal fixation aided by intraoperative 3-dimensional imaging improved the articular reduction in 72 displaced acetabular fractures. *Acta Orthop.* 2015;86:684–9.
  51. Elmadağ M, Güzel Y, Acar MA, Uzer G, Arazi M. The Stoppa approach versus the ilioinguinal approach for anterior acetabular fractures: a case control study assessing blood loss complications and function outcomes. *Orthop Traumatol Surg Res.* 2014;100:675–80.
  52. Erem M, Copuroglu C, Copuroglu E, Ciftedemir M, Ozcan M, Saridogan K. Effects of the incision preference in acetabular surgery on the postoperative functional outcomes. *Niger J Clin Pract.* 2019;22:862–8.
  53. Enocson A, Blomfeldt R. Acetabular fractures in the elderly treated with a primary Burch-Schneider reinforcement ring, autologous bone graft, and a total hip arthroplasty: a prospective study with a 4-year follow-up. *J Orthop Trauma.* 2014;28:330–7.
  54. Etemadifar M, Nemati A, Chinigarzade M. Operative management of acetabular fracture: a 10-year experience in Isfahan. *Iran Adv Biomed Res.* 2016;5:169.
  55. Ernstberger H, Pieroh P, Höch A, Josten C, Herath SC, Osterhoff G. Minimally displaced acetabulum fractures in geriatric patients: a comparison of open, percutaneous and non-operative treatment from the German Pelvic Injury Register data. *Eur J Trauma Emerg Surg.* 2021;47:1763–71.
  56. Firoozabadi R, Yu Chen E, Elhaddad M, Tornetta LP. Isolated buttress plating of posterior wall acetabular fractures: is it sufficient? *Arch Bone Jt Surg.* 2020;8:511–8.
  57. Farku NH, Faisham WI, Hadizie D, Yahaya S. Functional outcome of surgical stabilisation of acetabular fractures. *Malays Orthop J.* 2021;15:129–35.
  58. Fahmy M, Abdel Karim M, Khaled SA, Abdelazeem AH, Elnahal WA, Elnahal A. Single versus double column fixation in transverse fractures of the acetabulum: a randomised controlled trial. *Injury.* 2018;49:1291–6.
  59. Giannoudis PV, Kanakaris NK, Delli Sante E, Morell DJ, Stengel D, Prevezas N. Acetabular fractures with marginal impaction: mid-term results. *Bone Joint J.* 2013;95-B:230–8.
  60. Gary JL, Lefavre KA, Gerold F, Hay MT, Reinert CM, Starr AJ. Survivorship of the native hip joint after percutaneous repair of acetabular fractures in the elderly. *Injury.* 2011;42:1144–51.
  61. Frietman B, Biert J, Edwards MJR. Patient-reported outcome measures after surgery for an acetabular fracture. *Bone Joint J.* 2018;100-B:640–5.
  62. Hammad AS, El-Khadrawe TA, Waly AH, Abu-Sheasha GA. The efficacy of posterior plating and anterior column screw fixation in the management of T-shaped acetabular fractures - CART analysis of prospective cohort study. *Injury.* 2017;48:680–6.
  63. Güven N, Gokalp MA, Unsal SS, Turkozu T, Guner S. The outcomes of acetabular fractures treated surgically and factors affecting the result. *Ann Clin Anal Med.* 2018;09:93–6.
  64. Gusic N, Sabalic S, Pavic A, Ivkovic A, Sotosek-Tokmadzic V, Cicvaric T. Rationale for more consistent choice of surgical approaches for acetabular fractures. *Injury.* 2015;46(Suppl 6):S78–86.
  65. Gupta S, Singh J, Virk JS. The role of trochanteric flip osteotomy in fixation of certain acetabular fractures. *Chin J Traumatol.* 2017;20:161–5.
  66. Gültaş E, İltar S, Özmeriç A, Koçak A, Aydoğan NH, Alemardoğlu KB. Surgical treatment of acetabulum posterior wall fractures: comparison between undercounting and marginal impaction reconstruction method with odd methods. *J Clin Orthop Trauma.* 2019;10:900–3.
  67. Gorczyca JT, Powell JN, Tile M. Lateral extension of the ilioinguinal incision in the operative treatment of acetabulum fractures. *Injury.* 1995;26:207–12.
  68. Giannoudis PV, Nikolaou VS, Kheir E, Mehta S, Stengel D, Roberts CS. Factors determining quality of life and level of sporting activity after internal fixation of an isolated acetabular fracture. *J Bone Joint Surg Br.* 2009;91:1354–9.
  69. Gültaş E, Kılınc CY, Can Fİ, Şahin İG, Ağan AE, Gemci Ç, et al. A device that facilitates screwing at an appropriate angle in quadrilateral surface fractures: 105-degree drill attachment. *Turk J Med Sci.* 2022;52:816–24.
  70. Hislop S, Alsousou J, Chou D, Rawal J, Hull P, Carrothers A. Fix and replace: simultaneous fracture fixation and hip replacement for acetabular fractures in older patients. *Injury.* 2022;53:4067–71.
  71. Herscovici D, Lindvall E, Bolhofner B, Scaduto JM. The combined hip procedure: open reduction internal fixation combined with total hip arthroplasty for the management of acetabular fractures in the elderly. *J Orthop Trauma.* 2010;24:291–6.
  72. Heeg M, Klasen HJ, Visser JD. Operative treatment for acetabular fractures. *J Bone Joint Surg Br.* 1990;72:383–6.
  73. Heck BE, Ebraheim NA, Foetisch C. Direct complications of trochanteric osteotomy in open reduction and internal fixation of acetabular fractures. *Am J Orthop (Belle Mead NJ).* 1997;26:124–8.
  74. Hao Z, Zhou D, Wang F, Li L, He J. Temporary balloon occlusion of the abdominal aorta in treatment of complex acetabular fracture. *Med Sci Monit.* 2016;22:2295–300.
  75. Kang CS, Min BW. Cable fixation in displaced fractures of the acetabulum: 21 patients followed for 2–8 years. *Acta Orthop Scand.* 2002;73:619–24.
  76. Islam MN, Rahman MM, Islam MS, Kabir SJ, Alamgir MK, Kashem MT, et al. Outcome of open reduction and internal fixation of posterior wall fracture of acetabulum. *Mymensingh Med J.* 2020;29:502–8.
  77. Iqbal F, Uddin A, Younus S, Zia O, Khan N, Asmatullah. Surgical outcomes of acute acetabular transverse fracture using ilioinguinal and Stoppa approach. *J Acute Dis.* 2017;6:278.
  78. Iqbal F, Taufiq I, Najjad MKR, Khan N, Zia OB. Functional and radiological outcome of surgical management of acetabular fractures in tertiary care hospital. *Hip Pelvis.* 2016;28:217–24.
  79. Inoue M, Noda T, Uehara T, Tetsunaga T, Yamada K, Saito T, et al. Osteosynthesis for geriatric acetabular fractures: an epidemiological and clinico-radiological study related to marginal or roof impaction. *Acta Med Okayama.* 2021;75:177–85.
  80. Huang J-H, Liao H, Tan X-Y, Xing W-R, Zhou Q, Zheng Y-S, et al. Surgical treatment for both-column acetabular fractures using pre-operative virtual simulation and three-dimensional printing techniques. *Chin Med J (Engl).* 2020;133:395–401.
  81. Huda N, Islam MSU, Bishnoi S, Utsav K. Factors affecting the functional outcome of surgically managed displaced acetabular fractures. *Int J Burns Trauma.* 2021;11:105–11.
  82. Lawyer TJ, Jankowski J, Russell GV, Stronach BM. Prevalence of post-traumatic osteoarthritis in morbidly obese patients after acetabular fracture fixation. *J Long Term Eff Med Implants.* 2014;24:225–31.
  83. Kumar D, Kushwaha NS, Tiwari PG, Sharma Y, Srivastava RN, Sharma V. Outcome of acetabulum fractures treated with open reduction and internal fixation through Kocher-Langenbeck Approach: a retrospective study. *J Clin Orthop Trauma.* 2021;23:101599.
  84. Kim HY, Yang DS, Park CK, Choy WS. Modified Stoppa approach for surgical treatment of acetabular fracture. *Clin Orthop Surg.* 2015;7:29–38.
  85. Kim JJ, Kim JW, Oh HK. The submuscular sliding plate technique for acetabular posterior wall fractures extending to the acetabular roof. *Orthop Traumatol Surg Res.* 2014;100:967–70.
  86. Kim HJ, Kim SS, Jung YH, Lee KH. Effectiveness of hip arthroscopy performed simultaneously before open reduction and internal fixation for acetabular fracture and fracture-dislocation of the hip. *Hip Pelvis.* 2018;30:92–100.

87. Lannes X, Moerenhout K, Duong HP, Borens O, Steinmetz S. Outcomes of combined hip procedure with dual mobility cup versus osteosynthesis for acetabular fractures in elderly patients: a retrospective observational cohort study of fifty one patients. *Int Orthop*. 2020;44:2131–8.
88. Kubota M, Uchida K, Kokubo Y, Shimada S, Matsuo H, Yayama T, et al. Changes in gait pattern and hip muscle strength after open reduction and internal fixation of acetabular fracture. *Arch Phys Med Rehabil*. 2012;93:2015–21.
89. Kim JW, Shon HC, Park JH. Injury of the obturator nerve in the modified Stoppa approach for acetabular fractures. *Orthop Traumatol Surg Res*. 2017;103:639–44.
90. Lubovsky O, Kreder M, Wright DA, Kiss A, Gallant A, Kreder HJ, et al. Quantitative measures of damage to subchondral bone are associated with functional outcome following treatment of displaced acetabular fractures. *J Orthop Res*. 2013;31:1980–5.
91. Long H-T, Deng Z-H, Zou M, Lin Z-Y, Zhu J-X, Zhu Y. Effects of the acetabular fracture index and other factors of posterior wall acetabular fracture on functional outcome. *J Int Med Res*. 2017;45:1394–405.
92. Liaw F, Govilkar S, Banks D, Kankalanu P, Youssef B, Lim J. Primary total hip replacement using Burch-Schneider cages for acetabular fractures. *Hip Int*. 2022;32:401–6.
93. Lee C, Johnson EE. Use of spring plates in fixation of comminuted posterior wall acetabular fractures. *J Orthop Trauma*. 2018;32(Suppl 1):S55–9.
94. Li Y, Ge Y, Liu H, Zhu S, Wu X. Midterm results of digastric trochanteric flip osteotomy for high acetabular posterior wall fracture. *Int Orthop*. 2022;46:1881–9.
95. Li H, Yang H, Wang D, Xu Y, Min J, Xu X, et al. Fractures of the posterior wall of the acetabulum: treatment using internal fixation of two parallel reconstruction plates. *Injury*. 2014;45:709–14.
96. Liu Z-J, Gu Y, Jia J. The Kocher-Langenbeck approach combined with robot-aided percutaneous anterior column screw fixation for transverse-oriented acetabular fractures: a retrospective study. *BMC Musculoskelet Disord*. 2022;23:345.
97. Lin C, Caron J, Schmidt AH, Torchia M, Templeman D. Functional outcomes after total hip arthroplasty for the acute management of acetabular fractures: 1- to 14-year follow-up. *J Orthop Trauma*. 2015;29:151–9.
98. Lovrić I, Splavski B, Jovanović S, Soldo I, Radanovic B. Influence of surgery onto the appearance of the hip joint periarticular calcification in patients with the acetabular fracture. *Coll Antropol*. 2011;35:49–53.
99. Lont T, Nieminen J, Reito A, Pakarinen T-K, Pajamäki I, Eskelinen A, et al. Total hip arthroplasty, combined with a reinforcement ring and posterior column plating for acetabular fractures in elderly patients: good outcome in 34 patients. *Acta Orthop*. 2019;90:275–80.
100. Manson TT, Slobogean GP, Nascone JW, Sciadini MF, LeBrun CT, Boulton CL, et al. Open reduction and internal fixation alone versus open reduction and internal fixation plus total hip arthroplasty for displaced acetabular fractures in patients older than 60 years: a prospective clinical trial. *Injury*. 2022;53:523–8.
101. Maini L, Batra S, Arora S, Singh S, Kumar S, Gautam VK. Surgical dislocation of the hip for reduction of acetabular fracture and evaluation of chondral damage. *J Orthop Surg (Hong Kong)*. 2014;22:18–23.
102. Magill P, McGarry J, Queally JM, Morris SF, McElwain JP. Minimum ten-year follow-up of acetabular fracture fixation from the Irish tertiary referral centre. *Injury*. 2012;43:500–4.
103. Lundin N, Berg HE, Enocson A. Complications after surgical treatment of acetabular fractures: a 5-year follow-up of 229 patients. *Eur J Orthop Surg Traumatol*. 2023;33:1245–53.
104. McCormick LM, Lin CA, Westberg JR, Schmidt AH, Templeman DC. Acute total hip arthroplasty versus open reduction internal fixation for posterior wall acetabular fractures in middle-aged patients. *OTA Int*. 2019;2:e014.
105. Magu NK, Gogna P, Singh A, Singla R, Rohilla R, Batra A, et al. Long term results after surgical management of posterior wall acetabular fractures. *J Orthop Traumatol*. 2014;15:173–9.
106. Magu NK, Rohilla R, Singh A, Wadhvani J. Modified Kocher-Langenbeck approach in combined surgical exposures for acetabular fractures management. *Indian J Orthop*. 2016;50:206–12.
107. Malhotra R, Singh DP, Jain V, Kumar V, Singh R. Acute total hip arthroplasty in acetabular fractures in the elderly using the Octopus System: mid term to long term follow-up. *J Arthroplasty*. 2013;28:1005–9.
108. Manzoor QW, Sultan A, Mir BA. Osteosynthesis of common acetabular fractures operated on through a single posterior (Kocher-Langenbeck) approach with or without trochanteric flip osteotomy. A case series. *Orthop Traumatol Rehabil*. 2021;23:271–7.
109. Märdian S, Schaser KD, Hinz P, Wittenberg S, Haas NP, Schwabe P. Fixation of acetabular fractures via the ilioinguinal versus pararectus approach: a direct comparison. *Bone Joint J*. 2015;97-B:1271–8.
110. Mardani-Kivi M, Ettehad H, Mirbolouk A, Mousavi MS, Hashemi-Motlagh K, Saheb-Ekhteiari K. Surgical treatment of acetabular fractures and its learning curve. *Minerva Ortop Traumatol*. 2013;64:319–24.
111. McDowell S, Mullis B, Knight BS, Dahners LE. Modified Ollier transtrochanteric approach for the treatment of acetabular fractures. *Orthopedics*. 2012;35:e132–6.
112. Matta JM, Anderson LM, Epstein HC, Hendricks P. Fractures of the acetabulum. A retrospective analysis. *Clin Orthop Relat Res*. 1986;205:230–40.
113. Masse A, Aprato A, Rollero L, Bersano A, Ganz R. Surgical dislocation technique for the treatment of acetabular fractures. *Clin Orthop Relat Res*. 2013;471:4056–64.
114. Meena UK, Sharma AK, Behera P, Lamoria RK, Meena RC, Chahar PK. Treatment of acetabular fractures with quadrilateral plate injury - a comparison of two commonly used methods. *Orthop Traumatol Surg Res*. 2022;108:102951.
115. McMahon SE, Diamond OJ, Cusick LA. Coned hemipelvis reconstruction for osteoporotic acetabular fractures in frail elderly patients. *Bone Joint J*. 2020;102-B:155–61.
116. McGee A, Obinwa C, White P, Cichos K, McGwin G, Bergin P, et al. Pre-operative blood loss of isolated acetabular fractures. *J Orthop Trauma*. 2023;37:116–21.
117. Muzii VF, Rollo G, Rocca G, Erasmo R, Falzarano G, Liuzza F, et al. Radiographic and functional outcome of complex acetabular fractures: implications of open reduction in spinopelvic balance, gait and quality of life. *Med Glas (Zenica)*. 2021;18:273–9.
118. Mouhsine E, Garofalo R, Borens O, Fischer J-F, Crevoisier X, Pelet S, et al. Acute total hip arthroplasty for acetabular fractures in the elderly: 11 patients followed for 2 years. *Acta Orthop Scand*. 2002;73:615–8.
119. Monteleone AS, Feltri P, Molina MN, Müller J, Filardo G, Candrian C. Quality of life from return to work and sports activities to sexual dysfunction after surgical treatment of acetabular fractures. *Arch Orthop Trauma Surg*. 2023;143:1491–7.
120. Min B-W, Lee K-J, Jung J-W, Kim G-W, Song K-S, Bae K-C, et al. Outcomes are equivalent for two-column acetabular fractures either with or without posterior-wall fractures. *Arch Orthop Trauma Surg*. 2018;138:1223–34.
121. Mesbahi SAR, Ghaemmaghami A, Ghaemmaghami S, Farhadi P. Outcome after surgical management of acetabular fractures: a 7-year experience. *Bull Emerg Trauma*. 2018;6:37–44.
122. Miller AN, Prasarn ML, Lorch DG, Helfet DL. The radiological evaluation of acetabular fractures in the elderly. *J Bone Joint Surg Br*. 2010;92:560–4.
123. Mitsionis GI, Lykissas MG, Moutsis E, Mitsiou D, Gkias I, Xenakis TA, et al. Surgical management of posterior hip dislocations associated with posterior wall acetabular fracture: a study with a minimum follow-up of 15 years. *J Orthop Trauma*. 2012;26:460–5.
124. Moed BR. The modified Gibson approach to the acetabulum. *Oper Orthop Traumatol*. 2014;26:591–602.
125. Moroni A, Caja VL, Sabato C, Zinghi G. Surgical treatment of both-column fractures by staged combined ilioinguinal and Kocher-Langenbeck approaches. *Injury*. 1995;26:219–24.
126. Mouhsine E, Garofalo R, Borens O, Blanc C-H, Wettstein M, Leyvraz PF. Cable fixation and early total hip arthroplasty in the treatment of acetabular fractures in elderly patients. *J Arthroplasty*. 2004;19:344–8.
127. Mouhsine E, Garofalo R, Borens O, Wettstein M, Blanc C-H, Fischer J-F, et al. Percutaneous retrograde screwing for stabilisation of acetabular fractures. *Injury*. 2005;36:1330–6.
128. Negrin LL, Seligson D. The Kocher-Langenbeck approach: differences in outcome of transverse acetabular fractures depending on the patient's position. *Eur J Trauma Emerg Surg*. 2010;36:369–74.
129. Negrin LL, Benson CD, Seligson D. Prone or lateral? Use of the Kocher-Langenbeck approach to treat acetabular fractures. *J Trauma*. 2010;69:137–41.

130. Naranje S, Shamsheery P, Yadav CS, Gupta V, Nag HL. Digastric trochanteric flip osteotomy and surgical dislocation of hip in the management of acetabular fractures. *Arch Orthop Trauma Surg.* 2010;130:93–101.
131. Nayak T, Mittal S, Trikha V, Farooque K, Gamanagatti S, Sharma V. Short-term results of surgical treatment of acetabular fractures using the modified Stoppa approach. *J Clin Orthop Trauma.* 2020;11:1121–7.
132. Nicol G, Sanders E, Liew A, Wilkin G, Gofton WT, Papp S, et al. Does use of a quadrilateral surface plate improve outcome in elderly acetabular fractures? *J Clin Orthop Trauma.* 2020;11:1045–52.
133. Pompili M, Verdano MA, Marengi L, Corsini T, Ceccarelli F. Surgical treatment of displaced acetabular fractures: report of 13 clinical cases. *Acta Biomed.* 2012;83:147–53.
134. Pillella VK, John JL. A prospective study on functional outcome of open reduction and internal fixation of acetabular fractures. *J Pharm Res Int.* 2020;32:174–83.
135. Peter RE. Open reduction and internal fixation of osteoporotic acetabular fractures through the ilio-inguinal approach: use of buttress plates to control medial displacement of the quadrilateral surface. *Injury.* 2015;46(Suppl 1):S2–7.
136. Perumal R, Valleri DP, Gessesse MT, Jayaramaraju D, Rajasekaran S. Marginal impaction in complex posterior wall acetabular fractures: role of allograft and mid-term results. *Eur J Orthop Surg Traumatol.* 2020;30:435–40.
137. Patil A, Attarde DS, Haphiz A, Sancheti P, Shyam A. A Single approach for management of fractures involving both columns of the acetabulum: a case series of 23 patients. *Strategies Trauma Limb Reconstr.* 2021;16:152–60.
138. Park KS, Chan CK, Lee GW, Ahn HW, Yoon TR. Outcome of alternative approach to displaced acetabular fractures. *Injury.* 2017;48:388–93.
139. Øvre S, Madsen JE, Røise O. Acetabular fracture displacement, roof arc angles and 2 years outcome. *Injury.* 2008;39:922–31.
140. O'Toole RV, Hui E, Chandra A, Nascone JW. How often does open reduction and internal fixation of geriatric acetabular fractures lead to hip arthroplasty? *J Orthop Trauma.* 2014;28:148–53.
141. Ortega-Briones A, Smith S, Rickman M. Acetabular fractures in the elderly: midterm outcomes of column stabilisation and primary arthroplasty. *Biomed Res Int.* 2017;2017:4651518.
142. Oh CW, Kim PT, Park BC, Kim SY, Kyung HS, Jeon IH, et al. Results after operative treatment of transverse acetabular fractures. *J Orthop Sci.* 2006;11:478–84.
143. Nicol GM, Sanders EB, Kim PR, Beaulé PE, Gofton WT, Grammatopoulos G. Outcomes of total hip arthroplasty after acetabular open reduction and internal fixation in the elderly-acute vs delayed total hip arthroplasty. *J Arthroplasty.* 2021;36:605–11.
144. Pantazopoulos T, Nicolopoulos CS, Babis GC, Theodoropoulos T. Surgical treatment of acetabular posterior wall fractures. *Injury.* 1993;24:319–23.
145. Patterson JT, Cook SB, Firoozabadi R. Early hip survival after open reduction internal fixation of acetabular fracture. *Eur J Orthop Surg Traumatol.* 2023;33:1209–16.
146. Rommens PM, Herteleer M, Handrich K, Boudissa M, Wagner D, Hopf JC. Medial buttressing of the quadrilateral surface in acetabular and periprosthetic acetabular fractures. *PLoS ONE.* 2020;15:e0243592.
147. Roetman B, Seybold D, Keil D, Muhr G, Möllenhoff G. Langzeitergebnisse nach Azetabulumfrakturen unter Berücksichtigung von heterotopen Ossifikationen. *Zentralbl Chir.* 2006;131:188–93.
148. Rahimi H, Gharahdaghi M, Parsa A, Assadian M. Surgical management of acetabular fractures: a case series. *Trauma Mon.* 2013;18:28–31.
149. Qi X, Liu JG, Gong YB, Yang C, Li SQ, Feng W. Treatment of posterior wall fractures of acetabulum. *Chin J Traumatol.* 2009;12:113–7.
150. Qadir RI, Bukhari SI. Outcome of operative treatment of acetabular fractures: short term follow-up. *J Ayub Med Coll Abbottabad.* 2015;27:287–91.
151. Preston G, Heimke IM, Heindel K, Scarcella NR, Furdock R, Vallier HA. Survivorship of the hip joint after acetabulum fracture. *J Am Acad Orthop Surg.* 2021;29:781–8.
152. Ragnarsson B, Danckwardt-Lillieström G, Mjöberg B. The triradiate incision for acetabular fractures. A prospective study of 23 cases. *Acta Orthop Scand.* 1992;63:515–9.
153. Rickman M, Young J, Trompeter A, Pearce R, Hamilton M. Managing acetabular fractures in the elderly with fixation and primary arthroplasty: aiming for early weightbearing. *Clin Orthop Relat Res.* 2014;472:3375–82.
154. Rommens PM, Giménez MV, Hessmann M. Posterior wall fractures of the acetabulum: characteristics, management, prognosis. *Acta Chir Belg.* 2001;101:287–93.
155. Salama W, Mousa S, Khalefa A, Sleem A, Kenawey M, Ravera L, et al. Simultaneous open reduction and internal fixation and total hip arthroplasty for the treatment of osteoporotic acetabular fractures. *Int Orthop.* 2017;41:181–9.
156. Rommens PM, Schwab R, Handrich K, Arand C, Wagner D, Hofmann A. Open reduction and internal fixation of acetabular fractures in patients of old age. *Int Orthop.* 2020;44:2123–30.
157. Schwab JM, Zebrack J, Schmeling GJ, Johnson J. The use of cervical vertebrae plates for cortical substitution in posterior wall acetabular fractures. *J Orthop Trauma.* 2011;25:577–80.
158. Schellmann WD, Mockwitz J. Contzen H [Results after surgical reconstruction of the acetabulum]. *Monatsschr Unfallheilkd.* 1975;78:293–304.
159. Saterbak AM, Marsh JL, Nepola JV, Brandser EA, Turbett T. Clinical failure after posterior wall acetabular fractures: the influence of initial fracture patterns. *J Orthop Trauma.* 2000;14:230–7.
160. Sarlak AY, Selek O, Inanir M, Musaoglu R, Baran T. Management of acetabular fractures with modified posterior approach to spare external hip rotators. *Injury.* 2014;45:732–7.
161. Sarantis M, Stasi S, Milaras C, Tzeferonis D, Lepetsos P, Macheras G. Acute Total hip arthroplasty for the treatment of acetabular fractures: a retrospective study with a six-year follow-up. *Cureus.* 2020;12:e10139.
162. Salar N, Bilgen MS, Bilgen ÖF, Ermutlu C, Eken G, Durak K. Total hip arthroplasty for acetabular fractures: "Early Application." *Ulus Travma Acil Cerrahi Derg.* 2017;23:337–42.
163. Salameh M, Hammad M, Babikir E, Ahmed AF, George B, Alhaneedi G. The role of patient positioning on the outcome of acetabular fractures fixation through the Kocher-Langenbeck approach. *Eur J Orthop Surg Traumatol.* 2021;31:503–9.
164. Sharma V, Bansal H, Mittal S, Farooque K, Nayak T. Tricortical iliac crest graft as a salvageable option in the reconstruction of comminuted posterior wall acetabular fractures: our experience from a level 1 trauma centre. *Arch Orthop Trauma Surg.* 2023;143:277–85.
165. Sharma S, Mathur H, Zinzuwadia K, Jaysingani T. Short-term follow-up of anterior and posterior both column fractures of acetabulum managed through both column plating. *Eur J Orthop Surg Traumatol.* 2019;29:605–10.
166. Senegas J, Liorzou G, Yates M. Complex acetabular fractures: a transtrochanteric lateral surgical approach. *Clin Orthop Relat Res.* 1980;107–14.
167. Selvaratnam V, Panchani S, Jones HW, Chitre A, Clayson A, Shah N. Outcomes of acute fix and replace in complex hip posterior fracture dislocations with acetabular fractures: a minimum of 3 years follow-up. *Acta Orthop Belg.* 2021;87:635–42.
168. Singh A, Telagareddy K, Kumar P, Singh S, Singh RN, Singh PK. THA in patients with neglected acetabular fractures. *Sicot j.* 2022;8:37.
169. Siebenrock KA, Gautier E, Woo AKH, Ganz R. Surgical dislocation of the femoral head for joint debridement and accurate reduction of fractures of the acetabulum. *J Orthop Trauma.* 2002;16:543–52.
170. Shazar N, Eshed I, Ackshota N, Hershkovich O, Khazanov A, Herman A. Comparison of acetabular fracture reduction quality by the ilioinguinal or the anterior intrapelvic (modified Rives-Stoppa) surgical approaches. *J Orthop Trauma.* 2014;28:313–9.
171. Shi H, Xiong J, Chen Y, Wang J-F, Wang Y. Radiographic analysis of the restoration of hip joint center following open reduction and internal fixation of acetabular fractures: a retrospective cohort study. *BMC Musculoskelet Disord.* 2014;15:277.
172. Siebenrock KA, Gautier E, Ziran BH, Ganz R. Trochanteric flip osteotomy for cranial extension and muscle protection in acetabular fracture fixation using a Kocher-Langenbeck approach. *J Orthop Trauma.* 2006;20:552–6.
173. Verbeek DO, van der List JP, Tissue CM, Helfet DL. Long-term patient reported outcomes following acetabular fracture fixation. *Injury.* 2018;49:1131–6.
174. Ur Razaq MN, Khan MA, Ali A. Outcome of two column acetabular fractures treated operatively through single posterior approach. *J Ayub Med Coll Abbottabad.* 2016;28:718–20.

175. Tidermark J, Blomfeldt R, Ponzer S, Söderqvist A, Törnkvist H. Primary total hip arthroplasty with a Burch-Schneider antiprotusion cage and autologous bone grafting for acetabular fractures in elderly patients. *J Orthop Trauma*. 2003;17:193–7.
176. Tan KY, Lee HC, Chua D. Open reduction and internal fixation of fractures of the acetabulum—local experience. *Singapore Med J*. 2003;44:404–9.
177. Uchida K, Kokubo Y, Yamaya T, Nakajima H, Miyazaki T, Negoro K, et al. Fracture of the acetabulum: a retrospective review of ninety-one patients treated at a single institution. *Eur J Orthop Surg Traumatol*. 2013;23:155–63.
178. Ulrich C, Burri C, Neugebauer R. Primäre Alloarthroplastik bei Acetabulumfrakturen [Primary allo-arthroplasty in acetabulum fractures]. *Unfallchirurg*. 1986;89:49–56.
179. Swartman B, Pelzer J, Beisemann N, Schnetzke M, Keil H, Vetter SY, et al. Fracture reduction and screw position after 3D-navigated and conventional fluoroscopy-assisted percutaneous management of acetabular fractures: a retrospective comparative study. *Arch Orthop Trauma Surg*. 2021;141:593–602.
180. Swartman B, Pelzer J, Vetter SY, Beisemann N, Schnetzke M, Keil H, et al. Minimally invasive surgical treatment of minimally displaced acetabular fractures does not improve pain, mobility or quality of life compared to conservative treatment: a matched-pair analysis of 50 patients. *J Orthop Surg Res*. 2020;15:115.
181. Splavski B, Lovrić I, Muzević D, Soldo I, Pinotić K. Reducing pain and improving quality of life for patients suffering the acetabular fracture. *Coll Antropol*. 2013;37:183–7.
182. Soni A, Gupta R, Vashisht S, Kapoor A, Sen R. Combined anterior pelvic (CAP) approach for fracture acetabulum fixation - functional outcome evaluation and predictors of outcome. *J Clin Orthop Trauma*. 2020;11:1136–42.
183. Singh SV, Chopra RK, Puri G, Pheroz M, Kumar S, Bansal A, et al. Clinico-radiological evaluation of modified stoppa approach in treatment of acetabulum fractures. *Cureus*. 2020;12:e10193.
184. Yavuz IA, Aykanat C, Senel C, Inci F, Ceyhan E, Aslan Y, et al. The impact of surgical approaches for isolated acetabulum fracture on sexual functions: a prospective study. *J Orthop Trauma*. 2022;36:124–9.
185. Yang Y, Zou C, Fang Y. The Stoppa combined with iliac fossa approach for the treatment of both-column acetabular fractures. *J Orthop Surg Res*. 2020;15:588.
186. Yao S, Chen K, Zhu F, Liu J, Wang Y, Zeng L, et al. Internal fixation of anterior acetabular fractures with a limited pararectus approach and the anatomical plates: preliminary results. *BMC Musculoskelet Disord*. 2021;22:203.
187. Xu W, Zhu Z, Huang F, Mai Q, Fan S. Posterior wall fractures of the acetabulum: treatment using an anatomical plate through direct posterior approach. *Arch Orthop Trauma Surg*. 2023;143:3669–75.
188. Xiao K, Xu B, Ding L, Yu W, Bao L, Zhang X, et al. Traditional versus mirror three-dimensional printing technology for isolated acetabular fractures: a retrospective study with a median follow-up of 25 months. *J Int Med Res*. 2021;49:3000605211028554.
189. Wu H-Y, Shao Q-P, Song C-J, Shang R-R, Liu X-M, Cai X-H. Personalized three-dimensional printed anterior titanium plate to treat double-column acetabular fractures: a retrospective case-control study. *Orthop Surg*. 2020;12:1212–22.
190. Wu B, Wang HB, Meng CY, Jia CL, Zhao YF. Comparison of open reduction and internal fixation in treatment of delayed and early acetabular fractures. *Int J Clin Exp Med*. 2016;9:20454–61.
191. Wu H, Shang R, Cai X, Liu X, Song C, Chen Y. Single ilioinguinal approach to treat complex acetabular fractures with quadrilateral plate involvement: outcomes using a novel dynamic anterior plate-screw system. *Orthop Surg*. 2020;12:488–97.
192. Wollmerstädt J, Pieroh P, Schneider I, Zeidler S, Höch A, Josten C, et al. Mortality, complications and long-term functional outcome in elderly patients with fragility fractures of the acetabulum. *BMC Geriatr*. 2020;20:66.
193. Wenzel L, Rüdén C, Thannheimer A, Becker J, Brand A, Augat P, et al. The pararectus approach in acetabular surgery: radiological and clinical outcome. *J Orthop Trauma*. 2020;34:82–8.
194. Weaver MJ, Smith RM, Lhowe DW, Vrahas MS. Does total hip arthroplasty reduce the risk of secondary surgery following the treatment of displaced acetabular fractures in the elderly compared to open reduction internal fixation? A pilot study *J Orthop Trauma*. 2018;32(Suppl 1):S40–5.
195. Wang T, Hou X, Zhou Z, Liu J, Zhang S, Ge S, et al. Treatment of acetabular fracture involving anterior and posterior columns using a single pararectus approach: surgical experience and preliminary results. *Int Orthop*. 2023;47:233–40.
196. Wan Y, Yao S, Ma Y, Zeng L, Wang Y, Qu Y, et al. The novel infra-pectineal buttress plates used for internal fixation of elderly quadrilateral surface involved acetabular fractures. *Orthop Surg*. 2022;14:1583–92.
197. Wang P, Zhu X, Xu P, Zhang Y, Wang L, Liu X, et al. Modified ilioinguinal approach in combined surgical exposures for displaced acetabular fractures involving two columns. *Springerplus*. 2016;5:1602.
198. Zou R, Wu M, Guan J, Xiao Y, Chen X. Clinical results of acetabular fracture via the pararectus versus ilioinguinal approach. *Orthop Surg*. 2021;13:1191–5.
199. Zou R, Wu M, Guan J, Xiao Y, Chen X. Therapeutic effect of acetabular fractures using the pararectus approach combined with 3D printing technique. *Orthop Surg*. 2020;12:1854–8.
200. Zinghi G, Trono M. Acetabular fractures. *Chir Organi Mov*. 2003;88:247–52.
201. Zheng Y, Chen J, Yang S, Ke X, Xu D, Wang G, et al. Application of computerized virtual preoperative planning procedures in comminuted posterior wall acetabular fractures surgery. *J Orthop Surg Res*. 2022;17:51.
202. Zhang L, Yin P, Zhang W, Li T, Li J, Chen H, et al. An effective and feasible method, “Hammering Technique”, for percutaneous fixation of anterior column acetabular fracture. *Biomed Res Int*. 2016;2016:7151950.
203. Yu JK, Chiu FY, Feng CK, Chung TY, Chen TH. Surgical treatment of displaced fractures of posterior column and posterior wall of the acetabulum. *Injury*. 2004;35:766–70.
204. Yu C, Yu W, Mao S, Zhang P, Zhang X, Zeng X, et al. Traditional three-dimensional printing technology versus three-dimensional printing mirror model technology in the treatment of isolated acetabular fractures: a retrospective analysis. *J Int Med Res*. 2020;48:300060520924250.
205. Zha GC, Tulumuhan DM, Wang T, Wan GY, Wang Y, Sun JY. A new internal fixation technique for acetabular fractures involving the quadrilateral plate. *Orthop Traumatol Surg Res*. 2020;106:855–61.
206. Zhang R, Yin Y, Li S, Jin L, Guo J, Hou Z, et al. Fixation of displaced acetabular fractures with an anatomic quadrilateral surface plate through the stoppa approach. *Orthopedics*. 2019;42:e180–6.
207. Gary JL, VanHal M, Gibbons SD, Reinert CM, Starr AJ. Functional outcomes in elderly patients with acetabular fractures treated with minimally invasive reduction and percutaneous fixation. *J Orthop Trauma*. 2012;26:278–83.
208. Kumar D, Singh S, Srivastava S, Singh SK, Singh A, Sharma Y. Outcome of total hip arthroplasty in patients with failed open reduction and internal fixation of acetabular fractures. *J Clin Orthop Trauma*. 2021;20:101480.
209. Carrothers A, Alvarez-Berdugo D. AceFIT – acetabular fractures in older patients intervention trial: a feasibility study comparing three methods of treatment of acetabular fractures in older patients, surgical fixation versus surgical fixation and hip replacement versus non-surgical treatment. Available from: <https://trialsearch.who.int/Trial2.aspx?TrialID=ISRCTN16739011>. Accessed 15 Dec 2023.
210. Henawy A, Atef M. Assessment of modified Kocher-Langenbeck surgical approach compared with conventional Kocher-Langenbeck surgical approach in treatment of simple posterior wall acetabular fractures. Available from: <https://trialsearch.who.int/Trial2.aspx?TrialID=PACTR202204468763535>. Accessed 15 Dec 2023.
211. Hou Z. Surgical treatment of old acetabular fracture with posterior wall osteotomy. Available from: <https://ClinicalTrials.gov/show/NCT03193840>. Accessed 15 Dec 2023.
212. Hou Z, Shang S. Prospective comparison between W-shaped acetabular angular plate (WAAP) and reconstruction plate for the treatment of posterior acetabular wall fracture. Available from: <https://ClinicalTrials.gov/show/NCT02327949>. Accessed 15 Dec 2023.
213. Jouffroy P. Treatment of acetabular fracture: the contribution of the 3D impression. Available from: <https://ClinicalTrials.gov/show/NCT03312491>. Accessed 15 Dec 2023.
214. Melo L, Khoshbin A. GATOR: geriatric acetabular fractures: open reduction internal fixation versus replacement - a large cohort of acute



- open reduction internal fixation (ORIF) versus total hip arthroplasty for geriatric acetabular fractures. Available from: <https://ClinicalTrials.gov/show/NCT03713853>. Accessed 15 Dec 2023.
215. Ruktrakul R. Clinical results after fixation of acetabular fracture via Pararectus approach versus the modified Stoppa : randomized controlled trial. Available from: <https://trialsearch.who.int/Trial2.aspx?TrialID=TCTR20201222001>. Accessed 15 Dec 2023.
  216. Tang P. Treatment of acetabular posterior wall fracture with anatomical locking plate. Available from: <https://clinicaltrials.gov/study/NCT01437150>. Accessed 15 Dec 2023.
  217. Zhang R, Hou Z. Randomized trails of different fixations for acetabular fracture involving quadrilateral surface. Available from: <https://clinicaltrials.gov/show/NCT03026868>. Accessed 15 Dec 2023.
  218. Chalmers I, Glasziou P. Avoidable waste in the production and reporting of research evidence. *Lancet* (London, England). 2009;374:86–9.
  219. Kirkham JJ, Williamson P. Core outcome sets in medical research. *BMJ Med*. 2022;1:e000284.
  220. Copley PC, Tadross D, Salloum N, Woodfield J, Edlmann E, Poon M, et al. A systematic review identifying outcome measures used in evaluating adults sustaining cervical spine fractures. *Eur Spine J*. 2022;31:3365–77.
  221. Aquilina AL, Claireaux H, Aquilina CO, Tutton E, Fitzpatrick R, Costa ML, et al. What outcomes have been reported on patients following open lower limb fracture, and how have they been measured? *Bone & joint research*. 2023;12:138–46.
  222. Miller C, Cross J, O'Sullivan J, Power DM, Kyte D, Jerosch-Herold C. Developing a core outcome set for traumatic brachial plexus injuries: a systematic review of outcomes. *BMJ Open*. 2021;11:e044797.
  223. Watts AC, Hamoodi Z, McDaid C, Hewitt C. Elbow arthroplasty research methods, outcome domains, and instruments used in clinical outcome studies: a scoping review. *The Bone Joint J*. 2022;104-B:1148–55.
  224. Yalcinkaya A, Rahbek O, Tirta M, Jepsen JF, Rathleff MS, Iobst C, et al. Outcomes and outcome measurement instruments in lower-limb lengthening surgery: a scoping review to inform core outcome set development. *Acta Orthop*. 2024;95:715–22.
  225. Page MJ, Huang H, Verhagen AP, Gagnier JJ, Buchbinder R. Outcome reporting in randomized trials for shoulder disorders: literature review to inform the development of a core outcome set. *Arthritis Care Res*. 2018;70:252–9.

## Publisher's Note

Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.