REVIEW ARTICLE

Patient Weight-bearing after Pelvic Fracture Surgery—A Systematic Review of the Literature: What is the Modern Evidence Base?

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Abstract

Background: Little attention in the literature appears to have been paid to the issue of postoperative weight-bearing protocols for different injury patterns after pelvic fracture surgery. The primary aim of this study is to review the currently available literature to define the level of available evidence used to inform surgical decisions on weight-bearing after pelvic fracture surgery. Secondary aims are to assess the published methods of fracture classification, surgical management, and assessment or reporting of patient outcomes.

Methods: A systematic review of the English language literature from 1990 to 2016 was undertaken. Eligible papers were all papers reporting minimum 6-month outcomes following surgery for pelvic fractures in adults. Exclusion criteria included pathological fractures or those resulting from penetrating injury, solely osteoporotic fractures, or series with less than 6 months of follow-up data.

Results: There is very little published scientific data to inform the treating surgeon on postoperative weight-bearing protocols after pelvic fracture surgery, with no randomized trials and only 1 paper out of 122 stating this as a primary aim. More than half of the papers published did not state what postoperative protocol was employed. There is no standardization of outcome measures, with less than 20% of papers using the most common validated outcome scoring system; in contrast, there is good agreement on the use of either the Tile (75%) or Burgess and Young (20%) classification.

Limitations: Due to the lack of published studies looking at the topic of postoperative weight-bearing after pelvic fractures, no specific recommendations are possible. As large numbers of papers were included, they were not individually assessed for bias.

Conclusion: A review of postoperative weight-bearing regimes reveals a nonexistent scientific evidence base from which to make recommendations, although a consensus strategy has been identified. Future research needs to be directed at this topic, as has already been the case in numerous other fracture areas, since the advantages of early mobility are potentially significant. The reported methodology for assessing and reporting patient outcomes after pelvic fracture surgery reveals no consistent standards, and the majority of papers use no specific outcome scoring system.

Keywords: Pelvic fracture, Pelvis, Rehabilitation, Weight-bearing.

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Introduction

Surgery for pelvic fractures has become more common over the last three decades, as a result of improvements in all aspects of care for the traumatically injured patient. For all but the most severe cases, there has been a steady improvement in mortality rates,[1] and interest has increased in improving clinical outcomes for these patients. Modern fracture management is becoming more focused on techniques that facilitate early physiological rehabilitation, including early mobility and weight-bearing where possible. This is most commonly appreciated in the management of elderly trauma patients and, especially, the neck of femur fracture patients, but also applies to most other fracture regions, and has been one of the drivers for implant change and development.

Tradition dictates that the majority of patients following pelvic fracture surgery are kept nonweight-bearing, or, at least, minimal weight-bearing for several weeks, although protocols vary significantly from institution to institution. As a result, the primary aim of this paper is to interrogate the published literature in an attempt to identify the evidence base that exists to guide postoperative management, and, specifically, weight-bearing protocols, after pelvic fracture surgery. Secondary aims are to review the methods reported within the published literature to classify pelvic ring fractures and report clinical outcomes.

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Methods

A systematic review of the literature was carried out using the methods described in Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA).[2] The search terms used included "pelvic fracture," "pelvis fracture," "pelvic trauma," and "pelvic ring" for all databases, and results were limited to papers

published between 1 January 1990 and 31 December 2016. Results were also limited to English language literature only, and human subjects. Pubmed was used as the main search engine for Medline, and further searches were performed using the Scopus and the Cochrane Central Register of Controlled Trials.

Eligibility Criteria

Participants

Skeletally mature patients suffering from an acute traumatic pelvic fracture, either alone or as a part of a multiple injury scenario.

Intervention

Operative management of the pelvic fracture.

Comparison

No comparison was required as all patients were included as one study group.

Outcomes

Results reported in any form, with a minimum follow-up period of 6 months from injury. Formal outcome scores were recorded, but studies were included where the only outcomes were descriptive rather than formal. Descriptions of postoperative weight-bearing regimes were recorded where given.

Exclusion Criteria

The major exclusions were abstracts and conference proceedings, review papers, and case reports. A series of pathological or specific osteoporotic fractures, as well as injuries secondary to penetrating trauma, were excluded to keep the pathology as uniform as possible. Reports with less than 6 months outcome data were excluded.

Review Process

The method of acquisition of the final list of included papers is shown in Figure 1. References were copied into the reference management software from all three searches, and duplicates were removed.

The abstracts were read in full, and papers included or excluded according to the above criteria. Any ambiguity at this stage resulted in the paper being sourced rather than rejected. The resulting list of papers was then sourced in full and read by two of the authors. Further papers were removed at this stage for a variety of reasons, such as registry reviews, technical papers, cadaveric studies, short follow-up not stated in the abstract, and theory-only papers with no clinical information. The final list of included papers was then analyzed independently by two of the authors and a table created collating data on patient numbers, injury types and classifications, methods of treatment, post-operative protocols, and assessment of outcomes. Any conflicts in inclusions were solved by discussion and, where necessary, arbitration with the third author.

Results

The initial search generated a collection of 7,590 articles. Limiting the selection to the English language resulted in 6,925 papers. Removing duplicate returns from the three databases searched, and applying exclusion criteria to the abstracts resulted in a group of 386 included abstracts. After all papers were sourced in full and read, further papers were removed according to the exclusion criteria leaving a final cohort of 122 papers[3–124] (see the method as described in Fig. 1).

The 122 papers covered a total number of 7,799 patients, with a mean of 64 and a median of 32 per paper (range 9–1,409). There were no prospective randomized trials identified, and only 13 papers[11,12,14,37,66,77,104–106,120,121,123,125] included comparative cohorts, the remaining 109 papers all being case or cohort series.

Assessment of weight-bearing protocols after surgery revealed the following:

- There was only one paper[7] where the stated main aim of the paper is to assess the effects of weight-bearing on patients' outcomes; this was restricted to vertically stable but rotationally unstable fracture types managed with external fixation.
- Sixty-three papers (52%) did not state what amount of postoperative weight-bearing was allowed.
- Thirty-three papers (27%) had patients touch- or nonweight-bearing for a mean of 9 weeks.[4,5,9,11,12,17,25,28,29,32,36,37,39,40,43,52,54,58,59,61,74,77,81,85,89,95,111,113,114,121,126–128]
- Nineteen papers (15%) had patients partially weight-bearing for a mean of 8 weeks.[16,24,45,57,61,63,66,75,76,82,118,119,123,124,129–133]

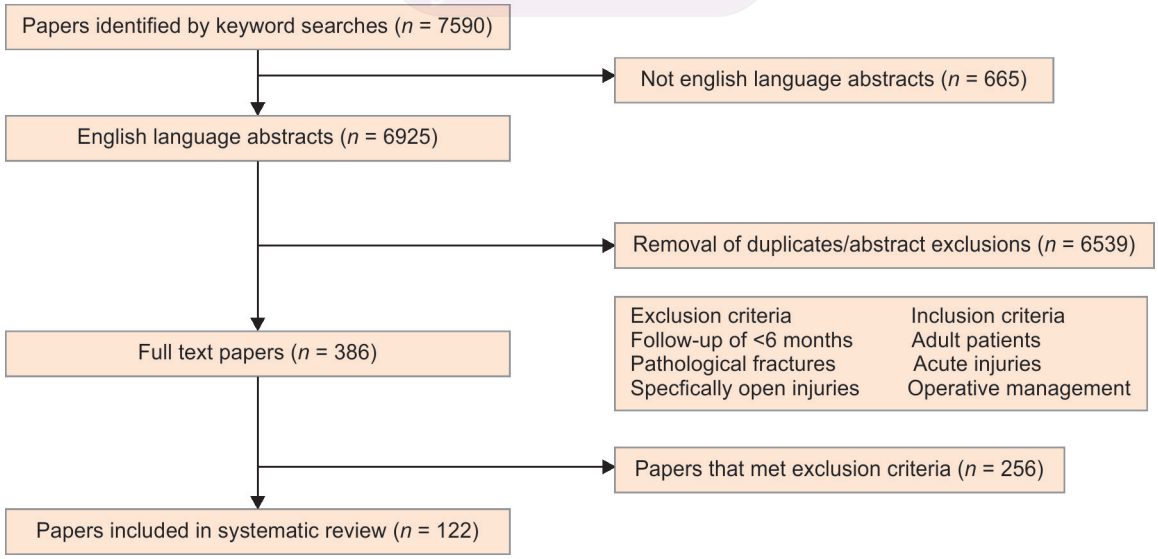

Fig. 1: Paper verification/exclusion process

Table 1: Injury classifications reported

	Tile classification	
Type A	*Type B*	*Type C*
765 patients (12.7%)	1,917 patients (31.9%)	3,328 patients (55.4%)
	Burgess and Young classification	
APC1—22 patients (1.6%)	APC2—374 patients (26.9%)	APC3—198 patients (14.2%)
LC1—124 patients (8.9%)	LC2—254 patients (18.2%)	LC3—119 patients (8.5%)
	Vert. shear—263 patients (18.9%)	
	Combined—38 patients (2.7%)	

- Seven papers (8.3%) allowed full weight-bearing as tolerated in at least some patients,[7,8,20,78,88–90] while two papers described enforced bedrest for 6 weeks.

Regarding injury classification, the most commonly used system was that of Tile[134] (used in 92 papers), followed by the Burgess and Young classification[135] (used in 24 papers). Eleven papers did not formally classify the injury type. The breakdown of injury types is given in Table 1.

The surgical management was varied across all types and is shown in Table 2. Table 3 shows the weight-bearing protocols employed for each Tile injury classification, and Table 4 shows the same weight-bearing data against the method of fixation.

Outcome measurements were highly varied across the papers with no standard method adopted. One hundred and three papers (85%) used radiological methods as well as clinical to judge outcomes, 5 papers did not report specific outcome measures, and 65 papers gave specific nonvalidated clinical outcome measures such as pain, walking distance, and gait. Regarding validated scoring systems, the most commonly used system was the Majeed[136] or the Lindahl[137] version of it, but only 24 papers (19.7%) used either method. Ten papers (8.2%) reported SF-36 scores, and there were less than five papers using any other specific outcome scoring method.

There was no clear correlation between the fracture types treated and the weight-bearing protocols reported, or any apparent trend in the management over time. There was, however, a slight trend in the management of type C fractures; of those papers reporting nonweight-bearing protocols, 86% included type C fractures, the figure being 84% for partial weight-bearing protocols but only 33% for full weight-bearing. The same figures for type B injuries were 56% for non- and full weight-bearing, and 68% for partial weight-bearing protocols.

Looking specifically at the subset of papers reporting only Tile type C fractures (vertically unstable as well as rotationally unstable), there were 1,433 patients in 33 papers, with a mean of 44 per paper. Within this group, 22% underwent anterior open reduction and internal fixation (ORIF) plus percutaneous posterior fixation, 19% had percutaneous posterior fixation only, and 35% had an open posterior procedure, with or without anterior fixation. No patients were managed with external fixation alone. Eleven papers did not state how patients were mobilized after surgery. Fourteen of the remaining papers reported non- or touch weight-bearing for a mean of 9.5 weeks. Six papers employed partial weight-bearing for the same time period, and two papers allowed full weight-bearing after fixation.[20,78]

Table 2: Surgical management reported

Type of surgical procedure	*Number of patients*	*Percentage of patients*
Ant ORIF and post percutaneous	792	18.5
Posterior percutaneous alone	641	15
Ant and post ORIF	638	14.9
Anterior ORIF alone	548	12.8
Anterior Exfix alone	400	9.4
Exfix plus posterior percutaneous	393	9.2
Posterior ORIF alone	387	9.0
Other	235	5.5
Ant and post percutaneous	183	4.3
Anterior percutaneous alone	56	1.3

Table 3: Cross table showing weight-bearing employed against Tile injury classification

Tile classification	*Full weight*	*Partial weight*	*Non or touch weight*
A	1	1	2
B	3	10	11
C	3	13	25

Table 4: Cross table showing weight-bearing employed against type of surgical fixation—percentage of patients for each fixation method

	Weight-bearing employed		
Fixation	*Non or touch weight*	*Partial weight*	*Full weight*
1	80	5	15
2	59	41	0
3	44	56	0
4	71	27	2
5	0	100	0
6	7	89	4
7	45	34	21
8	78	19	3
9	14	86	0

Fixation method:	
1	Anterior ORIF only
2	Anterior ORIF plus percutaneous posterior
3	Posterior ORIF only
4	ORIF front and back
5	Anterior percutaneous only
6	Posterior percutaneous only
7	Exfix alone
8	Exfix plus posterior fixation
9	Front and back percutaneous

Discussion

This systematic review of the available English literature publications on outcomes after surgically managed pelvic fractures

was, primarily, to establish the level of evidence regarding weight-bearing protocols after pelvic fracture surgery. The time period was defined from 1990 onwards with the aim of excluding historic papers, where management protocols generally included a high proportion of nonoperative management and long periods of bed rest.

It is clear that there is very little direct evidence to guide the treating surgeon on this subject, with no prospective trials and only 13 papers published with any sort of comparative cohort. In addition, surprisingly few papers used validated outcome scores that are comparable between methods and patient groups. Interpretation of this type of incomplete data with a view to informing surgical practice is inherently difficult.

There were no studies comparing the outcomes of protocols using different weight-bearing regimes. We identified only one paper where the stated aim was to investigate the effects of weight-bearing after fixation, but this was in a limited subset of patients managed in a specific fashion. More concerning is the fact that over half of the papers identified by this review reported evidence on the outcome of pelvic fractures without stating what postoperative weight-bearing regime was employed. From the literature, however, there does appear to be some degree of consensus, in that, if patients are not allowed to bear full weight, then the mean time of restrictions is between 8 and 9 weeks, regardless of the fracture type or the level of restriction. In addition, there is a trend toward imposing more restrictions on type C fractures rather than type A or B, although this is by no means universal.

There were two papers that allowed full weight-bearing as tolerated after fixation of solely type C fractures. Duwelius et al.[20] treated 16 type C injuries in 13 patients using computerised tomography (CT)-guided ilio-sacral screws, with 9 patients also receiving anterior fixation. Schildhauer et al.[78] reported 19 cases of spino-pelvic dissociation, all managed with lumbopelvic fixation and no anterior instrumentation. While neither paper reported formal outcome scores, both authors stated that all patients healed with no loss of fracture position, suggesting that with adequate stability full weight-bearing of even type C injuries can be safe. Five other papers[7,8,88–90] reported results after allowing full weight-bearing in at least some cases. The only one to use specific outcome measurements (Majeed) was Tan et al.,[88] who reported on the use of lumbopelvic fixation for spinopelvic instability. Their results in just nine patients were five excellent or good outcomes, three fair, and one poor. The remaining four papers all managed type B injuries with either external fixation or internal fixation, and all report predominantly good outcomes judged by various clinical indicators. No complications are reported in any of these seven papers that were attributed to the use of early weight-bearing by any of the authors.

Early weight-bearing after pelvic fracture surgery would have a number of possible benefits. Restricted weight-bearing and immobility are associated with a number of deleterious effects, most notably bone loss, muscle loss, and joint stiffness; mitigation against these problems should be beneficial to overall patient outcomes. In patients with multiple injuries, non- or touch weight-bearing is often impossible (e.g., due to upper limb injuries or contralateral lower limb injuries), leaving patients with pelvic fractures commonly restricted to bed or chair mobility for several weeks. Early weight-bearing may allow some of these patients to recover mobility earlier. In all patients (whether multiply injured or isolated pelvic fractures), earlier weight-bearing should lead to earlier discharge from hospital (as well as return to social and occupational activities), with concomitant financial and social benefits. We would postulate additional beneficial effects on venous thrombosis rates are associated, together with probable psychological benefits, with the earlier return of function in this high-risk group of patients.

There may be a number of reasons why the effects of early weight-bearing after pelvic fracture fixation have not been investigated, thus, far. There is an inherent fear that allowing patients to load fracture fixation may lead to loss of reduction and a poorer outcome; while this fear is entirely understandable, there appears to be little data to support it. Early weight-bearing has been investigated in other fracture regions,[138–140] and in addition is known to be beneficial for long bone fracture healing.[141] It may at first seem "unethical" to randomize patients between groups with differing weight-bearing regimes if the risk of one group is a failure of fixation; however, a well-constructed trial with informed consent as well as appropriate safeguards should negate this. It is also difficult to assess the exact level of weight-bearing activity patients have been doing, as patients' perceptions and reports of activity levels rarely match the reality.[142–147] However, the drive for early weight-bearing after fracture fixation in other anatomic areas has led to improved fixation techniques and implants and, perhaps, is the path pelvic fracture fixation should follow.

One of the main issues with investigating weight-bearing after pelvic fracture fixation is our ability to measure fracture reduction and displacement in the first place. Plain X-rays have been shown to be inaccurate to measure fracture displacement of less than 5 mm.[148–150] Given the complexity of the pelvis, which makes a radiographic assessment of displacement more challenging than for other fractures, nonanatomic reduction and malunion have been defined as being in the order of at least a centimeter of displacement.[151–154] Repeat CT scans are more accurate but involve high levels of radiation, while MRI scans are difficult to interpret after surgical fixation. In addition, to assess displacement early in the healing phase, imaging should be performed ideally with some degree of weight-bearing. One possible answer to this may be the use of radiostereometric analysis (RSA) technology. This has been shown to be accurate to the order of less than 0.01 mm in joint replacement surgery,[155–157] and has been used at our institution to monitor tibial plateau fractures.[158,159] With pelvic fractures, there may be some issues regarding the placement of the marker balls, especially if the surgery is percutaneous, but for most open procedures, it is a possible option and warrants further investigation. It is further limited though, in that few centers have the technology available to perform RSA analysis.

This paper does have limitations. We limited the papers to English language only and it is possible that the research question posed has been addressed in a different language. The papers selected were not assessed in any form for the quality of research or presence of bias. It was felt that with such large numbers of papers, this would be prohibitively time-consuming and would be unlikely to affect the outcomes of the review given the nature of the research question being asked. Despite a large number of papers included, there were no randomized studies. With the best available evidence today, it is not possible to make any firm recommendations. In addition, most published series do not specify the extent of other injuries sustained by patients which, in turn, has significant ramifications for postoperative weight-bearing. Given that the majority of long bone shaft fractures can be mobilized early after surgery, bilateral injuries or lower limb periarticular

fractures are ones that should impact on weight-bearing regimes after a pelvic fracture. While this figure is impossible to obtain from the literature, at the authors' institutions, it would affect less than 25% of cases.

In conclusion, within the current literature, there is very little comparative data to inform the treating surgeon on the issue of weight-bearing after pelvic fracture surgery. There appears a current consensus for type C fractures to be touch to partial weight-bearing for 8–9 weeks, and for type B injuries partial weight-bearing for the same period of time; it is possible, however, for all pelvic fracture types to be managed with full weight-bearing as tolerated, given adequate stability. Injury classification within the literature appears to be relatively well standardized, but few papers report the use of validated outcome scores making useful interpretation of the data difficult.

Ethical Approval

This article does not contain any studies with human participants performed by any of the authors.

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