Review article

Management of the open book APC II pelvis: Survey results from pelvic and acetabular surgeons in the United Kingdom

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ABSTRACT

The results of this questionnaire show that the opinion of pelvic and acetabular surgeons in the UK and Republic of Ireland vary as to the best method of fixation for APC II pelvic injuries. A single anterior plate and single sacroiliac joint (SIJ) screw was the most popular fixation method, chosen by 34%. 74% favour a single, opposed to two orthogonal anterior plates. Posterior fixation supplementing anterior plating is preferred by 63% of surgeons, 58% use a single versus 42% two SIJ screws. Case by case assessment and intraoperative screening to assess stability is essential when considering whether to stabilise the SIJ.

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1. Introduction

The purpose of this questionnaire was to determine the variation and preferred treatment of an open book pelvis, classification APC II type injury, by specialist pelvic and acetabular surgeons across the United Kingdom (UK) and Republic of Ireland (ROI).

The optimal operative fixation of APC II open book pelvic injuries remains controversial. Open book pelvis injuries are common in patients who have suffered blunt trauma,^{1–3} yet there is no clear consensus on the optimal method of fixation. Popular classification systems for pelvic injuries include the Young and Burgess classification,⁴ which is based on the force vector causing the injury and the Tile⁵ and AO/OTA classifications which are based on the stability of the injury. The Young and Burgess Anterior Posterior Compression II (APC II), Tile B1 and AO/OTA 61-B all approximate to the same injury. The injury pattern consists of disruption and diastasis of the pubic symphysis, disruption of the sacrotuberous, sacrospinous and anterior sacroiliac ligaments but crucially the posterior sacroiliac ligaments remain intact so there is only partial disruption of the posterior arch. This injury therefore has vertical stability but is rotationally unstable.

Various fixation techniques are recognized for the treatment of pelvic ring injuries involving disruption of the pubic symphysis. Fixation techniques for pubis symphysis diastasis include cerclage wiring,⁶ suture osteosynthesis, single or double plate and screw constructs, and box plate constructs. The most common management for this type of injury is open reduction of the diastasis across the pubic symphysis and internal fixation^{7–12} where a plate is fixed to the pubic bones, which maintains reduction while allowing the disrupted pubic symphysis and pelvic ligaments to heal.

Historically external fixation has been considered an acceptable method of definitive fixation.¹³ Open reduction of the diastasis and internal fixation using a plate placed on the anterior aspect of the pubic symphysis allows improved comfort and the avoidance of pin-tract complications and neurovascular issues associated with external fixators, and have been shown to be biomechanically¹⁴ and clinically¹⁰ superior. Orthogonal plating using two plates placed superiorly and anteriorly across the pubic symphysis perpendicular to each other offers greater construct stiffness. The theoretical disadvantage of orthogonal double plating is greater soft tissue stripping with the inherent adverse effects on bone and symphyseal healing.

Design-specific symphyseal plates with locking capability are now available, but evidence for benefit of this technique for acute pelvic symphysis disruption have not been conclusively demonstrated.^{15–17} Concerns have been expressed regarding the common modes of failure associated with locked-plate constructs in this setting.¹⁸ One of the most contentious areas in the

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management of APC II pelvic injuries is whether to stabilise the posterior pelvis. Theoretical benefits to stabilisation of the posterior pelvis with one or more SIJ screws include improved stability of both the SIJ and symphysis pubis.

Recently a new technique has been developed which uses spinal pedicle screws to create a subcutaneous 'external' fixator construct called INFIX.^{19,20} INFIX has reopened the debate with encouraging results equivalent to internal fixation for some types of pelvic fractures. INFIX has the advantage over external fixators of obviating the risk of pin-tract infection and irritation,^{21–23} however there have been reports of nerve injury complications.^{24–26} Clinical studies will be required to assess the outcome of the use of INFIX for stabilisation of open book pelvic injuries. At the time of design of this study INFIX was an emerging technique and so will not be assessed further by this questionnaire.

As far as the authors are aware this is the first survey of its kind to assess surgeons preferred management of APC II pelvic injuries across the UK and ROI.

2. Methods

A short questionnaire was prepared using the online questionnaire tool; *SurveyMonkey* (www.surveymonkey.com). An invitation to complete the electronic questionnaire was sent to the email addresses of sixty-four pelvic and acetabular surgeons in the UK and ROI. All responses were anonymized in order to encourage open participation.

Surgeons were presented with the following case of a typical pelvic injury accompanied by a diagram of the injury and an AP plain film radiograph of the pelvic injury [Figs. 1 and 2]:

The open book pelvis, classification APC2, Tile B1, OTA/AO 61-B type [Figs. 1 and 2], isolated, closed, neurovascularly intact and haemodynamically stable, in a young male with no comorbidities.

The surgeons were then asked to complete the following multiple choice questions related to the clinical scenario.

Questionnaire

1. How many pelvic fractures are you responsible for treating each year:

- 1–5
- 6–10
- 11–15
- 16–20
- >20

2. What would be your preferred operative management for the described injury?

- Single anterior superior plate
- Orthogonal double plate

Fig. 1. Diagram of OTA 61-B open book pelvis: Incomplete disruption of posterior arch, partially stable.

Fig. 2. AP radiograph of APC II, Tile B1, AO/OTA 61-B open book pelvis injury.

- Single anterior plate and sacroiliac joint screw fixation (one screw)
- Single anterior plate and sacroiliac joint screw fixation (two screws)
- Orthogonal double plating and sacroiliac joint screw fixation (one screw)
- Orthogonal double plating and sacroiliac joint screw fixation (two screws)

3. Do you prefer locking or standard plates?

- Standard plate
- Locking plate

4. If a locking plate is used, is it used in locking mode or as a conventional plate?

- Not applicable
- Locking mode
- Conventional plate mode

5. Regarding weight bearing status immediately post operatively (on the affected side), would you typically allow?

- Full weight bearing
- Partial weight bearing
- Non weight bearing

6. Please indicate the time frame until full weight bearing status allowed on the affected side?

- 0–4 weeks
- 4–8 weeks
- 8–12 weeks

3. Results

A total of 38 (59%) pelvic and acetabular surgeons responded to the questionnaire. The experience of the surgeons responding demonstrated a high volume of pelvic and acetabular practice for the majority of responders; 63% surgeons treat greater than 20 pelvic fractures a year [Graph 1]. Surgical management preferences varied considerably; the most popular method of surgical fixation chosen by 34% of surgeons was single anterior plating augmented with a single SIJ screw, the second most popular chosen by 24% was single anterior plating without posterior fixation [Graph 2]. In total 74% use one anterior plate, while 26% prefer two orthogonal anterior plates with or without any form of SIJ fixation. Anterior plating alone was the preference of 37% of surgeons, while 63% prefer anterior plating in combination with SIJ screw fixation. Of the surgeons that use SIJ screw fixation; 58% prefer a single SIJ

Graph 1. Responses to question 1. Number of pelvic injuries treated per year by each survey respondent.

Graph 2. Responses to question 2. Preferred operative management for the described injury.

screw while 42% prefer two SIJ screws. Surgeons which use two orthogonal anterior plates are less likely to stabilise the posterior pelvis compared to those that use a single anterior plate; 50% versus 68%. 95% of respondents preferred standard plates over locking plates for the pubic symphysis. 20% of surgeons report using locking plates in non-locking mode. Regarding weight bearing status on the affected side immediately post operatively 11% of surgeons allow full weight bearing, 46% partial weight bearing and 43% non-weight bearing [Graph 3]. There was no correlation between early full weight bearing and chosen method of fixation. When asked the time frame until full weight bearing is permitted on the affected side; 10.8% allow full weight bearing within 0–4 weeks, 29.7% within 4–8 weeks and 59.5% within 8–12

weeks post operatively [Graph 4]. See Table 1 for a full breakdown of the results.

4. Discussion

The results of this questionnaire show that opinion is divided amongst consultants who have a specialist interest in pelvic and acetabular trauma regarding a number of facets of the management of APC II pelvic injuries. There is lack of consensus on type of fixation and post-operative weight bearing status. This is due to a paucity of high level evidence to guide decision making. Much of the evidence comes from biomechanical studies often with conflicting results and relatively small case series which include

Graph 3. Responses to question 5. Weight bearing status on the affected side immediately post-operatively.

Graph 4. Responses to question 6. Time frame until full weight bearing status allowed on the affected side?.

a spectrum of pelvic injuries. Reasons for the lack of evidence include relative low frequency with which any specific type of pelvic injury occurs and evolving surgical techniques and implants. Key areas of debate highlighted by the survey include the use of a single anterior plate versus two orthogonal anterior plates and whether posterior stabilisation with a SIJ screw is necessary.

4.1. Single anterior plate versus two orthogonal anterior plates

The survey showed there was a preference for fixation with a single anterior plate versus two orthogonal anterior plates. There is

limited evidence to suggest there is benefit to using one compared to two orthogonal symphyseal plates. Numerous authors have conducted case series which suggest that stabilisation of pubic symphysis diastasis is satisfactorily performed with a single anterior plate.^{10,15–17, 27,7,8} The results of biomechanical studies vary in their conclusions regarding the use of orthogonal double plating. Biomechanical studies conducted by MacAvoy et al.²⁸ and Simonian et al.²⁹ showed no significant difference in the stability of fixation of simulated open book pelvis fractures fixed with a single versus two perpendicular anterior plates whereas Ponson et al.³⁰ showed that orthogonal double plating increased stiffness of

Table 1
Responses to questionnaire.

1. How many pelvic fractures are you responsible for treating each year?	
a. 1–5	3
b. 6–10	1
c. 11–15	6
d. 16–20	3
e. >20	25
Total number of responses to question 1	38
Percentage response to question 1	100%
2. What would be your preferred operative management for the described injury?	
a. Single anterior superior plate	9
b. Orthogonal double plate	5
c. Single anterior plate and sacroiliac joint screw fixation (one screw)	13
d. Single anterior plate and sacroiliac joint screw fixation (two screws)	6
e. Orthogonal double plating and sacroiliac joint screw fixation (one screw)	1
f. Orthogonal double plating and sacroiliac joint screw fixation (two screws)	4
Total number of responses to question 2	38
Percentage response to question 2	100%
3. Do you prefer locking or standard plates?	
a. Standard plate	36
b. Locking plate	2
Total number of responses to question 3	38
Percentage response to question 3	100%
4. If a locking plate is used, is it used in locking mode or as a conventional plate?	
a. Not applicable	27
b. Locking mode	1
c. Conventional plate mode	7
Total number of responses to question 4	35
Percentage response to question 4	92.1%
5. Regarding weight bearing status immediately post operatively (on the affected side), would you typically allow?	
a. Full weight bearing	4
b. Partial weight bearing	16
c. Non weight bearing	15
Total number of responses to question 5	35
Percentage response to question 5	92.1%
6. Please indicate the time frame until full weight bearing status allowed on the affected side?	
a. 0–4 weeks	4
b. 4–8 weeks	11
c. 8–12 weeks	22
Total number of responses to question 6	37
Percentage response to question 6	97.4%

fixation in a simulated Tile C1 pelvic model. The theoretical disadvantage of double plating is increased soft tissue stripping. In a case series by Putnis et al. use of single versus two orthogonal anterior plates was dictated by persistent intra-operative instability after single plating and poor bone quality.³¹

4.2. Posterior stabilisation with SIJ screws

There is long standing controversy regarding whether APC II pelvic injuries require stabilisation of the posterior pelvis in addition to internal fixation of the pubic symphysis, this is reflected in lack of consensus in survey respondents. 63% of responders use SIJ screws with this pattern of injury. A number of cadaveric biomechanical studies have been conducted which both support and refute the use of posterior pelvis stabilisation. Van de Bosch et al. concluded “the addition of a single sacroiliac screw in a Tile B1 fracture did not provide significant additional rotational or translational stability”,³² In contrast in separate studies Simonian et al.³³ and Dujardin et al.³⁴ both concluded that anterior plate fixation of the pubis symphysis alone did not significantly modify SIJ motion whereas with SIJ screws, SIJ motion was significantly reduced, in the case of Simonian with one and Dujardin with two SIJ screws. A number of authors have published results of retrospective case series of patients who sustained open book

pelvis injuries whose fixation included fixation of the posterior pelvis with a SIJ screw. Neither Morris¹⁸ nor Van de Bosch³⁵ (Van den Bosch EW & Van der Kleyn R, 1999) were able to show an advantage to using posterior stabilisation. Morris et al.¹⁸ found that rate of anterior fixation failure was not related to the presence or absence of posterior fixation. Van de Bosch et al.³⁵ reported no difference in functional outcome between patients treated with combined anterior and posterior internal fixation and those treated with anterior fixation alone. Putnis et al. advocate posterior fixation if there is >1 mm of SIJ displacement.³¹ Of the surgeons which use SIJ screws 58% prefer a single SIJ screw. There is little in the literature to guide surgeons on this, the only literature identified that addresses the use of one versus two SIJ screws relates to unstable pelvic injuries opposed to the partially stable APC II injury which the questionnaire in this publication pertains to. In a case series of unstable Tile B and C pelvic injuries analyzed by Khaled et al.³⁶ no difference in functional outcome was identified with the addition of a second SIJ screw. A number of biomechanical studies have looked at the use of different configurations of SIJ screws. Zhang et al.³⁷ created finite element models of unstable Tile type B and C pelvic injuries and concluded the use of a single S1 screw should be adequate for a type B dislocation. Sagi et al.¹² conducted a cadaveric biomechanical study simulating a vertically unstable APC III pelvic injury and

concluded that once an S1 SIJ screw had been properly placed there was no additional benefit to supplementary SIJ screws. Pelvic and acetabular surgeons are mindful of the potential risks associated with SIJ screws. These complications are well described, and potentially extremely serious,^{7,38–43} and the judicious use of SIJ screws among responders may reflect the surgeons assessment of risks and benefits for this particular injury in the specific case presented.

The ideal method of stabilising the pubic symphysis may not just be a case of which construct provides the most stable fixation. Collinge et al.⁴⁴ conducted a retrospective review of Tile B and C pelvic injuries treated with anterior plating with or without posterior fixation. There was a high incidence of failure of fixation which resulted in pubic symphyseal space widening, yet only one case required revision surgery. Collinge et al. question whether fixation failure may represent return to more physiological motion at the pubic symphysis.

4.3. Locking plates versus standard plates

Standard plates were favoured over locking plates by 95% of respondents. As yet there is no evidence to support the use of locking plate fixation of the symphysis pubis diastasis. Moed et al.,⁴⁵ Daily et al.¹⁷ and Prasarn et al.¹⁶ all conducted separate biomechanical studies comparing locking plates to non-locking plates for symphysis pubis diastasis fixation and none found a significant difference in stability. Moed et al. also published a report of 6 cases of locking plate failure for fixation of the pubic symphysis.⁴⁵ In contrast to this Hamad et al. published a case series of 11 occurrences of pubic symphysis diastasis fixed with locking plates and reported all patients to be asymptomatic and none requiring revision surgery.⁴⁶ There is concern that failure of locking plate fixation could result in significant bone stock destruction as the construct fails en masse. Some locking plates are ergonomically contoured for the pubic symphysis so are chosen for their fit rather than use as an angularly stable device. The authors believe this explains why 20% of survey respondents reported using locking plates in non-locking mode.

4.4. Post-operative weight bearing status

The results of the questionnaire showed there is neither consensus for post-operative weight bearing status on the affected side immediately post operatively nor for the duration until full weight bearing is permitted. There is limited evidence to support decision making regarding post-operative weight bearing status. Meissner et al. conducted a biomechanical study that advocated early partial weight bearing on pubic symphysis diastasis which underwent plate fixation.¹⁴ Specimens loaded with 100% of the forces acting on the pubic symphysis during walking, simulating full weight bearing led to early failure, however specimens loaded with 50% of the acting forces, simulating partial weight bearing, cycled to simulate 6 weeks of mobilisation did not result in failure. The post-operative weight bearing protocol used in a case series published by Aggarwal et al. for APC II injuries was immediate toe touch weight bearing for six weeks with a mobility aid, followed by partial weight bearing for six weeks, with unrestricted weight bearing after 3 months,⁴⁷ this is in line with the most popular response to the survey. Outside the rigidity of discrete multiple choice questions in real life the authors suspect surgeons decide upon weight bearing status based on factors such as patient age, weight, patient compliance, injury pattern, bone density, pre-trauma mobility, type and quality of fixation.

There are several elements of this study design which could introduce a risk of bias. They include; varying case load and experience of respondents, not all surgeons who were contacted

responded, despite great care being taken to contact all pelvic and acetabular surgeons in the UK and ROI there is no society or register so some will undoubtedly have not received the survey.

5. Conclusions

The results of this questionnaire provide a snapshot of the current practice of pelvic and acetabular surgeons in the UK and ROI and shows that consensus is varied for the best method of definitive fixation and post-operative weight bearing regimen for an APC II pelvic injury. Classification of pelvic injuries is not always straightforward and therefore as suggested by a number of survey respondents and advocated by the senior author, case by case assessment and intraoperative screening to assess stability is essential when considering whether to stabilise the SIJ. Bio-mechanical and clinical studies are required to assess single versus two orthogonal plate pubic symphysis constructs and anterior plating versus anterior plating with posterior stabilisation in APC II pelvic injuries.

Conflict of interest

None.

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