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SYMPOSIUM: DISRUPTIONS OF THE PELVIC RING: AN UPDATE

Is Fixation Failure After Plate Fixation of the Symphysis Pubis Clinically Important?

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Abstract

Background Plate fixation is a recognized treatment for pelvic ring injuries involving disruption of the pubic symphysis. Although fixation failure is well known, it is unclear whether early or late fixation failure is clinically important.

Questions/purposes We therefore determined (1) the incidence and mode of failure of anterior plate fixation for traumatic pubic symphysis disruption; (2) whether failure of fixation was associated with the types of pelvic ring injury or pelvic fixation used; (3) the complications, including the requirement for reoperation or hardware removal; and (4) whether radiographic followup of greater than 1 year alters subsequent management.

Methods We retrospectively reviewed 148 of 178 (83%) patients with traumatic symphysis pubis diastasis treated by plate fixation between 1994 and 2008. Routine radiographic review, pelvic fracture classification, method of fixation, incidence of fixation failure, timing and mode of failure, and the complications were recorded after a minimum followup of 12 months (mean, 45 months; range, 1–14 years).

Results Hardware breakage occurred in 63 patients (43%), of which 61 were asymptomatic. Breakage was not related to type of plate, fracture classification, or posterior pelvic fixation. Five patients (3%) required revision surgery for failure of fixation or symptomatic instability of the symphysis pubis, and seven patients (5%) had removal of hardware for other reasons, including late deep infection in three (2%). Routine radiographic screening as part of annual followup after 1 year did not alter management.

Conclusions Our observations suggest the high rate of late fixation failure after plate fixation of the symphysis pubis is not clinically important.

Introduction

Pelvic ring disruption often results from high-energy trauma. Initial management involves immediate resuscitation and the detection of associated injuries. Pelvic fractures may lead to life-threatening hemorrhage [2, 14] and, in the absence of another bleeding source, current management options include the use of a pelvic binder, emergency angiography and embolization, application of an external fixator, pelvic

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Each author certifies that his institution approved the human protocol for this investigation, which occurred at North Bristol NHS Trust, that all investigations were conducted in conformity with ethical principles of research, and that informed consent for participation in the study was obtained.
This work was performed at the Pelvic and Acetabular Reconstruction Unit, Frenchay Hospital, North Bristol NHS Trust, Bristol, UK.

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packing, early internal fixation, or a combination of these [1, 6, 21]. For definitive stabilization, a substantially displaced anterior fracture or symphysis pubis diastasis (when the symphysis is disrupted) has a better outcome if reduced anatomically [8, 12].

A variety of methods of achieving anterior ring reduction and fixation have been described in the literature; these include anterior external fixation, plate fixation, tension band wiring, and absorbable sutures [24, 25]. Whereas the use of an anterior external fixator can stabilize the pelvic ring [23], there is a high rate of complications. Pin site infection occurs in 13% to 50% [9, 11] and pin site placement may be inconsistent [22]. Aseptic loosening of the pins may also lead to loss of reduction and necessitate revision fixation [11]. Loss of reduction may also occur in the presence of a posterior ring injury, which is often not stabilized sufficiently by an anterior external fixator [8, 9, 19]. Biomechanical studies have demonstrated that symphyseal plating is effective in restoring anterior ring stability [4, 20] and efficacious outcomes have been confirmed in published case series (Fig. 1) [5, 12, 13, 15]. Plate fixation has a lower rate of complications [11, 17] and has become the preferred method of fixation. Several authors have described rates of hardware failure of 12% to 31%, loss of reduction of 7% to 24%, and revision rates of 3% to 9% [5, 7, 12, 15, 18, 26]. However, the timing and clinical consequences of implant failure are unclear.

The aims of this study were to determine: (1) the incidence and mode of failure of anterior plate fixation for traumatic pubic symphysis disruption; (2) whether failure of fixation was associated with the types of pelvic ring injury or pelvic fixation used; (3) the complications, including the requirement for reoperation or hardware removal; and (4) whether radiographic followup of greater than 1 year alters subsequent management.

Patients and Methods

Between January 1994 and August 2008, we treated 178 patients with anterior pelvic ring injuries, involving pubic symphysis disruption, with anterior plate fixation. Our indication for anterior plate fixation was complete pubic symphysis disruption. This may be associated with concominant pubic rami fractures. The contraindication was active infection in the anterior pelvis. One patient died within 1 month of surgery from associated injuries, 18 patients were lost to followup, and 11 patients were followed up for less than 1 year. The remaining 148 patients (83%) were followed a minimum of 12 months (mean, 45 months; range, 12 months to 14 years; median, 36 months). There were 112 males and 36 females with a mean age of 39 years (range, 9–80 years). There were 99 AO/OTA Type B injuries and 49 Type C injuries treated using three different plating systems (Table 1). The majority of injuries were treated using a six-hole 3.5-mm plate (Fig. 2). Supplementary posterior ring fixation was performed in 96 patients (47 of 99 AO/OTA Type B and all 49 Type C). It was the department policy to stabilize posterior injuries, including Type B injuries, with displaced or comminuted sacral fractures and sacroiliac joint fracture subluxations. Initial reduction of the symphysis pubis was

Table 1. Types of pubic symphysis plates

Plate type	Total number	Number broken
DCP	2	0
Recon plate	62	11
Matta plate	84	11
Dual plating	3	0

Fig. 1 An example of an open-book pelvic ring injury treated with symphysis pubis plating.

anatomical in 134 (91%) patients. The study was approved by the ethical committe for the hospital.

Patient details were extracted from the unit's prospective database and a retrospective review of medical records and radiographic imaging was performed to determine clinical and radiographic outcomes. Fractures were classified according to AO/OTA [10] from the preoperative AP, inlet, and outlet radiographs.

All operations were performed through a midline vertical rectus-splitting anterior approach with the skin incision either being transverse or vertical when associated with an abdominal operation. Where there was an associated pelvic ring or acetabular fracture, alternative approaches were used, including the ilioinguinal, Stoppa, and combined approaches. In vertically unstable fractures and AP compression fractures with considerable posterior instability, posterior fixation was performed before anterior fixation (Fig. 3). Anterior fixation was achieved using a dynamic compression plate (DCP; Synthes, Welwyn Garden City, UK), 3.5-mm reconstruction plate (either Synthes or Stryker Trauma, Newbury, UK), or Matta pelvic symphyseal plate (Stryker Trauma) with the aim of reducing all symphysis pubis diastases anatomically. Typically, we used a single six-hole 3.5-mm reconstruction or the specialized pubic symphysis plate but actual fixation was dependent on injury pattern; fewer than six screws were occasionally used in patients with good bone quality (those without risk factors for osteoporosis). If the injury involved the pubic rami, then the plate length was extended.

Fig. 2 The number of screws used for anterior fixation.

Patients were mobilized with toe-touch weightbearing on the side of the hemipelvic injury for 6 weeks. If both sides were involved, patients were restricted to bed-to-chair transfer and a wheelchair. At 6 weeks, mobilization was increased to 50% partial weightbearing and full weightbearing was started at 12 weeks. All mobilization was supervised by a physiotherapist, initially on a daily basis while an inpatient and then subsequently as an outpatient depending on availability of resources and other comorbidities.

Postoperative followup occurred at 6 weeks, 3 months, 6 months, 12 months, and then annually for 5 years in line with department policy at the time. Routine radiographic views taken at these appointments included AP pelvis, inlet, and outlet views. We reviewed the medical case notes to record complications, including deep infection, revision surgery, and hardware removal. Postoperative radiographs were used to assess symphysis pubis reduction and method of pelvic ring fixation, whereas radiographs taken at followup appointments were examined for loss of reduction (defined as displacement greater than 1 cm) and fixation failure.

Data analysis was undertaken using SPSS Version 17.0 (Chicago, IL, USA). We assessed differences in incidence rates of fixation failure between types of plate implanted

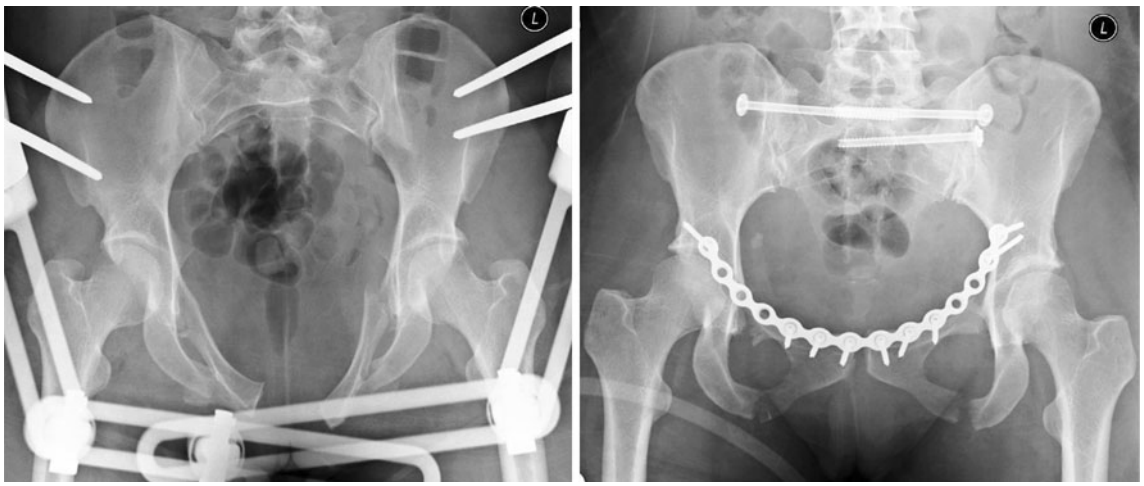

Fig. 3 An example of a pelvic ring injury with disruption of the symphysis pubis, both rami, and both sacroiliac joints stabilized using anterior and posterior fixation using a plate extended across the rami.

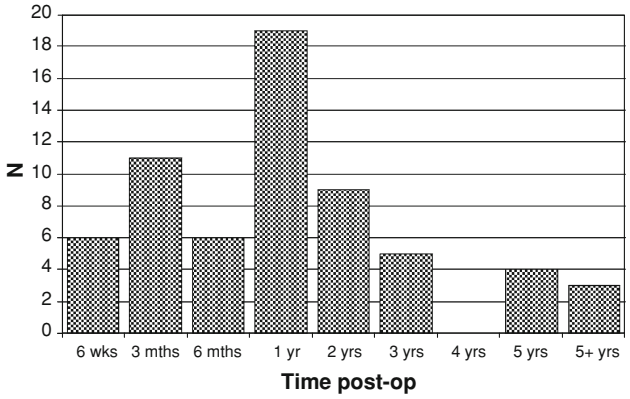

Fig. 4 The timing of initial hardware breakage.

using Pearson chi square test with Yates correction. We assessed differences in incidence rates of fixation failure between pelvic fracture types (AO/OTA B and C), the presence or absence of posterior fixation, and symphyseal reduction (less than 10 mm) with Fisher's exact test. The relationship between the presence or absence of screw breakage within 12 months of fixation and further implant failure later was assessed using Pearson's chi square test.

Results

Anterior fixation failure resulting from hardware breakage occurred in 63 patients (43%) at a median of 12 months (Fig. 4). This involved plate breakage only in 14 patients, plate and screws in nine patients (Table 1), and the screws only in 40 patients. Sixty-one of 63 of these patients were asymptomatic. In two patients the screws pulled out of the bone causing a recurrent diastasis without hardware breakage.

The rate of anterior fixation failure was not related to the type of plate used ($p = 0.8$), the type of pelvic ring injury ($p = 0.9$), the presence or absence of posterior fixation ($p = 1$), and symphyseal reduction (less than or greater than 10 mm) ($p = 0.1$). If hardware breakage occurred within the first 12 months, there was an increased risk of further breakage in subsequent years ($p = 0.009$). Typically this was individual screw breakage rather than plate breakage and was asymptomatic.

Revision of the anterior fixation was performed in five patients (3%) (Table 2). All patients underwent uneventful revision of fixation with successful healing and persisting stabilization of the symphysis. Loss of initial postoperative reduction of the symphysis pubis occurred in six patients (4%). In four patients, diastasis occurred after hardware breakage within the first 6 months; two were related to plate breakage and two were related to screw breakage. The other two patients had recurrent diastasis as a result of the screws pulling out of the bone with no hardware breakage; one of these patients only had one screw on each side of the symphysis. Two of the six patients with loss of reduction required early revision of fixation of the symphyseal diastasis as a result of one case of screw breakage and one of screw pullout without breakage. In the remaining four patients, the degree of diastasis (less than 2.5 cm) was not considered clinically important, because the patients were asymptomatic, no progression of displacement occurred, and no revision surgery was performed. Seven patients had removal of the hardware (5%) (Table 3). Three patients developed a late deep infection, one patient at 1 year and two patients at 3 years. They recovered fully after removal of the hardware, wound management, and antibiotic therapy with no evidence of persisting infection or recurrent symphyseal diastasis. No patients presented with an early deep infection and none required revision fixation after deep infection and plate removal. The majority of the 38 females treated with symphyseal plating were of childbearing age (median, 36 years old). Only three of these patients had plates removed electively after discussion regarding future pregnancy and vaginal delivery.

Findings on routine annual radiographic screening after 1 year did not alter patient management or outcome.

Table 2. Reason for revision procedure

Reason for revision fixation (5 patients)	Time postoperatively
Plate with 2 screws displaced immediately postoperatively; revised to 6-hole plate	3 days
Screw breakage with subsequent displacement	6 months
Recurrent injury (horse-riding)	12 months
Posterior nonunion and loose symphyseal plates (2 patients)	12 + 18 months

Table 3. Reason for metalwork removal

Reason for removal of metalwork (7 patients)	Time postoperatively
Screw backing out, single screw removed	6 weeks
Female of childbearing age (3 patients)	2, 3, 5 years
Retropubic abscess (2 patients)	1 and 3 years
Deep iliac abscess (1 patient)	3 years

Discussion

Although anterior plating is the recommended treatment for pubic symphysis disruption, the incidence and consequences of fixation failure have remained a concern.

Plating of the symphysis pubis is an effective method of treating displaced anterior pelvic ring injuries and, in the largest series we could identify, our results demonstrate efficacious radiographic results. The aims of this study were to determine the incidence and mode of failure of anterior plate fixation; whether failure of fixation is associated with the type of pelvic ring injury or pelvic fixation used; the complications, including the requirement for reoperation or hardware removal; and whether late fixation failure is clinically important or if longer-term radiographic followup of greater than 1 year is justified.

Our study is subject to a number of limitations. First, the minimum length of followup was 1 year, which may have meant we failed to detect a few additional cases of later fixation failure. Second, we had no measures of patient function. Our aim was to report on the radiographic success of the fixation technique and acknowledge this may not correlate with function. Third, this was a retrospective study in which the complications were recorded from the medical case notes and this may have led to minor complications being underreported although we suspect major complications would have been detected.

The striking finding from this series is the high rate of hardware breakage (Fig. 5). This is higher than previously reported in the literature, which ranged from 12% to 31% [5, 7, 12, 15, 18, 26]. However, it does not appear to often affect the clinical outcome because only three patients (2%) required revision after failure of fixation, two as a result of hardware breakage and one as a result of screw pullout. In two additional patients the anterior fixation failed late as a result of nonunion of the posterior pelvic injury. Other potential causes for the high rate of hardware breakage have been examined in this study. This was not related to the type of pelvic ring injury or to the use of posterior fixation, which may be the result of all potentially unstable posterior ring injuries having undergone fixation, thus achieving similar relative stability to the partially stable injuries that underwent only anterior fixation. Theoretically this is supported by cadaveric and clinical studies [7, 17, 23].

The overall revision rate of 3% compares well with the reported literature (Table 4). A systematic review in 2005 found implant failure in 16 of 277 patients, an overall prevelance of 6% [16], and revision rates may be up to 16% in certain patient groups [12, 13, 18]. No revision of fixation was required after infection but three patients (2%) developed a late deep infection at 1 year, 3 years, and 3 years and underwent hardware removal. Interestingly, none of these three patients had experienced initial postoperative wound problems and all were closed injuries. Furthermore, the outcomes compare well with results achieved using definitive external fixation in which revision rates may be as high as 17% and pin site infection rates up to 50% [11, 22]. Lindahl et al. [9] found that loss of reduction can occur in up to 57% of patients with external fixators, including the majority of open-book and Type C fractures, and concluded that internal fixation of these fractures may produce better results.

Our institution currently reviews all patients for 5 years with annual plain pelvic radiographs. The results from this study suggest that radiographic changes of implant failure at the symphysis pubis after 1 year do not affect future clinical outcome or management. It is proposed that, in the event of an uncomplicated postoperative recovery, it may be prudent to obtain plain radiographs up to 1 year postoperatively and, after this, either restrict routine imaging to an AP pelvic radiograph alone or only perform further radiologic imaging if the patient is symptomatic.

The role of symphysis pubis plate removal has been debated in the literature, although there remains a lack of evidence to guide clinicians [17]. There are arguments for routine removal in women of childbearing age [3] to

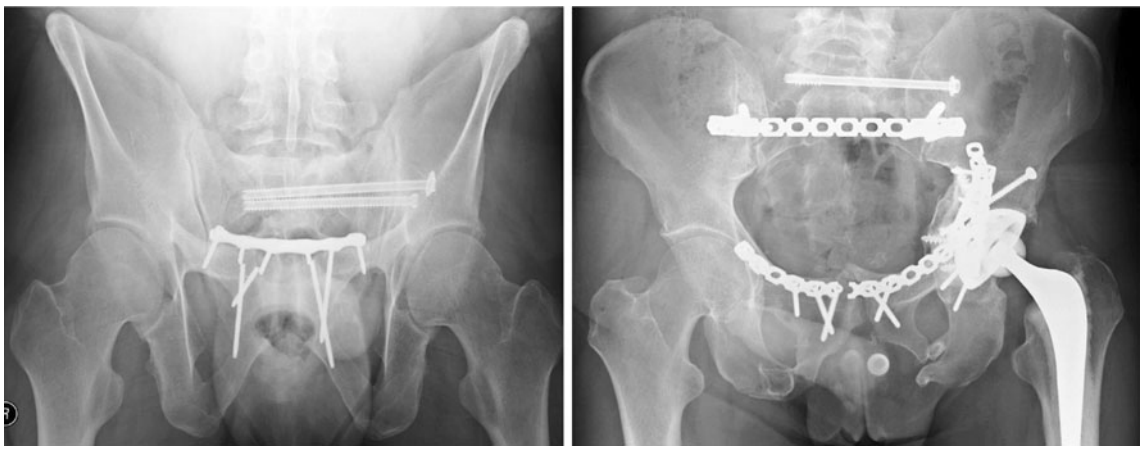

Fig. 5 An example of hardware breakage of symphysis pubis screws (left) and plate (right) with no subsequent displacement.

Table 4. Comparison of studies examining fixation of traumatic symphysis pubis diastasis

Author	Study type	Patients	Mean followup (months)	Anterior fixation failure	Loss of reduction	Revision anterior fixation	Deep infection
Giannoudis et al. [5]	Case series	74	42	9 (12%)	5 (7%)	0	1 (1%)
Lange and Hansen [7]	Case series	19	24	4 (21%)	ND	ND	1 (5%)
Matta [12]	Case series	69	36	ND	ND	2 (3%)	1 (1%)
Putnis et al. [15]	Case series	49	> 12	15 (31%)	6 (12%)	4 (8%)	0
Sagi and Papp [18]	Retrospective cohort	92	ND	25 (27%)	22 (24%)	8 (9%)	ND
Webb et al. [26]	Case series	14	20	0	ND	0	0
Current study	Case series	148	45	63 (43%)	6 (4%)	5 (3%)	3 (2%)

ND = no data available.

facilitate pregnancy and vaginal delivery, but some authors suggest this may not be necessary [5]. Only three of the patients in this study had elective removal of their plate for this reason, but the incidence of pregnancy after symphysis pubis fixation in the remaining patients was not specifically examined.

Symphysis pubis plating can be performed in cases of traumatic pubic symphyseal disruptions, particularly in the presence of posterior ring instability requiring fixation [8, 12, 23]. The current study confirms the efficacious radiographic results for symphysis pubis plate fixation of pelvic ring injuries and the low rate of associated complications. Hardware breakage occurs frequently but only clinically affects a small number of patients in the early postoperative period. Routine radiographic screening for up to 5 years did not alter clinical management after 1 year. The role of hardware removal, particularly in young women, is still to be resolved.

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