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ORIGINAL STUDY

Endobutton technique for dynamic fixation of traumatic symphysis pubis disruption

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Plate fixation, the conventional treatment for traumatic symphysis pubis disruption, carries the risk of implant failure and demands extensive exposure. The goal of the present study was to evaluate the outcome of dynamic fixation with the Endobutton CL, which has a long successful record in anterior cruciate ligament reconstructions.

Twenty-one APC-II injuries were treated from January 2006 to December 2009. The mean duration of follow-up was 23 months (18 to 26). All patients received Endobutton fixation. The incision length was 6.8 ± 1.3 cm. The external blood loss was 106 ± 15 mL. The average surgical time was 63 ± 12 min. The symphysis distance after reduction was 4.1 ± 1.2 mm. The symphysis distance at final visit was 4.2 ± 1.2 mm. Loss of reduction was not significant during bone healing (p = 0.09). The Majeed scoring was excellent in 15 patients, good in 5 patients and fair in 1 patient. One malreduction was seen ; there was no implant failure. Our results indicate that Endobutton fixation of the pubic symphysis might be used in the treatment of APC-II injuries.

Keywords : Endobutton ; dynamic fixation ; traumatic ; symphysis pubis diastasis.

INTRODUCTION

Pelvic ring injuries are rare, with an incidence between 0.3 and 8.2% of all fractures (*5*). Instability of the posterior pelvic ring with disruption of the pubic symphysis is a challenging problem.. The open-book injury (B type in the AO/ASIF system (*9*) and APC – Anterior-Posterior Compression - in the Young-Burgess system) is a result of an anteriorly directed force which causes pubic symphysis diastasis or pubic ramus fractures (*2*). Pubic symphyseal diastasis of less than 2.5 cm, classified as an APC-I injury pattern, represents a stable injury, and is generally managed nonoperatively (*11*). Injuries with pubic symphyseal diastasis > 2.5 cm, classified as an APC-II injury pattern, are associated with disruption of the anterior sacroiliac ligaments and resultant rotational instability. The APC-III injuries

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are characterized by complete sacroiliac joint disruption and are rotationally and vertically unstable (*24*). APC-II and APC-III injuries are routinely managed operatively (*11,14*). Open reduction and internal fixation (ORIF) of the pubic symphysis has been performed for several decades (*16*). Anterior plate fixation in combination with posterior fixation can provide rigid fixation for the APC injury. However, limitation of physiological movement in the symphysis results in the failure of the anterior pelvic metalwork in more than 30% of patients (*14*).

We introduce a new dynamic fixation technique of pubic symphysis diastasis using four Endobuttons (Smith & Nephew, Memphis, TN, USA). The purpose of this study is to evaluate the outcome of this new technique. Functional and radiographic evaluation was used to analyze the outcome during follow-up.

MATERIALS AND METHODS

Between January 2006 and December 2009, 21 patients with traumatic symphysis diastasis were included in this study, performed at a Level 1 regional trauma center. Institutional review board approval and informed consent from all patients were received. Included were all adult patients with a closed APC-II injury, ie : diastasis of the pubic symphysis > 25 mm without vertical displacement of a sacroiliac joint (SIJ). APC-III lesions with vertical displacement were excluded because Endobutton fixation does not provide vertical support. CT scan and push–pull test in the operating room under fluoroscopy were used to judge the existence of vertical instability. Excluded were patients with a medical contraindication, APC-III lesions, lateral compression, vertical shear or combined mechanism fractures, open fractures, and those associated with acetabular fractures or pubic fractures.

All patients received an external fixation during resuscitation. Two patients received early pelvic angiography/embolization to control haemorrhage and stabilize the blood pressure.

Operative Technique

All surgical procedures were performed through either a midline vertical incision or a Pfannenstiel incision by a senior pelvic surgeon. After the disrupted pubic symphysis was exposed, provisional reduction and fixation of the diastasis was accomplished by manual compression over the iliac crests and application of large towel clamps across the symphysis. Four holes were made in the lateral cortex for the passage of the Endobutton. A 4.5-mm Endobutton drill entered the lateral surface of the pubis on either side of the symphysis to exit at the pubic symphysis. The Endobutton depth gauge was used to determine the distance between the left and right entrance hole and the appropriate size of Endobutton CL. A no. 2 Ethibond suture (Johnson & Johnson, Piscataway, NJ, USA) was placed through the two small far holes of the Endobutton. Using a 1.0-mm folded wire, the Endobutton CL and the Ethibond suture were brought to the opposite pubis through the previously drilled holes. With very firm traction on the loop, a free Endobutton was slid beneath the loop and was initially tilted on its side. Then the Ethibond suture tails were passed through the first and fourth holes of the tilted plate on either side of the Endobutton CL loop and the Endobutton was turned flat. Finally the Ethibond suture was tied on top of the Endobutton CL loop. To complete the reconstruction of the pubic symphysis, the same procedure was repeated and another pair of Endobutton plates was placed beneath/above the prior ones (Fig. 1 & 2). One additional suture was passed through separate holes in the top rims of the pubis, creating stability in the superior inferior plane.

Wide spectrum antibiotics coverage was started preoperatively and continued for 2 days. Functional exercise was initiated one week after surgery. Weight bearing was allowed at 6 weeks postoperation.

All patients had a clinical examination with particular attention to function outcome, implant failure, loss of reduction and iatrogenic injury. Three fellowship-trained orthopaedic trauma surgeons evaluated the radiographs and clinical data. Radiographs were taken before primary treatment, after reduction and each month during follow-up. The functional outcome was measured using a scoring system described by Majeed (*8*) which was based on clinical findings such as pain, sitting, sexual intercourse, walking and work.

All quantitative data were expressed as mean ± standard deviation (SD) and analyzed with SPSS version 17.0 software (SPSS Inc, Chicago. IL). Statistical analyses were performed using t test and Fisher exact test. A p-value of < 0.05 was considered significant.

RESULTS

Twenty one cases have follow-up periods averaging 23 months (18 to 26). The average age was 35 ± 11.0 years. Average ISS was 21 ± 7.0. Three

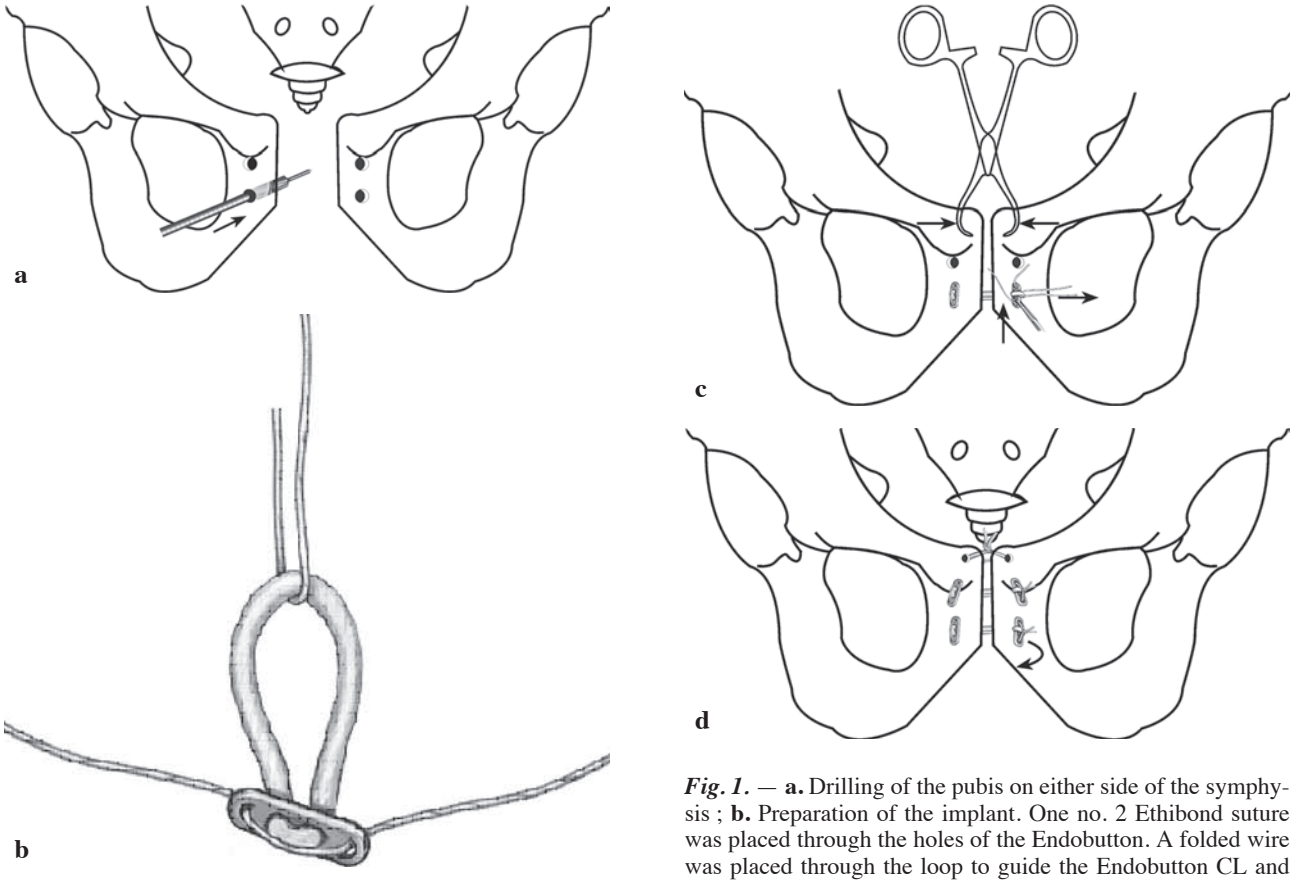

Fig. 1. — **a.** Drilling of the pubis on either side of the symphysis ; **b.** Preparation of the implant. One no. 2 Ethibond suture was placed through the holes of the Endobutton. A folded wire was placed through the loop to guide the Endobutton CL and the Ethibond suture through the holes in the pubis ; **c.** Reduction was accomplished by applying clamps across the symphysis. Using a wire, the Endobutton CL and the Ethibond suture were brought to the opposite pubic hole. With very firm pull on the loop, the second Endobutton was slid beneath the loop and was initially placed on its side ; **d.** The Endobutton was turned flat after the suture was passed through its holes. The Ethibond suture was tied on top of the Endobutton CL loop followed by fixation of another pair of Endobuttons. One suture was passed through a separate hole in the top rims of the pubis, creating stability in the superior inferior plane.

patients had spleen or liver injuries and received emergent laparotomy. Four patients had urethral injuries needing repair.

The intraoperative and postoperative wound blood loss was 106 ± 15 mL. The incision length was 6.8 ± 1.3 cm. The average surgical time was 63 ± 12 min. Since we were inexperienced at the very beginning, the first patient had a malreduction. The symphysis distance after reduction was 8.5 mm. Reduction and fixation skill improved rapidly. The average symphysis distance after reduction was 4.1 ± 1.2 mm. The symphysis distance at final visit was 4.2 ± 1.2 mm. Loss of reduction was not significant during bone healing ($p = 0.09$). No implant loosenings or hardware failures were seen. The Majeed scoring was excellent in 15 patients, good in 5 patients and fair in 1 patient. The rate of good or excellent results was 95%. No patient needed implant removal.

DISCUSSION

The Young-Burgess classification of pelvic injuries relies on the mechanism of injury and the integrity of anatomic structures to classify anteroposterior compression injuries (*24,25*). In open-book pelvic fractures, the symphysis pubis ruptures first followed by the anterior ligament of the sacroiliac joint, then the interosseous ligament, and finally the posterior sacroiliac ligament. A diastasis of 2.5 cm of the symphysis pubis has been defined as the

Fig. 2. — Twenty-eight-year-old man injured in a car accident. APC-II injury. Postoperative radiograph of the pelvis demonstrating excellent radiological outcome.

reference for damage to the anterior sacroiliac ligament and to differentiate a stable pelvis (APC I) from a rotationally unstable pelvis (APC II) (*24*).

The pubic symphysis is an anterior joint in the pelvic ring which, together with the posterior sacroiliac joints, allows motion of the pelvis during physical activity (*10,20,21*). ORIF using a plate across the pubic symphysis facilitates accurate reduction and is now the most popular method of stabilization for pelvic fractures (*14,18,19*). Loose or broken screws reported in up to 33% of cases confirmed movement around the anterior pelvic metalwork (*15*). The failure of plate fixation is largely due to the unique structure of the pubic symphysis. The pubic symphysis is a joint consisting of a fibrocartilaginous disc sandwiched between the articular surfaces of the pubic bones. Four ligaments (superior, inferior, anterior and posterior pubic ligament) reinforce the pubic symphysis. The anterior pubic ligament is reported to be a thick resistant structure, second only to the interpubic disc in maintaining stability of the pubic symphysis. The pubic symphysis resists tensile, shearing and compressive forces and allows a small amount of movement under physiological conditions in most adults (*1*). Physiological movements include transverse or sagittal translation of approximately 1 mm, rotation in the sagittal planes up to 2°, as well as vertical movements of approximately 2 mm (*20*). It seems that small-magnitude, multidirectional movements can occur at the pubic symphysis in normal activities.

There is considerable debate in the literature concerning the fixation techniques for the treatment of pubis symphyseal diastasis. Numerous forms of internal fixation have been advocated, first with cerclage wiring and then evolving to modern techniques of plate and screw fixation (*3,4,6,13,14*). Since the anterior fixation does not aim to achieve fusion, it only provides relative stability while allowing the symphysis to heal. It is a race to achieve healing before the implant fails. Plate fixation subjects a physiologically dynamic structure to relatively rigid fixation (*14*). Biomechanical studies revealed that the physiological forces across the pubic symphysis are subsequently transmitted through the plate during rehabilitation, potentially contributing to the failure of fixation (*15*). The theoretical benefit of two-hole plate over multiple-hole plate is that some motion is permitted around the single screw on each side of the pelvis. This allows some physiological motion and decreases the amount of stress carried by the implant, resulting in a lower failure rate (*15,22*).

To avoid implant failures, we recommend changing rigid fixation into a physiologically dynamic fixation in APC injuries. Fabian *et al* (*4*) advocated the use of wire sutures for reapproximating the disrupted symphysis pubis. Silk, kangaroo tendon, Parham bands, and osteoperiosteal grafts had been reported (*7*). Pins and screws lashed together with stout wire also have proponents (*23*). These methods were not popularized because the failure rates were high. The ideal implant would not only restore the normal biomechanics of the original ligament complex, but would also maintain reduction throughout the biologic healing process. Endobutton CL, which has a long successful track record in anterior cruciate ligament reconstructions, was used in the treatment (*12*). The device was modified for use by adding a second Endobutton to the construct, creating a knotless fixation. The Endobutton CL and Ethibond suture reproduced the normal course of

the anterior and superior pubic ligaments. The documented strength and stiffness of Endobutton CL exceed the native ligament complex by approximately 40% (internal testing by Smith and Nephew) (*17*). The deforming forces are distributed along the surface of the 2 metal Endobutton plates and not the suture material itself, thereby minimizing the chance of implant fatigue. The suture material is a continuous loop, thereby eliminating problems of knot slippage associated with other types of suture fixation (*17*). Since the Endobutton loop and Ethibond suture function as superior and anterior pubic ligament, they accommodate the rotation and translations of the symphysis and may allow the symphysis to behave more physiologically as it heals. Compared with plate fixation in the treatment of APC injuries, dynamic fixation using Endobutton has several advantages. Firstly, dynamic fixation can decrease the stress in symphysis pubis during ligament healing, thus decreasing the risk of implant failure and redisplacement. Secondly, Endobutton fixation needs less exposure compared to plate fixation and limits the risk of iatrogenic injuries. Finally, second stage surgery to remove hardware is unnecessary for Endobutton fixation. Because APC-II injury is vertically stable and APC-III is vertically unstable, dynamic fixation using Endobutton is not suitable for all pelvic injuries. We recommended dynamic fixation using Endobutton in APC-II injuries, and consider its use in APC-III injuries as contraindicated. Double screw fixation of the sacroiliac joint in addition to external fixation is the preferred approach in APC-III lesions. Therefore, the main limitation of dynamic fixation using Endobutton lies in its limited indications.

The greatest weakness in our study is the small number of cases. We will select more proper cases for further research.

It can be concluded that dynamic fixation of the pubic symphysis diastasis using Endobutton might be an alternative to pelvic plate fixation in the treatment of APC-II injuries.

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