



## Surgically treated type C injuries of the pelvic ring: A study of 21 patients.

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### Article History

Volume 6 Issue 12, 2024

Received: 25 May 2024

Accepted : 25 June 2024

doi:

10.48047/AFJBS.6.12.2024.692-702

### ABSTRACT

**Background-** Despite mounting evidence that internal fixation is the gold standard for treating Type C pelvic ring injuries, surgeons continue to disagree on the best approach to this complex medical problem.

**Patients:** Patients who had undergone regular reduction and internal fixation operations for pelvic ring injuries of type C1-C3 were the subjects of our study. There were twenty-one patients who participated in successive surgeries.

**Results** - A beautiful reduction followed by a successful pelvic ring fixation seems to be related with a positive result, according to the findings of our study. Damage to the lumbosacral plexus that had been present for an extended period, inability to achieve fixation, and inadequate reduction (dislocation that was more than 5 millimeters) were the most prevalent causes of worse outcomes.

**Conclusion** - According to the findings of our study, the most severe sacral fractures need more attention not only during preoperative planning but also during fracture reduction, nerve root decompression, and implant placement. Our study's results suggest that the best approach to restoring pelvic ring balance is a combination of posterior fixation and internal fixation for rami fractures that are misplaced (>10 mm), evanescent, or have anomalies in the symphysis.

**Keywords:** Pelvic ring; Type C Injury; Trauma

### Introduction-

An unstable pelvic ring illness is often linked with a variety of collateral damage [1, 2]. The fundamental cause of this condition is overcurrent trauma, which is the source of the disease. Several other factors, including minor pelvic injuries, brain trauma, and headache number one, might be responsible for the higher-than-average death rates. These factors include headache

number one. The priority when dealing with a patient who is hemodynamically unstable is to stabilize their airway. The purpose of this is to maintain enough blood flow and breathing for the patient. Additionally, the pelvic ring may be partially stabilized with the use of the external fixator [4]. The reason being, it decreases pelvic volume, which enhances tamponade and, thus, lessens bleeding. After the affected persons have stabilized, a thorough assessment may be conducted, and the pelvic ring lesion can be repaired.

Injuries to the pelvic ring that were merely temporary were best treated with external fixators, which gained widespread acceptance in the 1970s [5]. After further investigation, it was determined that an outer body that was positioned anteriorly was not capable of providing an effective solution for type C, which is a temporary form of pelvic ring dysfunction. As a consequence of this, the patient was unable to move about freely without putting themselves at danger of additional fracture degeneration [6]. Procedures such as percutaneous screw fixation and closure reduction have recently been suggested [7]. Internal fixation has been suggested as a strategy for treating transitory posterior pelvic ring injuries [8]. This recommendation has been in place up until this point. There has been some variation in the fixation criteria for anterior pelvic ring injuries, but it has not been substantial [9]. It is feasible to provide effective compensation for type C pelvic ring fractures, according to biomechanics researchers [10]. The injured posterior and anterior pelvic rings are internally repaired to achieve this goal. Using internal fixation and conventional reduction techniques for the anterior and posterior pelvic ring parts, we have been working toward the main goal of rebuilding the pelvic ring architecture over the last several years. If the anterior deficiency is more than 10 millimeters misplaced or if it is transitory and caused by a pubic bone fracture, symphysis dysfunction, or both, then internal fixation should be used to repair it. Although posterior fixation is recommended for the treatment of anterior abnormalities that have been displaced, internal fixation may also be employed for the treatment of temporary anterior deficiencies. Taking into account the research under consideration, we examined the potential medical and radiological consequences of this operation in the long run.

#### **Methods-**

Among the warning signals that need open or closed reduction and internal fixation are fractures of the pelvic bone, dislocations or fractures of the sacroiliac joint, and any lesion to the posterior pelvic ring that is misdirected or might potentially be deadly. If you have any of these conditions, you should seek medical attention immediately. For patients with pubic bone fractures that were displaced by more than 10 millimeters, general symphysis illness, or both, internal fixation was used as an alternative therapeutic option. An open reduction and internal fixation image was conducted on a total of 14 fractures that were performed on 12 patients. Additionally, a displaced acetabular fracture was also diagnosed and treated.

Between May 2020 and October 2021, we assessed twenty-one patients in a row who had type C pelvic ring injuries. Internal fixation procedures, either open or closed, were performed on these individuals. The study was carried out three weeks subsequent to the damage's severity. At the time of the injury, the data subject was between the ages of 18 and 76 years old, which is the age that is presumed to have been present. There was an injury to the lumbosacral plexus in eight out of twenty-one case studies. Both patients who were diagnosed as having type C injury also had partial spinal wire or cauda equine damage, as well as a contemporaneous thoracolumbar vertebral fracture. In addition to suffering paraparesis, both individuals had concomitant injuries. Seven individuals were diagnosed with bladder ruptures, and each of them needed surgical

intervention and treatment. It turned out that this series did not have a urethral rupture or other abnormality.

### **Surgical and postoperative care**

Crutch mobility was initiated one to two days after the accident for patients with type C1 injuries. This was done without placing any weight on the side that was injured, and it was only done if the lower extremity injuries that matched the injury allowed for it. Following a period of time ranging from eight to twelve weeks, the implementation of the complete program began. In the process of gradually increasing the loading, the primary considerations that were taken into account were the kind of fracture as well as the continuing radiological monitoring. Patients with maximum type C2 and type C3 damage to the posterior pelvic ring may begin using crutches to run games anywhere from eight to twelve weeks following the accident, depending on the size and shape of the lesion.

### **Radiological assessment**

The amount of vertical displacement that occurred inside the pelvic rings as a result of the accident was determined by using radiographs that were obtained of the patient's front and posterior pelvis. For the purpose of determining the amount of vertical displacement, the distal end of the femoral head (C1-1 and C1-2 damages) and the advanced sacral factor (C1-three damages) were used in the calculation. This mismatch was caused by the fact that the AP X-ray data produced a line that was orthogonal to the sacral long axis [11]. A confirmation of the anterior projection displacement of the posterior pelvic ring damage was made possible by the use of computed tomography capabilities. Immediately before to the first treatment, immediately after the reduction and internal fixation procedures, and immediately prior to the last follow-up session, the radiographs were collected. Regardless of the rationale, we were unable to get a precise evaluation of the anterior pelvic fragments' AP displacement by the utilization of CT. Based on the maximum residual displacement within the posterior or anterior pelvic ring injury, there were four categories for radiographic results: excellent (greater than five millimeters), good (between six and ten millimeters), light (between eleven and fifteen millimeters), and evil (greater than fifteen millimeters) [12]. If the maximum displacement was greater than five millimeters, the radiographic results were considered excellent. The study was significantly improved by the contributions made by each individual.

### **Outcome evaluation**

Twenty-three months was the suggested duration of follow-up, with a likely range ranging from twelve to eighty-five months. In the course of our examination of all twenty-one patients, we paid particular attention to their hip motions, gait, sitting difficulties, pelvic tilting, scoliosis, and chronic abnormalities of the sensory and motor nerves. Prior to and during the operation, this neurological examination was performed from L4 distally. The assistance of the operating surgeon was required for this evaluation. In the most recent follow-up, the implementation of the plan was also covered, with the assistance of the original author. A six-point scale was used in order to evaluate the motor neurological impairments that were present in the wasting limbs. In the first scenario, no noticeable muscular action is observed. In the second scenario, partial range of motion against gravity is observed in the limbs. In the third scenario, full variety of movement against gravity is observed in the limb sections. In the fourth scenario, muscular energy is higher than true but significantly lower than usual. Finally, in the fifth scenario, the regular limb is typically compared to the contralateral joint limb [13].

No discomfort, mild pain (due to sporadic or regular activity), moderate pain (due to restricted activity, alleviated by rest), and severe pain (due to constant rest and difficulty when active) were

the different degrees of pain that were graded for residual pain. A website on the internet disclosed the presence of pelvic ring discomfort in either the anterior or posterior region. Following a short pause in the pelvic ring, the real scoring system was brought back into play in the final results. As a result of the fact that it has been injured on several occasions, the machine is no longer regarded to be capable of performing certain tasks. As an extra point of interest, the most recent examination of final medical outcomes was amended to mostly reflect outcomes after a pelvic injury [14]. This modification provides an additional point of interest.

A significant chunk of the examination was carried out with the Hanoverian pool result rating taken into consideration [15]. The ranks of the medical final score and the radiological final score are determined by this device using a seven-factor scale. This scale is used to establish the rankings of both of these measurements. Six components indicate that the end result will be fantastic, four and five components hint that the product will be palpable, and two and three components indicate that the conclusion will be terrible or awful from the device's point of view. There is a significant majority of seven criteria that indicate an outstanding ultimate outcome. Additionally, this gadget takes into consideration any urological concerns and difficulties. It was with the aid of the first author that a part of the final analysis of the data was carried out. Interviews were the primary method by which we gathered information on urological and sexual deficits. An increased frequency of urine, discomfort during urination, disruption of bladder features, and incontinence were the four categories that were used to classify the findings of the urological examination. [15] An examination for dyspareunia was performed on the females, while an examination for erectile dysfunction was carried out on the men. It is no longer possible for urodynamic testing to evaluate the characteristics of urinary tract reduction in individuals who do not exhibit any obvious urological symptoms.

### **Statistics**

The statistical analysis was conducted using SPSS 11.0.1 for Windows, a program created by SPSS Inc. of Chicago, Illinois, USA. We used the Ahead-Step-Sensible method of multivariate logistic regression to find the undistorted components that are most likely related to the result. Additionally, confidence intervals for 95% are included with the raw and adjusted odds ratios that are displayed in the statistics. When it comes to statistical significance, values that are not equal to one are regarded to be significant.

### **Results**

There were twenty-one patients, and twelve of them had both their anterior and posterior fixations finished. Two external fixations were present in addition to the 10 internal anterior fixations that were identified. The method of posterior fixation was the one that was the least complex in nine different circumstances. Because of their type C3 injury, five of these patients had anterior damage that was only moderately displaced (less than 10 millimeters), and four of them did not have any anterior damage at all. At least five of the six patients who were diagnosed with bilateral posterior Type C abnormalities had their internal fixation rectified such that it was complete in every respect.

On the other hand, the anterior deficiencies present in plates did not undergo any changes (Figure 1). A total of eight of the twelve patients had percutaneous implantation of 58 sacral iliac screws, which eliminated the need for open reduction of the fracture. An anterior fixation signified that an adjustment was made to the operating duration of 95 minutes (20-225) minutes, while a posterior fixation meant that an operating time of 98 minutes (15-325 minutes) was changed. A preexisting acetabular fracture was avoided because to the fixation that was performed throughout the most significant portion of the surgical procedure. A modification was made to

the implied total blood loss, which was modified to 1.4 grams (zero, 1 - 5, 0). Only seven of the victims had surgical procedures during the first twenty-four hours after the tragedy.

When it came to the final X-ray findings, nine patients had genuine results, five patients had accurate results, and seven patients had very great outcomes (there was no final negative result). The preoperative displacement, which is also referred to as the vertical or AP displacement, was altered to be more than ten to sixty millimeters with regard to any pelvic ring injury or damage that occurred inside the posterior or anterior ring. It was determined that three patients had suffered the first failure of fixation, and the ultimate radiograph result for each of them was either negative or correct. As can be observed, the fixation fails in the posterior pelvic ring of one of the patients in the same manner as it fails in the anterior pelvic ring. This is confirmed by the observation.

There were six participants for whom the findings of the practical assessment were accurate, seven subjects for which they were negative, nine subjects for whom they were highly positive, and none of the individuals for whom they were damaging. In point of fact, a significant drop in size must have likely caused them a great deal of suffering. It was shown that injury to the lumbosacral plexus was related with unsatisfactory clinical results in six out of the twelve cases. In this particular group, there were three individuals who had reduction results that were inadequate. Additionally, one of the twelve patients had a reduction that was not anatomical, in addition to the negative practical consequence. On the other hand, there is no longer any connection between the pelvic fracture and the spinal canal stenosis in that particular patient. In spite of the exceptional radiological success, the disappointing practical outcomes in two patients were due to the persistent discomfort that was present in the posterior area of the pelvic ring. Out of the twenty-one patients, thirteen of them reported experiencing discomfort that lasted for an extended period of time, and eight of those patients reported experiencing pain that was localized to an area inside the posterior pelvic ring.

Within each and every patient who had concurrent injury to their lumbosacral plexus, there was indications of at least a partial recovery of their neurological function. As of the most current follow-up, it was discovered that fourteen patients had completely recovered from their neurological damage and did not exhibit any motor or sensory abnormalities in their lower legs. Every single patient, with the exception of one, generated findings that were either correct or exceptional or both. The individual who was impacted and had a negative result experienced discomfort at the rear of the pelvic ring. In the course of the follow-up, eight patients exhibited the least severe sensory impairment, and the outcomes that they obtained from their practical experiences were either good or correct. During the most recent follow-up, six of the eighteen patients who had partial motor impairments were having chronic lower limb radicular discomfort. This was the case across all of the patients.

A significant majority of patients (16/18) who had achieved a final radiological result that was either excellent or correct had at the very least gained an amazing practical outcome of some kind. When the radiological data were compared to the practical results, there was a significant degree of agreement (odds ratio of four to zero; confidence interval of 95%: 116). In addition, seven individuals who had a radiographic result that was either very excellent or exceptional were seen to have a practical outcome that was either true or negative. cases with symptomatic lumbosacral plexus were present in four of these seven cases. There were three patients out of the total of 19 who had a very excellent or spectacular ultimate radiological and practical result (odds ratio: 9.2; 95% confidence interval: 2.735.3) who had the greatest percentage of nerve root

damage (motor impairments). In relation to this location, this was the most important factor or component.

In both the multifactorial analysis and the investigation of individual prognostic factors, it was shown that a favorable radiological result (a displacement of no more than 5 millimeters) and the observed outcomes are directly connected with one another. To add insult to injury, the fact that it was one of the last practical conclusions of the statistical study revealed that the damage to the brain was irreparable. On the other hand, there was no association between the severity of the injury, the kind of fracture (C1, C2, or C3), and the healing process. Other significant indicators that may be used to predict outcomes include age (less than 33 years) and sexual activity among women.

Urologic anomalies were discovered in three males and two females, all of whom were female. Only one of these individuals had urinary symptoms more often than the rest, whereas four of them had problems with their bladders. Among the individuals who suffered from erectile dysfunction, there were five guys. Urologic and sexual problems were shown to be connected with a significant amount of lumbosacral plexus injury in six of the individual cases that were investigated. It is possible that this was altered in one of the afflicted individuals as a result of a rupture in the bladder. Due to the fact that none of the patients exhibited any neurological or urological impairments linked with the illness, the etiology of erectile dysfunction became unclear in two of the instances. On the other hand, the Hanoverian pelvic final result assessment, which incorporates the findings of scientific and radiological testing into a single evaluation, was found to be very good in 15 instances, accurate in three patients, negative in two patients, and suggested dangerous in one patient. Despite the fact that there were just a few instances of issues, some of them were rather serious. When the internal repair was performed on two of the patients, there was no decrease in the amount of damage. It has been proven that this phenomenon took place in the posterior pelvic ring in four individuals, two of whom required further surgical intervention.

## **Discussion**

The posterior supporting sacroiliac complex must remain intact in order to ensure the continued stability of the pelvic ring. However, biomechanical studies have shown that the pubic symphysis and pubic ramus play a crucial role in maintaining pelvic ring balance in patients with type C injuries. The additional 40% of the overall ring balance is also their fault [16]. Further, biomechanical research has shown that in cases of transient type C injuries, an anterior external fixator is insufficient for preserving proper balance. Until the wounded individual can be moved in a stable way, there is no chance of a fracture redislocation occurring [17, 18]. Internal fixation in the anterior and posterior pelvic rings not only prevents headaches, but also allows us to produce harm via clear instability. This is distinct from our earlier proposal.

Reading about the effects of a pelvic ring injury may often lead to difficulties in interpretation. This is due to the fact that neurological and other concomitant injuries can also have an influence on a meaningful recovery. An example of this would be the modification of the useful scoring tool that was developed by Majeed (1989) in order to take into consideration the outcomes that follow pelvic injuries [19]. The ability to differentiate between uncommon medical collections and fracture sorts is made much simpler by the use of a scoring gadget of exceptionally high quality. In order to eliminate the possibility of inter-observer variability, we collaborated with the same author throughout the whole of our research project in order to carry out the assessment of the final follow-up outcomes. On the other hand, the helpful reviews were

no longer blindfolded, and it could have been more effective to perform the evaluations with the assistance of an impartial reviewer.

Sequential reporting of radiological and positive findings in the medical application gives more exact data on outcomes, in contrast to unmarried assessment, which throws all of the important components into confusion. This is done in order to prevent any possibility of misunderstanding by doing the reporting in a sequential manner. For the purpose of evaluating the effects of various medical collection and treatment procedures in the future, it could be beneficial to conduct a validated analysis of the findings obtained from the end-of-pool research approach.

The appropriateness of allowing a significant amount of residual displacement is a topic that is still being discussed, despite the fact that internal fixation has been the treatment of choice for short-term pelvic ring injuries for a very long time. The findings of a study that was carried out by Baron MD and colleagues (2021) shown that a T-bar with a diameter of ten millimeters is an acceptable instrument for the therapy of posterior pelvic ring injuries. Moreover, studies have shown that the insertion of an extra anatomical T-bar for posterior damage does not considerably improve the pain experienced in the back [20]. There were a number of studies that came to the conclusion that a poor prognostic indication was present when the residual posterior pelvic ring displacement was more than 10 millimeters [21]. When it came to the computation of the Hannover score, the final findings were regarded to be correct if the residual posterior displacement was more than 5. The results of our X-ray research showed that there is a strong connection between a positive X-ray result (a maximum residual displacement of 5mm inside the anterior or posterior pelvic ring lesion) and either exceptional or acceptable outcomes. That was due to the circumstances that were present.

When it comes to stabilizing sacral fractures, sacral iliac luxations, and sacral iliac fractures, sacroiliac screw fixation is often advised [22]. In any case, you need to exercise extreme caution while inserting cannulated screws into the sacrum medial to the sacral foramina in order to protect yourself from any potential complications. When the L5 nerve root was wounded, there was just one instance of it occurring in each patient. Since sacral ilioscrews on their own are not likely to be able to maintain the correct equilibrium of the pelvic ring, comminuted sacrum fractures, which are the most severe kind of sacrum fracture, offer difficulties for the scientific community. Examples of this phenomena are provided by six people who had displacement after screw fixation. These individuals serve as illustrative examples. For the most serious injuries to the posterior pelvis, it is vital to have a special interest in the procedure and to carefully prepare for it before the operation. In five of our patients who had suffered sacral fractures, the anterior displacement had diminished to the point where it was no longer required to proceed with repairing the fracture. Unfortunately, the localization of two patients became more severe as a result of an inaccurate assessment of the posterior damage sample as being more severe. On the other hand, the injury to the anterior pelvic ring that was caused by plates did not alter. In addition to this, the internal repairing technique for sacral fractures that have a high load and little displacement is facilitated by this. It is possible that the use of percutaneous fixing methods with cannulated screws positioned under fluoroscopic guidance might be beneficial for the treatment of minimally displaced lateral sacral fractures.

Significant morphological or virtually anatomical reductions caused a great deal of discomfort for a significant number of our patients, despite the fact that 83% of our patients had good or acceptable practical outcomes. The practical results were often classified as either good or fair. A statistically significant association was shown to exist between the unsatisfactory

reduction, fixation failure, and absence of reduction (maximum residual displacement more than 5 mm) and the undesirable practical consequence. This correlation was demonstrated via the use of statistical analysis. In the event that reoperation is performed, it is anticipated that a reduction that is not operating well or that does not exist at all will be corrected at some point six weeks after the trauma. In practice, four of our five reoperations are carried out with great precision, resulting in a radiological correction that is completely error-free. This guarantees that each and every one of our activities will be successful. A correlation was also discovered between the incidence of irreparable brain injury and bad practical results during the evaluation of unmarried prognostic factors. This link was considered to be of great importance. In four of our patients, the explanation for an insufficient practical result became obvious since all of them had outstanding postoperative outcomes and no longer had any neurological handicap. This was the case because they eliminated all neurological impairment. Damage to the lumbar plexus was the most common cause of poor practical reasons in patients who also had urological impairment at the same time.

It suggests that reducing the posterior pelvic ring as soon as it is possible to do so might be an effective method for reducing the amount of neurological damage that has been sustained. When it comes to the lumbosacral nerves, it is reasonable to believe that the healing process is dependent on mechanical elements. These factors include the tension or compression of the nervous system that is created by bone fragments, as well as the degree of damage that was done to the nerve roots already [23, 24]. The halving of the pelvis, the decompression of the sacral nerve roots, and the stability of the tire in avoiding traction on the wounded nervous system are all things that seem to be crucial for the rehabilitation of the neurological system. During the first phase, if it is thought that the individual in question has suffered nerve injury and hemodynamic stabilization, this must be done as quickly as possible (within one or two days).

Our investigation suggests that a link between the excellent and radiological results is not out of the question. Although the decrease in the pelvic ring fracture could be due to anatomical reasons, the results might still be skewed due to ongoing neurological impairment. Several reasons contributed to an unsatisfactory user result; however, insufficient reduction, fixation failure, lack of reduction, and permanent damage to the lumbosacral plexus were the most common and significant. Potentially having far-reaching effects is also covered in this group. During the initial stage of the process, surgical correction may be necessary for unstable pelvic ring injuries. These injuries might cause neurological problems, including distraction or compression of the nerve roots, and other warning signs. The patient's hemodynamic stability must be confirmed before proceeding with this stage. Because of these characteristics, extreme care must be used during the preoperative planning stages and while healing the most severe sacral fractures. According to this study's results, symphysis disease, misplaced (more than 10mm), and risky pubic fractures along the occlusal posterior fixation need reduction and internal fixation. A more balanced pelvic girdle is the intended outcome of this study.

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Figure 1: The patient's lower midline incision is fixed with an extended 3.5 mm reconstruction plate.

