

The therapeutic and physiotherapeutic benefits of TiFi anastomosis after pelvic fractures

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Abstract: Background: Pelvic fractures are caused by high-energy trauma, consisting of traffic accidents, falls from heights. They are associated with a high percentage of complications, as well as the need for rapid surgical repair. The least invasive anastomosis for this type of injury is the TiFi method, which shows minimal postoperative complications and the possibility of early rehabilitation and weight-bearing, mobilising patients after surgery.

Methods: Review of thematically available articles from the last 20 years on TiFi pelvic fracture anastomosis after high-energy trauma and ongoing rehabilitation.

Results: After extraction, 10 articles on the surgical treatment of pelvic fracture with the TiFi method and rehabilitation management were obtained. 100% of the papers indicated a beneficial effect of the applied, minimally invasive anastomosis in restoring pelvic stability. Patients derived therapeutic and physiotherapeutic benefits from TiFi, compared with other applied anastomoses. The articles used defined the study group in the age range of 16–76 years, recommend that rehabilitation should be included as soon as possible after surgery, wheelchair mobility without loading of the lower limbs is acceptable 1 week after surgery, starting loading within 6–8 weeks after surgery. The decision to start loading is dependent on the operator related to the patient's condition and the bone fusion visible on X-ray. The follow-up of patients after TiFi included a minimum of 1 year with extensions up to 3 years.

Conclusions: More evidence and research is still needed to rigorously determine the timing of safe limb loading and the feasibility of implementing a specific rehabilitation plan in patients following TiFi pelvic fusion. However, the current reports already provide some insight into the need to start patient improvement as soon as possible, with operator decision-making and a period of 6 weeks after surgery as the baseline elements to begin full patient mobilisation.

Keywords: pelvis fracture, TiFi, rehabilitation, physiotherapy, trauma, classification, retrospective.

Submitted: 22-Mar-2025; **Accepted in the final form:** 20-Jun-2025; **Published:** 31-Jul-2025.



Introduction

Pelvic fractures are associated with high-energy and multi-organ injuries. They usually arise as a result of: motor vehicle accidents, motorbike accidents, pedestrian collisions e.g. when crossing lanes, falls from heights from a roof, from a tree and crush injuries. Pelvic fractures most commonly affect young men [1, 2].

Pelvic trauma very often results in injuries to concomitant soft structures such as the internal iliac artery and vein, bladder (20%), urethra (14%), lumbosacral plexus, rectum and vaginal vault. Fractures of the hip plates also occur. Frequent complications following pelvic fractures and subsequent mortality account for a high proportion of those treated. They are mainly related to direct post-traumatic consequences, including concomitant injuries such as internal haemorrhage, rupture or rupture of the urinary bladder (35%), perineal, genital trauma.

There are five main qualifications for pelvic fractures, which also include Denis fractures, i.e. sacral fractures. The listed qualifications are established according to high- and low-energy injuries. High-energy ones are further subdivided into those arising by mechanism (Young and Burgess) [1] and by type of injury (Tile and OTA — Orthopaedic Trauma Association). Low-energy injuries, which are most commonly osteoporotic, overload fractures and fatigue fractures.

One of the most common injuries is a type C pelvic ring fracture. It is important to note that when there is an anterior pelvic ring injury, there is also a separation of the pubic conjunctiva. The qualification is then according to Tile or OTA. The basic examination for appropriate qualification is a computed tomography (CT) scan and, in the case of polytrauma, a so-called Trauma Scan is performed.

The fixation of this type of fracture should be done in the shortest possible time by using an appropriate treatment method. One of the most commonly used anastomoses for this type of fracture is anastomosis with a TiFi transiliac internal stabiliser.

The availability of articles on the topic of the effect of TiFi-type anastomosis after multiple organ injuries on the therapeutic and physiotherapeutic benefits obtained for patients is very limited. Most of the scientific papers refer to pelvic fractures in general, and their conclusions recommend renewed research and increased knowledge on this topic.

This applies to both surgical treatment and subsequent rehabilitation, which is of great importance in relation to the task of returning to independent living, improvement, quality of performance of activities of daily living and fitness [3]. The authors of the available publications describe the ways and speed of the onset of rehabilitation and loading, but due to the scarcity of evidence, these are often not significant or large-scale studies, but merely attempts to standardise subsequent physiotherapy measures. It therefore seems important to identify the benefits and drawbacks of TIFI anastomoses in patients with pelvic fractures.

The aim of this study is to evaluate the therapeutic and physiotherapeutic benefits of TiFi anastomosis after pelvic fractures.

Material and Methods

The literature analysis included a methodological review of MEDLINE, PubMed, and EMBASE databases from the last 20 years. The selection of research papers was based on topics concerning the use of the TIFI anastomosis for pelvic stabilisation after fractures, as a leading method in patients after traumatological/orthopaedic injuries.

Key search words were: pelvis fracture, Tifi, rehabilitation, physiotherapy, trauma, classification, retrospective.

By means of selection, research papers on children, adolescents were rejected.

The studies concerned age groups in the range of 16–65 years, people who were physically active, physically active before the accident.

Finally, 10 research papers from peer-reviewed journals considering TIFI fusion after traumatic pelvic fractures were eligible for review.

Results

Number of papers and diversity of study population.

The search yielded 10 papers indicating the use of TIFI pelvic fracture anastomosis.

The study groups consisted of people following multi-organ injuries — polytrauma as a result of traffic accidents: motorbike, pedestrian, car and crush accidents. All available articles used included injuries, pelvic fractures from accidents [1–10] (Table 1).

Table 1. Characteristics of the study groups of patients after pelvic trauma with TiFi anastomosis.

Author <i>et al.</i> (Year)	Age of respondents	Type of injury	Testing time 3/6/12/, possible load time
1. Muller <i>et al.</i> (2021)	Up to 42 years	Injuries taken into account are high-energy injuries, i.e.: traffic accidents, falls from height, multi-organ injuries	Follow-up time of at least 12 months. Use of elbow crutches or a walker is advisable for 6–8 weeks after surgery. Full use of the limb 3 months after surgery.
2. Saito <i>et al.</i> (2022)	Up to 65 years		Evaluation period up to 12 months after surgery. Possible mobilisation, upright standing in wheelchair without weight bearing after 1–2 weeks after surgery
3. El-Hamalawy <i>et al.</i> (2023)	18–54 years		Average follow-up time 12–20 months.
4. Rickman <i>et al.</i> (2019)	Up to 64 years		Minimum follow-up time of 6 months. Average time of load restrictions 8–9 weeks
5. Piccione <i>et al.</i> (2021)	Up to 65 years		Observation of patients min 12 months. No-load period: 6–12 weeks, passive mobilisation after 15 days
6. Nagai <i>et al.</i> (2024)	Up to 65 years		Follow-up time 12 months. Burden and mobilisation to be decided by the operator
7. Kassem <i>et al.</i> (2023)	18–43 years		Follow-up time of at least 12 months. Determination: the method allows early rehabilitation, but without giving time data and loading capacity
8. Seemann <i>et al.</i> (2021)	19–47 years		Follow-up time 12 months to 3 years
9. Dienstknecht <i>et al.</i> (2011)	16–76 years		Follow-up time up to 3 years. Mobilisation from day 12 after surgery with partial loading up to 15 kg 6–8 weeks. Removal of the anastomosis after approx. 12 months.
10. Salasek <i>et al.</i> (2012)	15–65 years		Follow-up of patients at 6-week intervals after surgery, at 12 months, and every 12 months thereafter (the authors report an average follow-up period of 16 months) Mobilised at an average of 5 weeks after surgery

Methods used

Cross-sectional (4), review (3), prospective (2), retrospective(1) research papers.

Methods used to assess patient follow-up in selected articles.

After TIFI anastomosis, patients were followed up using methods such as radiological case assessment, Form 36(SF-36), Short Musculoskeletal Function Assessment (SMFA-D), Pelvic Outcome Score, postoperative patient follow-up for approximately 12 months (Table 2).

Table 2. Assessment methods used in the patients studied.

Parameters	Author <i>et al.</i> (Year)
Rtg	Kassem <i>et al.</i> (2023) El-Hamalawy <i>et al.</i> (2023) Saito <i>et al.</i> (2022) — FFP classification type fracture pelvis Salasek <i>et al.</i> (2012)
SF-36	Seemann <i>et al.</i> (2021)
SMFA-D	Seemann <i>et al.</i> (2021)
Pelvis Outcome Score	Dienstknecht <i>et al.</i> (2011) Seemann <i>et al.</i> (2021)
Post-operative observation 12 months Over 12 months	All authors maintained a minimum follow-up time of 12 months Salasek <i>et al.</i> (2012) maintained an observation of up to 16 months

Discussion of results

Unstable ring fractures are very serious injuries usually caused by traffic accidents, falls from heights [2]. Operative treatment and physiotherapy are necessary and very important in such cases.

Following a review of the available scientific papers on TiFi pelvic anastomosis, the authors are not clear on the impact of treatment, rehabilitation and the timing of appropriate loading after surgery. Similar views in the papers exist regarding the physiotherapeutic methods used and the patient's return to self-care.

King's Health Partners studied patients with TIFI anastomosis, up to six weeks after surgery. They found the impact of pelvic surgery to be so good that they concluded that patients could be rehabilitated as early as the first or second day after surgery [4]. In the study [5]. It was confirmed that, after surgery, patients should start with small movements of the lower limbs in weight-bearing. This included groups of motor activities, i.e. active foot exercises in dorsiflexion and plantar flexion, assisted active exercises in the form of lower limb inversion, isometric exercises targeting the quadriceps thigh muscle, gluteus maximus muscle and upper limb exercises [5] or forcing excessive knee joint extension [6]. The authors of this articles also set short-term goals that increase patients' motivation to work and achieve particular stages of fitness such as independence, wheelchair mobility. At the onset of loading, physiotherapy includes gait training, trunk exercises with resistance, stabilisation and mobility exercises [7]. Mroz [8] highlighted in his work the extremely important aspect of mobility training, which is necessary to regain the range of mobility in the joints responsible for mobility, learning to walk with a walker or with crutch assistance, as well as

training aimed at restoring balance and proprioception. Researchers suggest that the final stage of rehabilitation should include specialised functional exercises aimed at returning to activities of daily living. Also in elderly people with pelvic fractures and treated with TIFI anastomoses, it has been confirmed that the main focus will be training aimed at rapid mobilisation, pain relief and improvement, quality of life [9]. According to the authors, it is also important to adapt the home environment with aids such as handrails, non-slip mats and mobility aids. Already in 2010, Ziden *et al.* [10] studied the status of patients after long-term (min. 6 months) rehabilitation. However, the study did not show complete patient satisfaction and larger statistical influences on the improvement of their motor status. Most authors suggest further research on this topic and that the patient should be approached individually after a pelvic fracture and the type of fusion.

Piccione *et al.* [11], in a review of the literature found insufficient evidence regarding rehabilitation in terms of its duration and therapy modalities, while recommending early postoperative physical intervention to improve recovery. In the literature review, they highlighted the loading component after surgical pelvis fracture (PF). They emphasised that, according to AO principles, the weight-bearing exclusion period is 6–12 weeks, after which loading should be progressively increased and loading should be increased by 25% per week. [12] In studies targeting unstable PF, the time to fracture healing was 12–18 weeks. Phruetthiphat OA suggests that in these patients there is an extended time to onset of loading.

Piccione *et al.* [11], in their overview, mention early rehabilitation as an element to prevent complications, contractures, disorders from other systems. The authors also draw attention to patients' repositioning transfers, transfers and wheelchair transfers between 2–6 weeks [11, 13]. They mention the effect and importance of isometrics exercises on the gluteal and quadriceps thigh muscles, and an important factor in gait re-education. A review study by Rickman *et al.* [14], shows that there is a large deficit regarding loading criteria after PF. The authors point to a lack of specific information regarding, in particular, the safe time to start loading [14, 11]. Puccini *et al.* [11] are the next to point out that the timing of initiation and management of rehabilitation is poorly studied. The authors point out more than once in their scientific papers on PF patients that more research needs to be done on this aspect. From the currently available data, therefore, the time of loading after surgery draws our attention in the authors' discussion. According to the review, it has been confirmed that the most optional period for loading after PF is 6–12 weeks [12] and phruetthiphat OA and the individual mobilisation process can be started optimally after 15 days according to Gribnau *et al.* [15], while increasing loading, 25% every week is recommended by Ruedi [12]. Weight-bearing recommendations should be explored and thoroughly researched, as the advantages of early mobility are quite significant for patient recovery [14]. A literature review by Duwelius *et al.* [16] and a paper by Gurevitz *et al.* [17] found that some papers described a 6-week no-load period (in bed), but most papers indicated a 9.5-week no-load period. Due to and based on the very small collections, the authors conclude that a potential period to start loading after PF is 8–9 weeks, and suggest that the degree of pelvic loading should be additionally selected according to the patient's pain tolerance [16, 17]. Nagai *et al.* [18] tried to find a uniform protocol for rehabilitation after PF fracture but without much success, they recommend the need for further research. In their study, they highlighted an interesting aspect, i.e. the mobility of patients after PF injuries. In the study, muscle strength was measured at 3 and 12 months after surgery where it was found that gait normalised at 12 months after surgery. In defining the loading criterion, the authors indicate that, considering young patients, the period without loading was 6–12 weeks [19]. They unequivocally point out that functional assessment and rehabilitation are very important in terms of rapid recovery [18].

Kassem *et al.* [20] confirm that TiFi anastomosis is a minimally invasive method that is valid and effective in the treatment of sacral fractures, with a short operating time and minimal blood loss. TiFi anastomosis can be considered to provide a low risk of postoperative complications and a lower risk of overcompression of the fracture line. According to the authors, it is a stable technique for sacral fractures, in addition to the technique allowing early rehabilitation. It has been shown that immediately after surgery, knee and foot exercises were allowed in bed, partial loading was allowed after 2 to 6 weeks, with this being verified by radiological assessment to determine fusion and the patient's subsequent ability to progress to full loading [20]. Perhaps a radiological examination at some interval would be helpful and would ensure that patients are not excluded from exercise for long periods of time with sufficient bone fusion already accomplished and confirmed to allow gradual weight-bearing.

Seemann *et al.* [21] in their study also demonstrated that the TiFi method has a less invasive and tissue-sparing component. A lower tendency for pain and better functional results were confirmed compared to (SPF — spinopelvic fixation / poposterior pelvic ring fracture).

The authors concluded that there were fewer complications after TiFi compared to other surgical techniques, so that patients did not have to be re-operated due to wound healing disorders, infections. However, the results are not sufficient for our review and patients, as specific procedures and results as to the rehabilitation performed were missing.

In contrast, Muller and Fuchtmeier [22] reviewed the literature on TiFi anastomosis, where in their conclusions they strongly emphasised that it can be used in acute conditions and is safe. However, they concluded that there was too little evidence as to the function of this anastomosis [22]. Other authors have confirmed that the use of the TiFi anastomosis allowed immediate full weight bearing on the unaffected side and partial weight bearing on the operated side [23]. They point out that crutches or a walker should be used for about 6–8 weeks [23]. On the other side, there have been reports of only adopting a sitting position with lower limbs lowered for a period of 6 weeks, followed by the use of full weight bearing after 3 months postoperatively [24]. For bilateral pelvic injury, a sitting position or transfer to a wheelchair for 6 weeks was recommended. The possibility of removing the anastomosis up to 12 months after surgery or later in patients treated with TiFi anastomosis has also been described [24]. The authors also mention the low complication rate after TiFi anastomosis they also point out the need for further studies, which are necessary to determine the timing of anastomosis removal and the method and timing of rehabilitation.

El-Hamalawy *et al.* [25], also confirm that TiFi anastomosis required a significantly shorter operating time and showed greater fixation of the entire ring. Due to such good stabilisation, many cases did not require additional anterior stabilisation. In these studies, the average follow-up period of patients after TiFi was 13 months. TiFi anastomosis was shown to allow early rehabilitation and mobilisation of the patient. Unfortunately, no mention of specific rehabilitation was found in this method and comparative analysis.

On the other, Dienstknecht *et al.* [26] found that, on average, patients after TiFi anastomosis achieved independent mobilisation with limited weight-bearing for 12 days — uprightness without weight-bearing on the operated side. Removal of the TiFi anastomosis occurred after an average of approximately 11.9 months (Range 5 to 26 months). The authors report that complaints, if any, (pain, discomfort) were less after TiFi anastomosis compared, for example; with SPF on loading and walking, and decreased after removal of the anastomosis. The majority of patients surveyed experienced no discomfort or limitations during daily activities. A small number experienced minor mobility limitations and intermittent pain with the presence of the anastomosis.

Salasek and Pavelka [27] evaluated TiFi stabilisation in type C pelvic fractures where they mainly considered patients after high-energy trauma — traffic injuries, falls from heights. Patients were mobilised at 5 weeks postoperatively and followed up at 6-week intervals up to 1 year post-operatively and for a further 2 years. They concluded that TiFi is a minimally invasive method of pelvic stabilisation and has a low risk of complications and shorter operative time compared to other methods.

The above interesting studies and findings are niche, as a longer period without weight bearing on the pelvis and lower limbs appears in most papers. In most patients, especially after bilateral anastomosis, it has been confirmed that a period of at least 6 weeks is needed to start weight-bearing, but at the same time with the use of appropriate orthopaedic supplies, i.e. elbow crutches, balcony.

Summary

Immediately after surgery, prompt bedside rehabilitation is advisable to reduce the development of complications, such as thromboembolism, reduction and limitation of joint range of motion and prevention of muscular atrophy. Many studies also indicate that the anastomosis can be removed within 12 months after surgery, which is, however, only an indicative period. Besides, the removal of the anastomosis is also dependent on limitations and discomfort in activities of daily living, mobility.

Each of the scientific studies reviewed above mentions the importance of prompt activity, rehabilitation, but there is no specific programme shown for use in patients following TIFI pelvic surgery. There is also no single position regarding uprighting, as well as an indicated appropriate time for loading the lower limbs after surgery. There is undoubtedly a need for further, more thorough research related to the rehabilitation management of patients with a TiFi anastomosis as well as after removal of the anastomosis.

Recommendations and actions

In view of the deficiencies presented, physiotherapy management procedures should be developed in various research centres around the world in order to establish an optimal recovery programme for these patients. Currently, on our part, we have undertaken such an analysis and the bioethics committee of the CMUJ has accepted and approved a draft for a procedure that will, in the future, fill the knowledge gaps regarding the functional work of pelvic trauma patients with TiFi anastomosis.

Further research is needed to improve and refine the management of patients with pelvic injuries and fusions. Pelvic injuries need to be treated as soon as possible due to the effects of high-energy trauma and complications. They require early and comprehensive rehabilitation, which is essential to restore strength, ranges and future mobility as well as to avoid post-operative sequelae resulting from prolonged immobilisation.

Conclusions

Therapeutic and physiotherapeutic benefits have been demonstrated in patients following TiFi anastomosis.

Operative treatment with a TIFI anastomosis is a good choice and has a beneficial effect on the stabilisation and rapid recovery of patients after pelvic injury.

The optimal time to start lower limb weight-bearing after TiFi pelvic anastomosis is 6–8 weeks, with recommendations for early bedside rehabilitation.

There are no established stages of physiotherapy after TIFI anastomosis. Further research is needed in this area.

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