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Dynastab S: A new concept for high energy fractures of the distal tibia

Dynastab S – nowa metoda leczenia złamań zmiażdżeniowo-kompresyjnych dalszej nasady piszczeli

Key words: *external fixation, pylon fractures, range of motion in the knee joint*
Słowa kluczowe: *stabilizacja zewnętrzna, złamania typu „pylon", zakres ruchu w stawie kolanowym*

SUMMARY

Background. *High energy fractures of the distal tibia („pylon fractures") usually result in severe reduction of the range of motion of the superior ankle joint. If there is severe soft tissue trauma coexisting with the fractures, the possibilities for surgical treatment are limited. Our study examined the suitability of the DYNASTAB S external fixator (for ankle joint stabilization).*

Material and methods. *We studied 25 adult patients (15 men, 10 women), treated from April 2001 to March 2003, to whom the DYNASTAB-S stabilizer was applied for an average of 10.5 weeks.*

Results. *In all patients bone union was achieved, with a good range of motion in the talo-crural joint. All patients tolerated the applied treatment well. The average hospital stay was 9 days. There were 2 cases of transient inflammatory reaction of the skin around the screws, and 1 case of algodystrophy syndrome, which resolved after physical treatment combined with pharmacotherapy.*

Conclusions. *The Dynastab S external fixator is very successful in the treatment of fractures with poor prognosis in traditional methods of conservative and surgical treatment, providing bone union and good functional efficiency of the superior ankle joint. The use of the mechanical joint imitating the movement of the injured ankle joint allows for early joint rehabilitation without loss of stability of the fracture. Adaptation of the device to the operated limb is excellent. The Dynastab S external fixator can be recommended for wider use in the treatment of pylon fractures.*

STRESZCZENIE

Wstęp. *Wysokoenergetyczne złamania dalszej nasady piszczeli, znane jako złamania typu „pylon fracture", najczęściej prowadzą do sztywności stawu manifestującej się w postaci redukcji zakresu ruchomości w stawie skokowym górnym. W przypadku towarzyszących uszkodzeń tkanek miękkich leczenie operacyjne jest często niemożliwe. W tych przypadkach odpowiednim leczeniem wydaje się być stabilizacja zewnętrzna. W pracy prezentujemy zastosowanie stabilizatora zewnętrznego Dynastab S.*

Materiał i metody. *Badaniami objęto 25 dorosłych pacjentów (15 mężczyzn, 10 kobiet), leczonych w okresie od kwietnia 2001 r. do marca 2003 r., u których zastosowano stabilizator zewnętrzny Dynastab S przez średnio 10,5 tygodni.*

Wyniki. *U wszystkich pacjentów osiągnięto zrost kości oraz dobry zakres ruchu w stawie skokowo-goleniowym. Wszyscy badani pacjenci dobrze tolerowali leczenie, a średni okres hospitalizacji wynosił 9 dni. Zanotowano 2 przypadki przejściowej reakcji zapalnej skóry w okolicy śrub oraz 1 przypadek zespołu bolesnej dystrofii, który cofał się po zastosowaniu zabiegów fizykalnych połączonych z farmakoterapią.*

Wnioski. *Za pomocą stabilizatora zewnętrznego Dynastab S można osiągnąć zrost kości oraz dobrą sprawność funkcyjną operowanego stawu w leczeniu złamań o bardzo złym rokowaniu przy tradycyjnych metodach leczenia zachowawczego i chirurgicznego. Zastosowanie stawu mechanicznego naśladującego ruch uszkodzonego stawu umożliwia wczesną rehabilitację stawu bez utraty stabilności złamania. Dostosowanie stabilizatora do operowanego stawu jest bardzo łatwe. Stabilizator zewnętrzny Dynastab S zasługuje na szersze stosowanie w leczeniu wysokoenergetycznych złamań dalszej nasady piszczeli.*

INTRODUCTION

High-energy fractures in the region of the superior ankle joint often lead to posttraumatic stiffness, reducing the range of motion [1-4]. Long lasting immobilization, the risk of thrombo-embolitic complications, considerable post-traumatic swelling, injuries within soft tissues, and the impossibility of applying stable osteosynthesis are major problems in conservative and surgical treatment [4-6]. The risk of this common complication could be reduced by functional or surgical treatment, but in the case of severe soft tissue trauma coexisting with bone fractures, the possibilities for surgical treatment are limited. In these cases, external fixation seems to be sufficient for proper stabilization. Currently available techniques of external fixation allow for effective stabilization of fractures with simultaneous maintenance of motion within the damaged joint, which reduces the risk of posttraumatic stiffness [7,8].

High energy distal tibia fractures, known in the literature as „pylon fractures," cause many therapeutic problems, in spite of the fact that they make up only 3-5% of all joint injuries. This is due to the varying course of the fracture line, the position of the foot at the moment of injury, edema, and blistering of the skin. For these reasons, conservative and surgical treatment of high energy fractures in this region is seldom successful, and is sometimes impossible. Often the only solution in this case is functional treatment.

The articulated external fixation technique provides the unique possibility to perform stabilization in such a way as to allow the range of motion of the affected joint to be maintained. The present study presents an effectiveness analysis of the DYNASTAB S fixator (for ankle joint stabilization) in the treatment of complicated fractures of the distal epiphysis and metaphysis of the tibia.

Construction of the Dynastab S external fixator

The aim of the construction was to accomplish two purposes: allowing the patient free movement, and functional treatment of the joint fracture. This is made possible thanks to an built-in axial active articulated joint hinge, imitating movement in the region of the superior ankle joint, which allows the patient to execute dorsal and plantar flexion movements similar to those performed in physiological conditions.

The Dynastab S external fixator is build from a pre-joint link, on which are fixed 2 clamp-leads for screws (5 mm in diameter). The clamp leads for the bone screws are fixed under a constant angle, creating a spatial arrangement in the shape of a tent, which gives stability to the tibia bone shaft and reduces the risk of losing stability due to osteolysis. A pre-joint link joins the frame of the stabilizer with the use of a non-resisting spherical articulated joint. This articulated joint has 240 degrees of movement around the long axis of the stabilizer, and also allows for bending the frame from 25 to 30 degrees in every direction. This is of vital importance during the reduction of fractures and the correction of limb axis. Inaccuracies in the overlap of the mechanical axis of the articulated joints of the fixator and the anatomical axis of the joint are corrected with a cylindrical joint on the fixator, which is between the frame and the joint link. The active joint link, which makes it possible to provide functional treatment of the fracture, has 180 degrees of motion. The control of motion is in increments of 15 degrees (see Fig. 1 and 2)

MATERIAL AND METHODS

Our research involved a group of 25 patients with pylon fractures (15 males, 10 females, average age 42.1 years) hospitalized in the period from April 2001 to March 2003. In the treatment Dynastab S external fixator was applied, which was invented by polish orthopedic surgeons: J. Deszczynski and J. Karpinski and is produced by a polish medical company. This is an unique method of functional treatment involving external stabilization. The Dynastab S external fixator was used on all 25 patients. The patients were qualified for treatment according to fracture type in the AO and Gustillo-Anderson scales (see Table 1). Most of them had coexisting soft tissue trauma.

The fractures were immobilized with the Dynastab S fixator, implanted in the operating room under X-ray monitor control, with epidural anesthesia. In compound fractures with significant joint surface depression, open reduction was performed first, and fixation was accomplished with K-wires or metal plates with screws (see Fig. 3 A, B, C). The Dynastab S fixator was then applied. The active mechanical

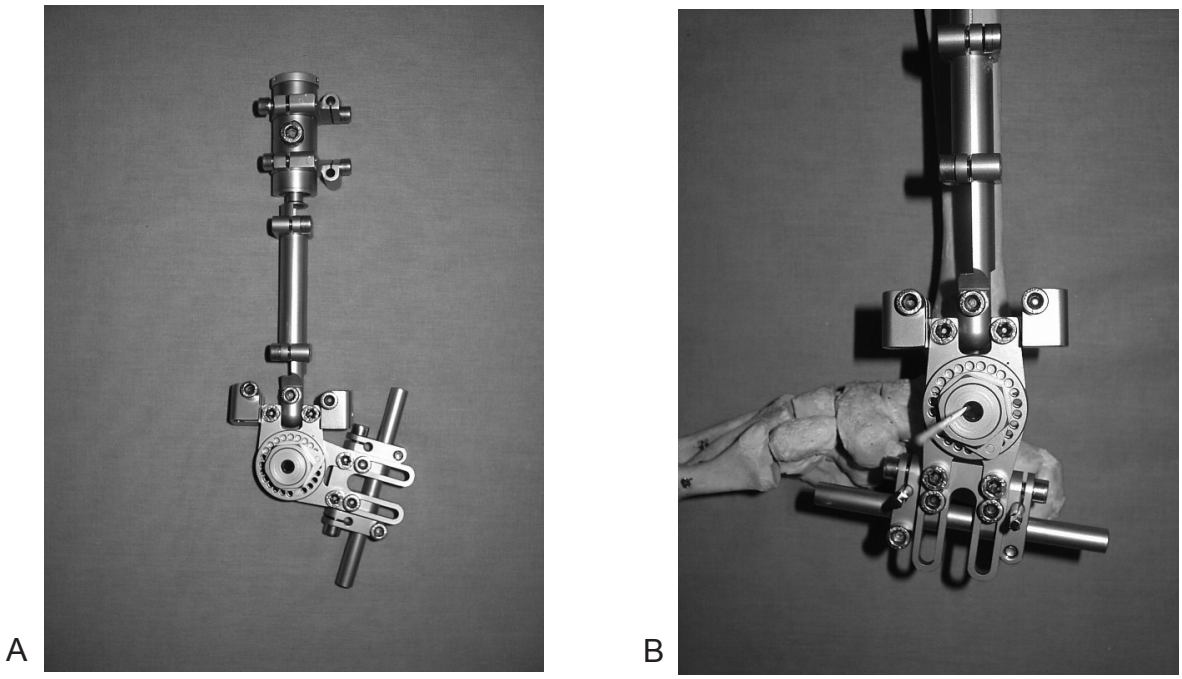

Fig. 1. Dynastab S external fixator (A, B)
Ryc. 1. Stabilizator zawnętrzny Dynastab S (A, B)

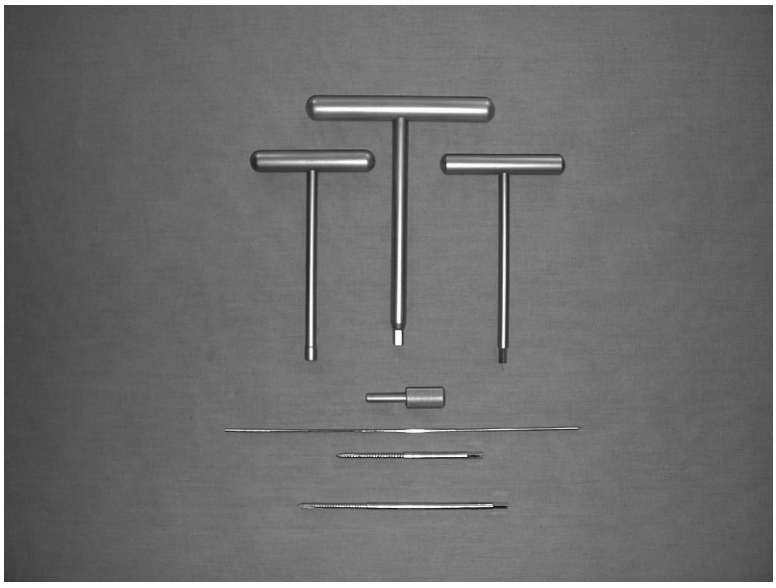

Fig. 2. Instrumentation for Dynastab S fixation
Fig. 2. Instrumentarium do stabilizatora Dynastab S

Tab. 1. Classification of fractures in the study population according to AO fracture type
Tab 1. Zestawienie złamań badanej populacji wg AO

FRACTURE TYPE (AO)	A	B			C		
		B1	B2	B3	C1	C2	C3
%	2	10	12	30	18	10	18

joint link of the Dynastab S fixator was blocked in the 90-degree position (see Fig 4 A, B).

Starting from the second day after surgery, the patients received exercises of the hip and knee joint and isometric exercises of the muscles. Active motion began between the 2nd and 4th weeks (see Fig. 4 C, D). Partial weight bearing was attempted in the 8th to 10th post-operative week, and full weight bearing in about the 16th week (according to clinical and X-ray evaluations)

An X-ray examination was performed directly after the implantation, then between the 5th and 7th day after surgery, and then every 4 weeks. The radiological parameters included:
- tibio-talar angle,
- evaluation of joint surface,
- symptoms of post traumatic arthrosis or ankylosis.

Clinical examinations were performed every 2 weeks.

Outcome was evaluated on the basis of the subjective opinion of the patients, as well as clinical and functional examinations of joint and limb function in the 4th, 12th, and 36th month after injury (see Fig 5 A, B, C). The criteria for these examinations included:
- edema;
- pain;
- range of motion in the superior ankle joint;
- joint stability;
- ability to walk.

RESULTS

In all cases appropriate bone union with full range of motion in the superior ankle joint was obtained in a range of plantar flexion comparable to the contralateral joint, with minimal reduction of movement in the range of dorsal flexion. In all patients bone union was confirmed by clinical and X-ray examination with a good range of motion in the region of the talo-crural joint. All our patients tolerated the applied external fixation well, and expressed satisfaction with the treatment outcome, estimating their limb function as good (see Fig 6). The average time of treatment using the Dynastab S external fixator

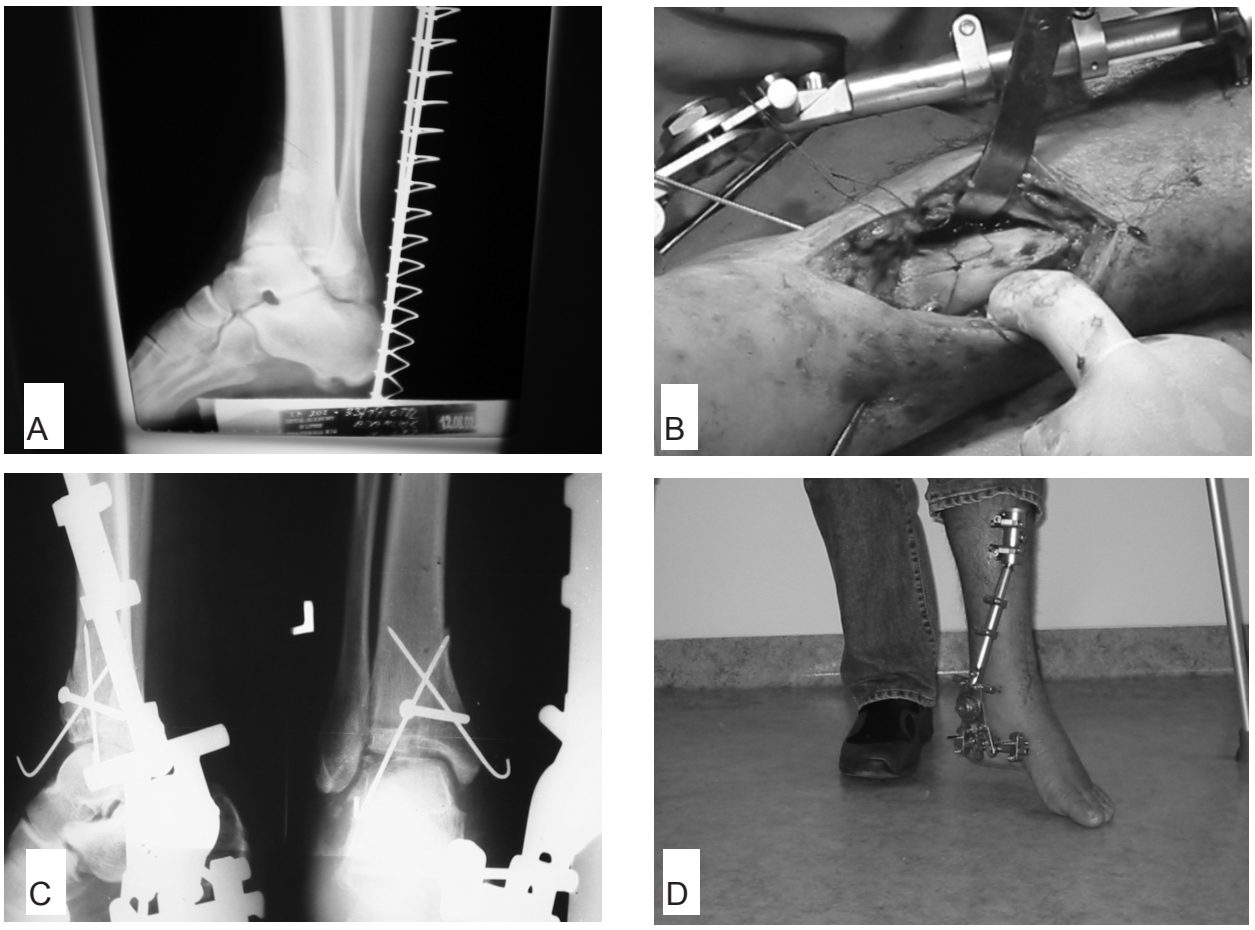

Fig. 3. A crush fracture type B3 (AO). (A) pre operation, (B) intra operative, (C) after operation, (D) 4 weeks after surgery
Fig. 3. Złamanie zmiażdżeniowe typu B3 (wg AO). (A) przed operacją, (B) w czasie operacji, (C) RTG po operacji, (D) 4 tygodnie po operacji

was 10.5 weeks, and the average hospital stay was 9 days (see Fig. 7).

Measurements of the range of motion in the superior ankle joint made at 4, 12, and 36 months after implantation showed a decrease in the range of motion in dorsal flexion by 5.7 degrees for the affected limb in comparison to the opposite limb, and plantar flexion reduced by 3.2 degrees. In 2 cases there was a transient inflammatory reaction of the skin around the screws of the fixator, and one case of algodystrophy syndrome, which resolved after initiation of physicotherapy together with pharmacotherapy.

DISCUSSION

High energy distal tibia fractures, known in the literature as „pylon fractures", lead to severe therapeutic problems i. g. posttraumatic stiffness, reducing the range of motion [3-4]. The conservative method of treatment was established in these kind of fracture in the 50th of the previous century [9,10,11,12]. Long lasting immobilization, the risk of thrombo-embolitic complications, considerable post-traumatic swelling, injuries within soft tissues, and the impossibility of anatomical reduction of the ankle joint surface are major problems in conservative treatment [4-6]. There was an opinion that the surgical way is the treatment of choice. But open reduction and internal fixation is very difficult in such type of the lower limb fracture and post surgical treatment (casting) leads to posttraumatic stiffness and reduction of range of motion [13,14].

Ayeni et al. stated that in his assessment of patient treated only with casting after closed reduction, there was 50% of cases with poor results. Additionally there was no possibility to observe soft tissues and the skin [10].

Rüedi et al. reported results of treatment after internal fixation and after closed reduction and immobilization in the cast. In the first group he observed 73% and in the second 40% of good results. Most common complication was: posttraumatic osteoarthritis (50%), varus deformity (30%) and reflex sympathetic dystrophy (14%) [13].

In some cases after treatment with various method the stiffness, pain and osteoarthritis can result. Then

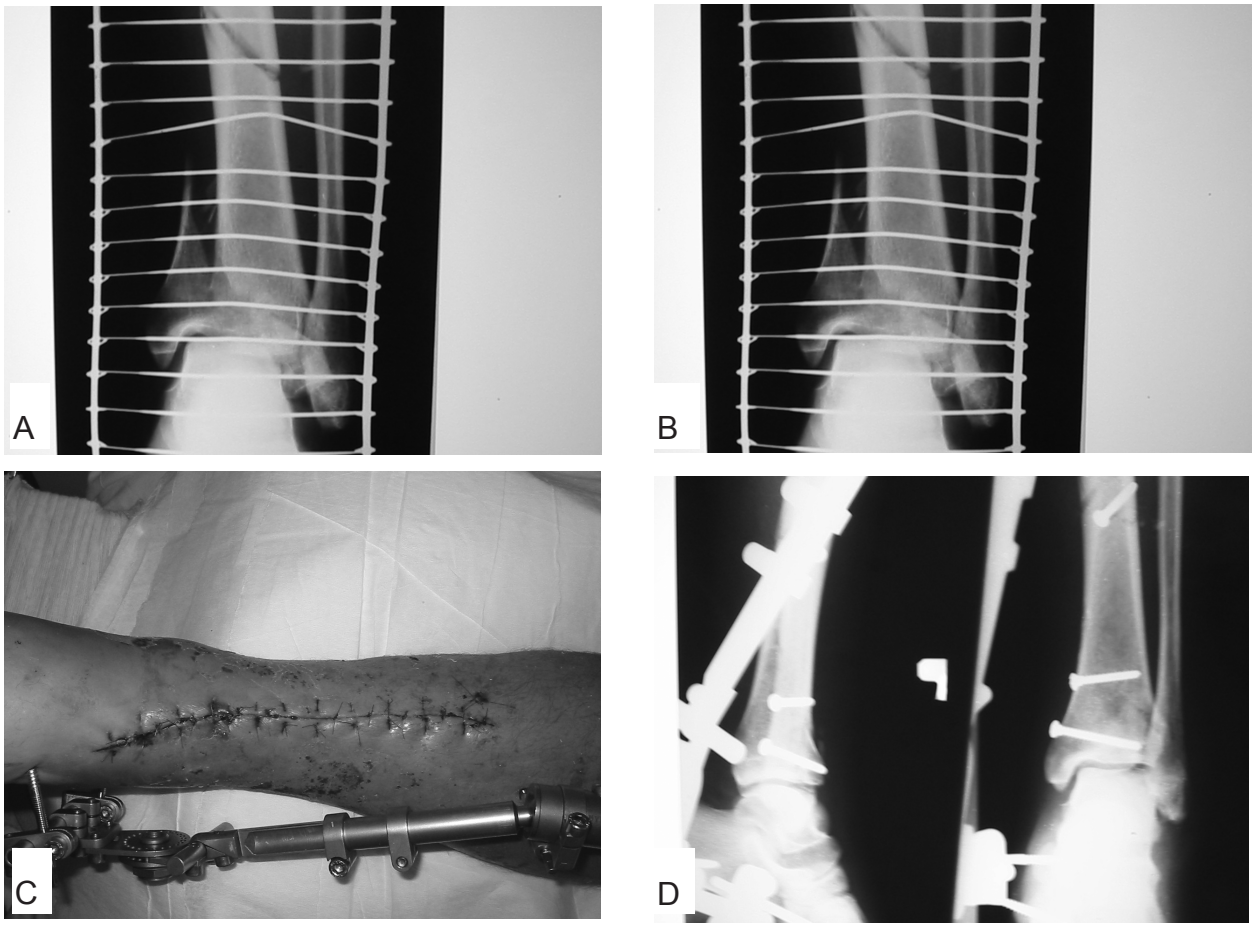

Fig. 4. A crush fracture type B3 (AO) with tibia shaft fracture. (A, B) preoperative, (C,D) after surgery
Fig. 4. Złamanie zmiażdżeniowe typu B3 (wg AO) trzonu kości piszczelowej, (A,B) przed operacją, (C,D) po zabiegu

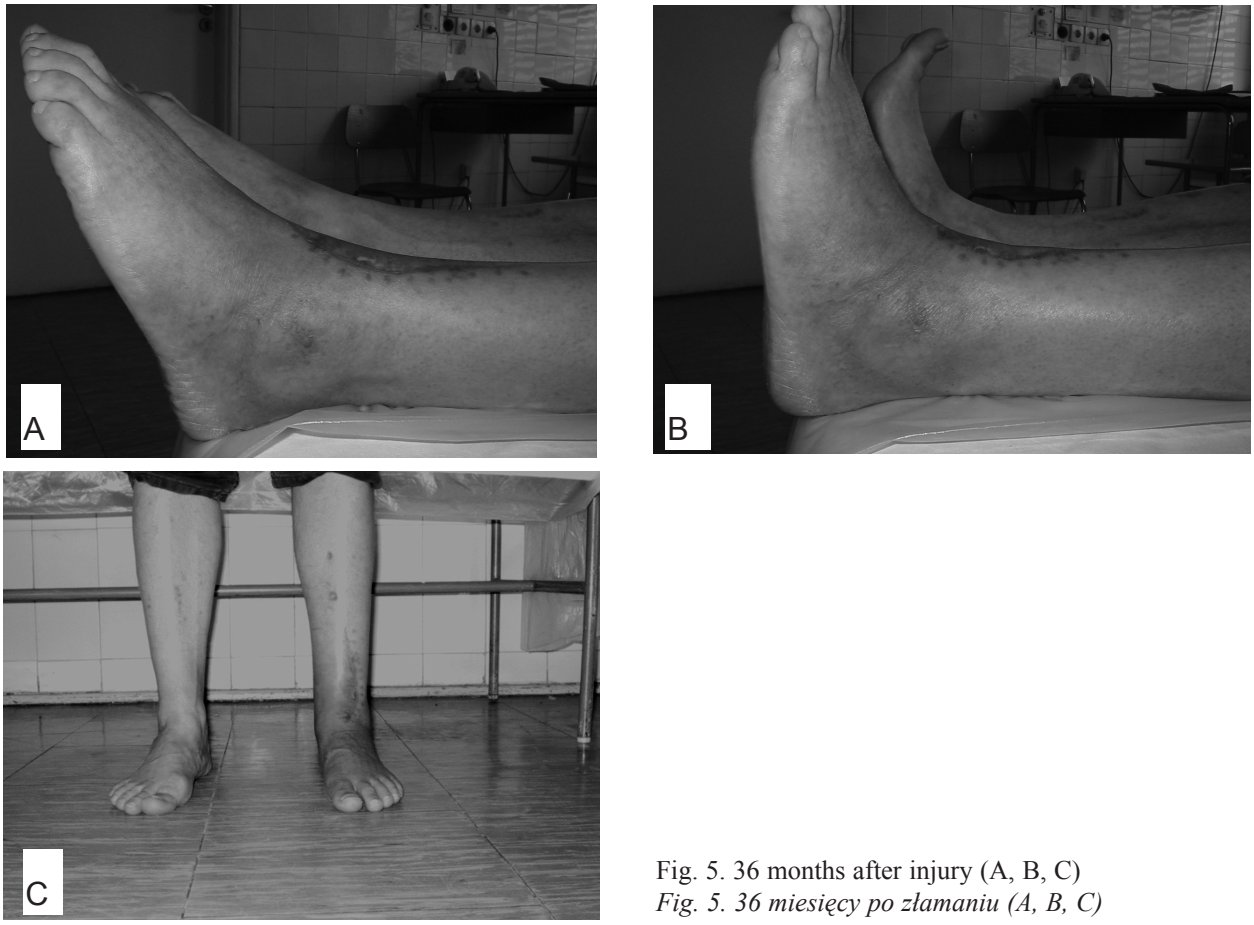

Fig. 5. 36 months after injury (A, B, C)
Fig. 5. 36 miesięcy po złamaniu (A, B, C)

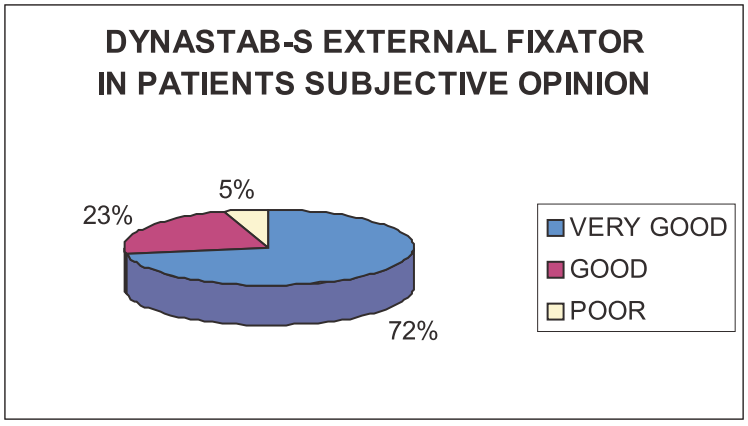

Fig. 6. Dynastab-S external fixator in patients subjective opinion
Ryc. 6. Stabilizator Dynastab-S w subiektywnej opinii pacjentów

could be necessary to do an arthodesis of the thalocruralal joint [15,16] or an alternative way of treatment these complications which is total ankle arthroplasty [17].

To dissolve this huge therapeutic problem there other methods appeared.

Often the only solution in this case is functional treatment. Tylman proposed functional treatment of distal tibia fractures. This way is useful and usually leads to good results but has some disadvantages i. g. staying in bed for a long period and its not possible to correct severe replacement [17].

External fixation seems to be sufficient for proper stabilization. Currently available techniques of exter-

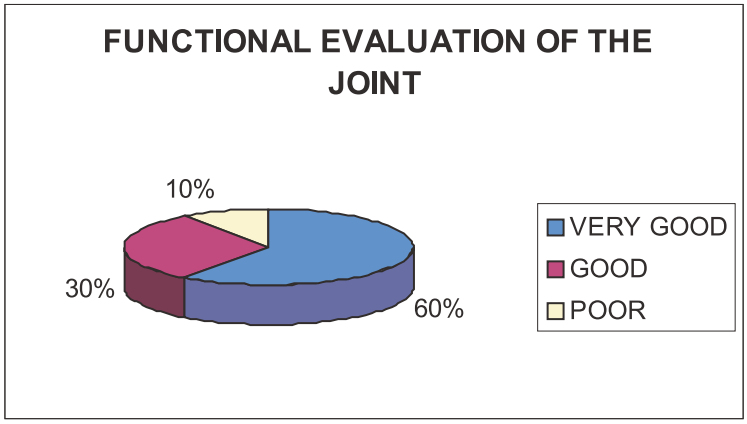

Fig. 7. Functional evaluation of the joint
Ryc. 7. Ocena funkcji stawu

nal fixation allow for effective stabilization of fractures with simultaneous maintenance of motion within the damaged joint, which reduces the risk of post-traumatic stiffness [7,8,15,16].

The articulated external fixation technique provides the unique possibility to perform stabilization in such a way as to allow the range of motion of the affected joint to be maintained [2]. Our study presents an effectiveness analysis of the DYNASTAB S fixator (for ankle joint stabilization) in the treatment of complicated fractures of the distal epiphysis and metaphysis of the tibia. There is no possibility to compare this unique method with other ways of treatment of distal tibia fractures.

In current and past medical literature no information whatsoever was found on presented concept of treatment of pillon fractures which would be similar to treatment with Dynastab S external fixator. Our results emphasize the role of external fixation and functional movement in the treatment of „pylon fractures". In conclusion it is recommended to do further work to examine DYNASTAB S fixator in the treatment of this kind of fracture.

CONCLUSIONS

1. The Dynastab S external fixator – a modern external fixator designed for the treatment of complicated fractures in the region of ankle joint, especially in articular fractures -was very successful in the treatment of fractures that would have had a poor prognosis under traditional modes of conservative and surgical treatment.
2. The use of a mechanical joint imitating the movement of the injured ankle joint in the Dynastab S fixator, with the range of motion controlled in 15-degree increments, allows for early joint rehabilitation without loss of stability of the fracture.
3. Our observations of patients with high energy fractures of the distal tibia indicate that the external fixation technique using Dynastab S after joint surface reconstruction allows for bone union, good function and efficiency of the superior ankle joint.
4. The small size, rigidness, endurance, and considerable compensatory possibilities of the fixator described here make adaptation of the device to the operated limb excellent; reduction of the fracture is easy, stability of the fragments is good, and there is easy access to co-existing wounds.
5. In the future, the Dynastab S external fixator should find wider use in the treatment of pylon fractures.

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