# The Use Of Dispofix External Fixator In Open Tibia Fractures

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**Abstract**

A non experimental, observational-analytical, retrospective and transversal study was conducted. The sample was formed with 67 patients treated with the DISPOFIX external fixator, in the Orthopedic Service, at Vryheid Hospital, Kwazulu Natal, since January, 1st, 1998 until December, 31st, 2007, with a diagnosis of open tibia fracture. The following patients didn't qualify for the study: Patients with follow-up less than 12 weeks after the fracture consolidation, patients with incomplete medical records and those who didn't complete treatment in Vryheid Hospital. The fractures were classified according to the model of Gustilo and Schmidt's stability criteria. The variables: age, affected limb, production's mechanism, level of fracture, fracture consolidation's time and complications were collected from the clinical files. The Vryheid Hospital management approved the realization of this study on January, 29th, 2007.

## INTRODUCTION

The tibia is one of the long bones of the skeleton, located in the low extremities; it is destined to support weight and plays an important role in the act of standing and walking. With poor coverage of soft parts, it is subcutaneous in the anterior-medial area ([1,2,3]) . It provided with precarious irrigation if it's compared with other long bones which are surrounded by powerful muscles ([4,5]) .

In open fractures, the injury that takes place in the skin and in the underlying tissues, allow communication between the external way and the focus of fracture ([1,6,7,8]) .

Open tibial fractures are generally produced by trauma of high energy, and the integral evaluation of the patient is of vital importance, the limb being only one part of the problem ([9]) .

The aim of the treatment include a suitable union, correct aliment, restoration of the mechanism of the knee and the ankle joints, as well as to achieve the normal activity of the patient, as soon as possible ([10]) .

External fixation is indicated in all open fractures, where the soft tissues are compromised and it's necessary to stabilize the fracture as soon as possible ([6]) .

External fixation is presently, the best method to stabilize an open fracture, since it doesn't include osteo-synthesis material in the focus fracture and it allows for easy access to the soft tissues and mobility of the nearby joints ([7]) .

Nevertheless, external fixation presents problems, as loosening and infection of the pins, and high valuations of vicious consolidation (which can come up to 20%) will sometimes need a bone graft to obtain the consolidation ([11]) .

It's possible to increase the rigidity of the external fixator when ([12]) :

- The diameter and the number of pins for bony segment are increased.
- The distance between the pins near to the fracture is shortened.
- Add a second longitudinal bar, to the same pins.
- Shorten the distance between the bar and the bone.
- Apply pins in different planes, with the bar, in the plane of major force to increase the rigidity.

The system of Checketts-Otterburn ([13]) is used to classify the grade of infection under the trajectory of the pins and is

followed up in every case as well. The grades from 1 to 3 are considered mild infections and grades from 4 to 6 will be considered severe infections.

As system of fixation, DISPHOFIX external fixator was used; it was applied without considering the complexity of the lesion.

Management of open tibia fractures portends a great challenge to the orthopaedic surgeons and this often varies with the etiology and mode of presentation.

## PATIENTS AND METHODS

Vryheid District Hospital is located in the Abaqulusi sub-district, a district of Zululand (DC26), in the province of Kwazulu Natal, South Africa. It offers care to a population mainly rural, and mostly of black race. This area is considered to be one of the regions with more disadvantages, both economic and social, in South Africa. In the sub district there are 14 primary health care clinics and 3 mobile clinics, which send its cases to this hospital.

To do this study, the admitted patients with the diagnosis of open tibia fracture were examined, and the relevant information of these patients were taken from patient's hospital files, in order to reach the proposed targets.

## TYPE OF STUDY

Non experimental, observational - analytical, retrospective and transverse study was done.

## UNIVERSE

Consisted of 164 patients who attending the Orthopedic Service at Vryheid Hospital, Kwazulu Natal Province, in the period from January, 1 $^{st}$ , 1998 until December, 31 $^{st}$ , 2007 with the diagnosis of open tibia fracture.

## SAMPLE

Consisted of, 67 patients who attended the Orthopedic Service at Vryheid Hospital, Kwazulu Natal Province, in the period from January, 1 $^{st}$ , 1998 until December, 31 $^{st}$ , 2007 with the diagnosis of open tibia fracture, treated with a DISPOFIX external fixator.

## CRITERIA FOR EXCLUSION

- Patients with follow up, less than12 weeks, after the consolidation.
- Patients with deficient information in the medical records.
- Patients attending before January, 1 st , 1998 or after December, 31 st , 2007.A
- Patients who did not complete the treatment in Vryheid Hospital.

## STUDY VARIABLES

The clinical information was gathered, from patient's hospital files which was included in the study, and filed in the Department of Admission in Vryheid hospital. 10 parameters were analyzed.

### 1. SEX:

- Female.
- Male.

### 2. GROUP OF AGES:

- Up to 15 years.
- From 16 to 30 years.
- From 31 to 45 years.
- From 46 to 60 years.
- 61 or more years.

### 3. BROKEN TIBIA:

- Right.
- Left.

### 4. ETIOLOGY

- Sports accidents.
- Traffic accidents.
- Falls.
- Gun shot.
- Direct trauma.

### 5. TYPE OF FRACTURE, ACCORDING TO THE CLASSIFICATION OF GUSTILO.

Classification of Gustilo ($_{6,14}$) :

Type I: The wound is clean and is smaller than 1 cm.

Type II: The wound is longer than 1 cm and does not have

extensive soft tissue damage.

Type III A: This fracture type is a wound associated with extensive soft tissue damage usually larger than 10 cm with periosteal coverage. (Periosteum is the outermost layer of bone. It has a rich vascular supply and is important in bone growth and repair.) This fracture type also includes less traumatic fractures with increased chances of complications, such as gunshot wounds, farmyard injuries, and fractures requiring vascular repair.

Type III B: This type is defined as bone with periosteal stripping that must be covered; these fractures nearly always require flap coverage.

Type III C: This type of injury requires vascular repair.

The following variants of Type III are included as special categories:

- Open fractures that happened in agricultural or rural areas.
- Those fractures happened in rivers or lakes with waters sewers.
- All the fractures produced by the bullet of a firearm.
- Those fractures produced by traumatism of high energy.
- All open fractures that happened in war or natural disasters.

## 6. STABILITY OF THE FRACTURE, ACCORDING TO THE CRITERIA OF STABILITY PROPOSED BY SCHMIDT ()

The fractures are considered to be stable where we find:

- Frontal angulation < 5 degrees.
- Sagittal angulation < 10 degrees.
- Rotation < 5 degrees.
- Shortening < 1 cm.

The fractures are unstable, where we find:

- Frontal angulation > 5 degrees.
- Sagittal angulation > 10 degrees.
- Rotation > 5 degrees.
- Shortening > 1 cm.

The fracture is unstable, when any of the instability criteria exists.

## 7. LEVEL OF THE FRACTURE:

a. Segmental (More than one focus of fracture).

b. Distal third.

c. Middle third.

d. Proximal third.

## 8. IMMEDIATE COMPLICATIONS:

- Infections.
- Injury of peripheral nerves.
- Vascular injuries.
- Traumatic shock.
- Compartment syndrome.

## 9. LATE COMPLICATIONS:

- Shortening of the leg.
- Affected the functionality of the limb.
- Sudeck bone atrophy.
- Infections: The system of Checketts-Otterburn (13) was used, to classify and follow up an infection under the trajectory of the pins of the external fixator.

## CHECKETTS-OTTERBURN CLASSIFICATION:

**Figure 1**

| GRADE | Appearance | Treatment |
|---|---|---|
| 1 | Slight redness, little discharge. | Improved pin site care. |
| 2 | Redness of skin, discharge, pain, and tenderness in the soft tissues. | Improved pin site care, oral antibiotics. |
| 3 | Redness of skin, discharge, pain, and tenderness in the soft tissues, not improved with antibiotics. | Affected pin or pins resided and external fixation can be continued. |
| 4 | Severe soft tissue infection involving several pins, sometimes with associated loosening of the pin. | External fixation must be abandoned. |
| 5 | Severe soft tissue infection involving several pins, sometimes with associated loosening of the pin but also involvement of the bone; also visible on radiographs. | External fixation must be abandoned. |
| 6 | This infection occurs after fixator removal. The pin track heals initially but will break down and discharge in intervals. Radiograph shows new bone formation and sometimes sequestra. | Curettage of the pin track. |

- Delay of consolidation.
- Non union.

### 10. TIME OF CONSOLIDATION OF THE FRACTURES:

- Up to 16 weeks.
- From 17 until 20 weeks.
- From 21 until 24 weeks.

### 5.5. TO EVALUATE THE FINAL OUTCOME OF OUR PATIENTS, THE FOLLOWING CLASSIFICATION WAS USED:

### GOOD:

- Time of consolidation up to: 16 weeks.
- No complications.
- No disorders of the joint mobility.

These three requisites must be fulfilled, to be included in the category of good result.

### FAIR:

- Time of consolidation between: 17 to 20 weeks.
- There were complications that were solved.
- Disorder of the joint movement: no involvement in walking.

When at least one of the previous requisites is presented the patient is included, in this category.

### BAD:

- Time of consolidation from: 21 until 24 weeks.
- Presence of complications: not be solved.
- Disorder of the joint movement: affection of gait.

When at least one of the previous requisites is presented the patient is included, in this category.

### 5.6. PROCEDURES

All the procedures were performed following the protocols established in Vryheid Hospital.

### DISPHOFIX TECHNIQUE

- Reduce the fracture.
- First pin is inserted into the largest bone fragment.
- Main rod is attached and tightened to the pin with a clamp.
- Required number of clamps mounted on the main rod.
- After exact reduction of the fracture the second pin is inserted and tightened with the clamp, at the most distant point possible from the first pin.
- The remaining pins are inserted, as close as possible, to the focus fracture and tightened to the main rod with clamps.
- Check the final fracture position and tighten all nuts with a hexagonal wrench.
- The main rod can be cut to length, if required.

### 5.7. COMPILATION AND PROCESSING OF THE INFORMATION:

This was processed according to the statistical information obtained with the program of Microsoft Excel 2003. The statistical analysis rested on skills of descriptive simple statistics. The frequencies observed for the variables were expressed in percent. For the evaluation of the relationship between qualitative variables, the test of Chi-square is used. The resultant differences associated to minor probability of 0.05, were considered to be statistically significant. The

evaluation of probability of related factors, with specific values of the variables, was based on the calculation of Odds Ratio (OR), from stage of risk.

The graphs were prepared with the Software Microsoft Office Excel 2003. With the obtained information, we develop and discussed our study, arriving at an important group of results, which allowed us to make conclusions.

## 5.8. ETHICAL ASPECTS

The management of Vryheid Hospital approved this study on January, 29 th , 2007.

The model of informed consent current assent in the Kwazulu Natal Health System was completed by the studied patients.

## RESULTS AND DISCUSSION

Álvarez López ([1]) , Sertorio Greco ([16]) and Faraj ([17]) used external fixation to treat some of their patients.

Checketts ([12]) used external fixation, as the fundamental technique to treat tibia diaphysis fractures.

Álvarez López ([1]) and Gautier ([18]) believe that the fixation with AO plates and screws should only be carried out when an appropriate fixation with other surgical methods can't be achieved.

Other authors ([11,19,20,21,22,23,24,25]) says that the intramedullary fixation has better results as a treatment for an open tibia fracture. Although, it remains debatable if is better to ream or not to ream the intramedullary canal ([19,20,21,26]) .

However Court-Brown ([8]) found a higher incidence of infection and pseudoarthrosis in fractures of Type III B, where an intramedullary nail was used and the canal reamed.

### Figure 2

Chart 1: Classification of patient according to their sex Hospital Vryheid 1998 – 2007

| Sex | # of cases | % |
|---|---|---|
| Male | 49 | 73.1 |
| Female | 18 | 26.9 |
| Total | 67 | 100 |

Open tibial fractures were more frequent in male patients with 49 cases (73.1%), in relationship to female patients (Chart 1).

Álvarez López ([1]) found similar results, in his study of 48 patients with open tibia fracture.

The male sex is more active than the female one, thus increasing the risk of open tibia fracture in males.

### Figure 3

Chart 2: Classification of patient according to their age Hospital Vryheid 1998 – 2007

| Age(Years) | # of cases | % |
|---|---|---|
| Up to 15 | 7 | 10.4 |
| 16 to 30 | 24 | 35.8 |
| 31 to 45 | 17 | 25.4 |
| 46 to 60 | 11 | 16.4 |
| 61 and more | 8 | 12 |
| Total | 67 | 100 |

Ages between 16 and 30 years was the most affected, with 24 cases (35.8%), followed by the group from 31 to 45 years, with 17 patients (25.4%). The rank of this series was 70 (Chart 2).

Other authors ([1102728]) have reported important statistics, where the patients with ages between 15 and 45 years are those most affected ones. This author found similar result.

These injuries are more frequent in these age groups because they are active people, generally subjected to dangerous labor activities, or they are transported with high risk of traffic accidents, when they travel to their work or study place.

### Figure 4

Chart 3: Classification of patient according to the mechanism that caused the fracture Hospital Vryheid 1998 – 2007

| Production mechanism | # of cases | % |
|---|---|---|
| Traffic accidents | 31 | 46.3 |
| Firearm projectile | 15 | 22.4 |
| Direct trauma | 12 | 18 |
| Falls | 7 | 10.4 |
| Sport's accident | 2 | 2.9 |
| Total | 67 | 100 |

Traffic accidents, with 31 cases (46.3%), followed by firearm bullets, with 15 cases (22.4%), were the biggest cause of open tibia fractures. Other causes in order of frequency were direct traumas with 12 cases (18%), falls with 7 cases (10.4%) and sport accidents with 2 cases (2.9%) (Chart 3).

Álvarez López ([1]) (59%), Blanco ([11]) (43%), Ceballos ([28]) (61%), Park ([29]) (24.8%) and Stewart ([30]) (91.8%) agree with this author's results, because they mention traffic accidents, as the first cause of open tibia fractures.

The average of traffic accidents in South Africa is one of the biggest in the world ([31,32]) .

On the other hand the social violence existing in South

Africa justifies the high percentage of open fractures, by firearm bullets.

**Figure 5**

Chart 4: Classification of patients according to the fractured tibia Hospital Vryheid 1998-2007

| Extremity | # of cases | % |
|---|---|---|
| Left | 43 | 64.2 |
| Right | 24 | 35.8 |
| Total | 67 | 100 |

The left tibia was more affected with 43 cases (64.2%) and the right tibia was broken in 24 cases (35.8%) (Chart 4).

According to this author's opinion, these results are random, and there is no reference to this aspect found in the revised bibliography.

**Figure 6**

Chart 5: Classification of patient according to the anatomical level of the fracture Hospital Vryheid 1998 – 2007

| Anatomical level of the fracture | # of cases | % |
|---|---|---|
| Middle third | 43 | 64.2 |
| Distal third | 11 | 16.4 |
| Proximal third | 9 | 13.4 |
| Complex | 4 | 6 |
| Total | 67 | 100 |

The middle third of the tibia was more affected with 43 fractures (64.2%), not a marked difference among the distal third with 11 cases (16.4%) and the proximal third with 9 patients (13.4%), only 4 cases (6%) had complex fractures (Chart5).

Álvarez López [1] , Sertório Greco [16] , Gaebler [23] , Joshi [24] , Park [29] and Stewart [30] found an increased incidence of open fractures, in the middle third of the tibia, this author found similar result.

Open fractures in the middle third of the tibia, are more frequent because of the anatomical characteristics of the tibia [1,2,3] .

**Figure 7**

Chart 6: Classification of patient according to Gustilo's pattern for open fractures Hospital Vryheid 1998 – 2007

| Gustilo's classification | # of cases | % |
|---|---|---|
| Type I | 13 | 19.4 |
| Type II | 31 | 46.3 |
| Type III - A | 9 | 13.4 |
| Type III - B | 11 | 16.4 |
| Type III - C | 3 | 4.5 |
| Total | 67 | 100 |

Open fractures were classified according to the proposal of Gustilo [2,20] , 13 fractures (19.4%) classified as Type I, 31cases (46.3%) classified as Type II, 23cases (34.3%) included in Type III. That has three subtypes: III A 9 cases (13.4%), III B 11 cases (16.4%) and III C 3 cases (4.5%) (Chart 6).

Authors like Álvarez López [1] , Blanco [11] and Beltrán Ortiz [25] found larger numbers of patients affected with open tibia fracture Type II, according to Gustilo's classification. Similar results were found by this author.

However Ceballos [28] found more patients with open fractures Type III in his report.

This classification described by Gustilo is extremely useful to define the treatment and the possible clinical evolution.

**Figure 8**

Chart 7: Interrelation among the classification of Gustilo for the open fractures and the radiological approaches of stability of Schmidt Hospital Vryheid 1998 – 2007

| Gustilo's classification | Stable fracture | Unstable fracture | Total |
|---|---|---|---|
| Type I | 10 | 3 | 13 |
| Type II-III | 6 | 48 | 54 |
| Total | 16 | 51 | 67 |

Chi Square=24.96 Chi>7.86 p <0.001 (Highly significant) GL=1

Value of OR=26.67 Risk factor >1

From 13 cases classified as open fractures open Type I, 10 fractures were stable according to the approach of Schmidt and 3 fractures unstable, while in 54 fractures Type II and III, 6 fractures were stable and 48 fractures were unstable (Chart 7).

The previously mentioned values indicate that a marked relationship exists among the degree of the open fracture according to the classification of Gustilo, and the radiological approach of stability described by Schmidt.

We don't find, in the revised literature, any study that makes reference to this relationship.

**Figure 9**

Chart 8: Classification of patient according to the immediate complications found in the open tibia fractures Hospital Vryheid 1998 – 2007

| Immediate complications | # of cases | % |
|---|---|---|
| Traumatic Shock | 6 | 9.5 |
| Infection | 5 | 7.5 |
| Vascular injury | 3 | 4.5 |
| Total | 14 | 21.5 |

The immediate complication most frequent in our study was traumatic shock, diagnosed in 6 patients (9.5%). Also reported was infection in 5 cases (7.5%) and vascular injury

in 3 patients (4.5%) (Chart 8).

Infection is the most frequent complication in open tibial fractures. Many revised authors agree with that ([1,23,24,25,27,33,34]) ; although according to Gaebler ([23]) and Milner ([34]) the acute infection that arise after an open tibia fracture, have a good response to aggressive surgical treatment. This author agrees with the approach discussed in this paragraph.

Other authors didn't report the presence of traumatic shock in their patients, after an open tibia fracture. This author consider that this immediate complication found in this study, is due to local conditions in the region, where a patient must be transferred from distant rural areas on bad roads, to the place where they are going to be assisted, missing in occasions the golden hour for the trauma patient.

**Figure 10**

Chart 9: Classification of patient according to the late complications found in the open tibia fractures Hospital Vryheid 1998 – 2007

| Late complications | # of cases | % |
|---|---|---|
| Infection | 7 | 10.4 |
| Late consolidation | 3 | 4.5 |
| Shortening | 2 | 2.9 |
| Joint function affected | 2 | 2.9 |
| Total | 14 | 20.7 |

The infection in the wires of the external fixator was the most frequent late complication, where 7 cases (10.4%) were registered, followed by late consolidation in 3 fractures (4.5%). Shortening of the fractured leg was also found in 2 patients (2.9%) and the joint function was affected in 2 cases (2.9%) (Chart 9).

In this study, no patient died, as a consequence or of derived complications from an open tibia fracture.

For Álvarez López ([1]) , Blanco ([11]) and Patel ([35]) infection in the wires, late consolidation and pseudarthrosis are the most common late complications in open tibia fractures.

Sertorio Greco ([16]) found 10% infection of open fractures in his study. Similar results were found by this author.

Other authors ([27,36,37]) described the affection of joint motion as another late complication.

Late infections in the wires of the external fixator can be reduced substantially; intensifying the local care, of asepsis and antisepsis.

Complications depend in great measure on the ability and knowledge of the orthopedic in charge of the case and on the patient's intrinsic factors.

In South Africa where the pandemic of AIDS affects the poorest populations with little resources, it is at great importance to actively treat the patient from the start in order to avoid sepsis in a patient with an open tibia fracture.

Movement of the joints can be preserved with early physiotherapy.

**Figure 11**

Chart 10: Classification of patient according to time for fracture consolidation Hospital Vryheid 1998 – 2007

| Time of consolidation(Weeks) | # of cases | % |
|---|---|---|
| Up to 16 | 60 | 89.5 |
| 17 to 20 | 4 | 6 |
| 21 to 24 | 3 | 4.5 |
| Total | 67 | 100 |

In 60 patients (89.5%), the consolidation of the fracture was achieved in a period of up to 16 weeks, in 4 cases (6%) the fracture consolidated between 17 and 20 weeks and in only 3 patients (4.5%) the fractures were consolidated between 21 and 24 weeks (Chart 10).

Shaw ([38]) in his study of 44 tibia fractures, in all open fractures Type I and II treated with external fixation consolidation were achieved. This author found similar result.

However, Keating ([39]) in his study of 100 tibia fractures, 53 open and 47 closed, obtained 95% consolidation using the external fixator ORTHOFIX.

This author considers that the dynamization of the external fixator plays an important roll in the consolidation process. In our study the external fixator was dynamized between 4 and 6 weeks after being placed.

Some objectives factors have influenced the consolidation process:

- Fracture type according to the classification of Gustilo.
- The patient's age.
- Anatomical place where the fracture is located.
- Early infections.
- Patient's health.

Subjective factors are influencing the consolidation process;

the most important is the patient's cooperation during the treatment, following doctor's orders.

**Figure 12**

Chart 11: Classification of patients according to the results Hospital Vryheid 1998 – 2007

| Results | # of cases | % |
|---|---|---|
| Good | 56 | 83.6 |
| Fair | 7 | 10.4 |
| Bad | 4 | 6 |
| Total | 67 | 100 |

The system designed to evaluate the final results of this study, was based on three aspects (page 6):

- Time of fracture consolidation.
- Complications.
- Function of the injured limb.

Sidharthan ($_{40}$) used the approaches of Johner and Wruhs, to evaluate the final results, after a fracture in a tibia diaphysis.

We didn't find in the revised literature a system to evaluate the final results of the patients with an open tibia fracture.

## CONCLUSIONS

Open tibia fractures in South Africa are more often caused, by traffic accidents and gun shot bullets.

Reduction and external fixation with DISPOFIX is the suitable treatment, for an open unstable tibia fracture Type I or II and in a fracture Type III independently of the stability.

Infection and late consolidation are the most frequents complications in an open tibia fracture.

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