Aus der Unfallchirurgischen Klinik der Medizinischen Hochschule Hannover:

“Monorail technique or external fixators for segmental bone defects of the lower limb? Long term follow-up of 50 cases.”

Dissertation zur Erlangung des Doktorgrades der Medizin in der Medizinischen Hochschule Hannover.
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                            Prof. Dr. Michael Winkler
Dedicated to:

my sister, who just graduated from the medical school.
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1. Declaration

The following manuscript, which includes data from this dissertation is sent to the Journal of “Injury” and is at the moment under review.

- Liodakis E, Krettek C, Kenawey M, Wiebking U, Hankemeier S:
  Comparison of 39 posttraumatic tibia bone transports performed with and without the use of an intramedullary rod. The long term outcomes.

There was no financial support for this study. The author and his supervisor have not received or will receive benefits for professional or personal use from a commercial party related directly or indirectly to the subject of this article. This dissertation has lasted 3 years (2006-2009).


2. Dissertation

2.1 Introduction

Management of long bone defects in the lower extremity has always been challenging for the orthopaedic surgeon. Most often segmental bone defects are reconstructed by transplantation of vascularized or non-vascularized autogeneous bone, allograft bone transplantation, or segment transport [1].

Advantages of free vascularised bone grafts include the ability to treat concomitant soft tissue defects by osteocutaneous flaps and better resistance to infections [2, 3]. However, problems with vascularised bone grafts include donor site morbidity [4], possibility of necrosis due to anastomotic complications [5], long remodelling time and high fracture rate [6]. The advantages of bone transport include minimal soft tissue trauma, treatment of large bone defects with regenerate of the same diameter and elimination of donor site morbidity. On the other hand, bone transport using external fixators alone, as first introduced by Ilizarov, requires long-term treatment with external fixators [7]. Complications are very common, including pin tract infections, joint stiffness, malalignment and refractures. The treatment of choice depends on many factors such as vascularity, location, size and aetiology of the defect. Further factors that should be taken into consideration include include the patient’s age, co-morbidities, immunosupression, smoking and general health.
In 1992, Raschke et al. [8,9] described a technique of segmental transport over an intramedullary nail to provide a more comfortable bone transport process, to shorten the external fixation period, and to provide internal support for the regenerated bone. This technique is gaining wider acceptance because of the improvement in patient comfort. Two important drawbacks of this procedure are the inability to correct associated complex deformities and the risk of introducing infections especially from pin tracts into the medullary cavity.

To the best of our knowledge, there are no large studies comparing the two methods including long term follow-up results. Therefore, we compared a group of patients who had segmental bone transport using the monorail technique with another group of patients with segmental bone transport using an external fixator alone. We evaluated the complications associated with each method including the long term follow-up results.
2.2 Historical review of the bone segment transport

The method of segment transport, which involves the transport of a bone fragment across an intercalary bone defect with new-bone formation at the trailing end (Figure 1), was introduced in 1951 from Professor Gavril Ilizarov and has become until today the standard treatment of large bone defects [10,11,12].

Prof. Ilizarov practiced in an isolated area of the world (Kurgan, Siberia) as a general practitioner. After World War II chronic osteomyelitis associated with loss of bone, non-unions, and skeletal deformities were so common that Ilizarov found himself practicing orthopaedics although he had had no formal training in that specialty [10]. With the use of modular-ring external fixators and transosseous wires attached to the rings under tension to stabilize the bone fragments, he introduced the concept of induction of local bone formation with a minimally invasive procedure (distraction osteogenesis). He did not have access to the many technological and medical advances that took place during that period. As a result, he relied on distraction osteogenesis to treat a variety of musculoskeletal conditions. The reconstruction of bones affected by post-traumatic conditions, such as intercalary defects and deformity, was the broadest application of his method [10,11]. The method of bone transport was used to salvage many limbs that otherwise would have been amputated because of extensive segmental bone
Ilizarov later tried to use a modification of this method for limb lengthening. Since then more than 2000 studies have been published and various modifications of the Ilizarov apparatus have been developed. Nowadays, bone transport can be performed with various types of ringed and unilateral fixators, which provide equal bone formation [9].

Figure 1. Tibial bone loss treated with bone transport. This technique relies on the body to heal a corticotomy site while the bone is slowly shifted (transported) through the limb to fill a gap.
Michael J. Raschke [8,9] developed in 1992 in Munich, Germany the monorail segmental transport system in order to eliminate fixator associated complications and accelerate return to normal daily activities. This system is composed of an unreamed intramedullary nail and a unilateral distraction device (Figure 2). The external fixator can be removed at the end of the transport. No external fixator is required for the consolidation period. This procedure is gaining wider acceptance especially in the treatment of femoral bone defects, where a bulky external fixator is not tolerated. Paley et al [13] have used this system for femoral limb lengthening and compared the outcome of these patients with patients who had lengthening using the Ilizarov device. They concluded that the intramedullary nail protected against refractures.

Figure 2. Schematic representation of the Monorail System.
Baumgart et al [14] used in 1997 in Munich, Germany a fully implantable distraction nail in the treatment of large bone defects. This nail contains a fully programmable sliding mechanism for limb lengthening and bone transport. No external fixators are required for this procedure (Figure 3). This device is however not widely accepted, because of the technical problems associated to the motor of the distraction nail. A further drawback of this procedure present the costs of the motorized nail that cannot be afforded from the most institutes.

Figure 3. Bone transport with the use of a fully implantable motorized distraction nail.
2.3 Patients and Methods

We retrospectively analyzed the charts and radiographs of 49 patients (48 adults and one child (Table 1, case 3) who underwent segmental bone transport in the lower extremity between 1992 and 2007 in our institution. The patients were divided into two groups. The first group (n=26) had segmental bone transport using only an external fixator (ring or unilateral) and the second (n=24) was treated with the monorail technique. Criteria for inclusion included all patients with a complete segmental bone defect of the femur or tibia larger than 3 cm and minimum follow-up of two years. One patient (Table 1, case 1; Table 2, case 1) with chronic osteomyelitis was initially treated with the monorail technique and after recurrent infection with the Ilizarov device. This patient was included in both groups. The medical records were reviewed to determine the patient’s gender, age, location and size of the defect, the presence of chronic infection defined by positive cultures for more than two months preoperatively, the number of previous surgeries, smoking habits and complications such as deformities, persistent infections, amputations and bone regeneration insufficiency. Deformities were defined as pathological angulation of 5° and more according to the classification of Paley et al [15].

Aetiology of the defects were posttraumatic (n= 46), bone tumors (n=2) or complete failures of regenerate following intramedullary lengthening (n=2, figure 4).
All patients received a questionnaire including the SF-36 Health Survey questionnaire (page 33) with the following questions in addition: (1) Are you satisfied with the procedure or would you prefer a primary amputation? (2) Have you returned to your original profession or have you changed profession? (3) Have you resumed sport activities? (4) Are you smoking? Two patients were lost from follow-up.

The mean age of the patients in the fixator group was 47.6±17.0 years and 43.0±14.2 years (p=0.293) in the monorail group. Thirty three percent of the monorail and 32% of the fixator patients were females (p=0.774). The defect length measured 8.0±2.9cm in the fixator group and 7.7±3.3cm (p=0.452) in the monorail group. Femoral defects were more commonly managed using the monorail technique (n=9) in comparison to the external fixator group (n=2) (p=0.022). Twenty percent of the monorail and 24% of the external fixator patients were smokers. The average clinical and radiological follow-up was 7.9±5.6 years.

Seventeen patients (65.4%) in the external fixator group and 10 (41.7%) in the monorail group had chronic osteitis prior to segment transport (p=0.032). History of open fractures was present in 64% and 50% of the external fixator and monorail patients respectively. In the fixator group, more operative procedures had been performed prior to the segment transport compared to the monorail group (external fixator group: 6.0±2.6, monorail group: 3.2±2.9, p<0.0001).
Patients and Methods

Statistical analysis

Descriptive analysis was performed and represented as means, ranges and standard deviations for continuous response variables and as percentages for discrete variables. Comparison between the two groups was analyzed with the Mann-Whiney U test and by the Chi square test. The SPSS (SPSS 15.0, SPSS Inc., Chicago, IL, USA) software package was used to perform statistical analysis. \( P < 0.05 \) was considered to be statistically significant.

Figure 4A. Callus regeneration insufficiency after intramedullary nail lengthening.
Figure 4B. Anteroposterior and lateral radiographs after retrograde segmental transport and docking operation.
### "External fixator Group"

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<th>Sex</th>
<th>Age (years)</th>
<th>Femur/ Tibia</th>
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<th>L: left</th>
<th>Defect length (cm)</th>
<th>Chron osteitis (&gt;2Months)</th>
<th>Open fracture</th>
<th>Nicotine abuse</th>
<th>No of operations before transport</th>
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Table 1. Preoperative data of the fixator group
### Patients and Methods

#### "Monorail Group"

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<td>23.</td>
<td>Male</td>
<td>50</td>
<td>Tibia</td>
<td>L</td>
<td>8</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>24.</td>
<td>Male</td>
<td>28</td>
<td>Femur</td>
<td>R</td>
<td>5</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>1</td>
</tr>
</tbody>
</table>

Table 2. Preoperative data of the monorail group
2.4 Results

The external fixator has been applied for 15.9±6.1 in the external fixator group and for 5.9±1.5 months in the monorail group respectively (p<0.0001).

The mean number of additional surgical procedures was 3.1 per patient (range, 0-11) in the external fixator group and 3.0 (range, 0-14) in the monorail group. Surgical procedures after bone transport included the following: bone grafting (n=22), plating of the docking site (n=18), corrective osteotomies (n=5), hardware removal (n=27), transtibial amputations (n=3), transfemoral amputations (n=2), talotibial fusion (n=6), debridements (n=46), arthrolysis of knee or hip joint (n=9), hip or knee endoprosthesis (n=3), skin grafting or myocutaneous flap (n=2), ORIF of refractures (n=2), placement of new pins (n=6) and partial diaphyseal tibial replacement (n=1). A docking operation was performed in 11 patients in the external fixator group and in 7 patients in the monorail group (p=0.239). Five patients had debridement for pin tract infections in the fixator group and two in of the monorail group (p=0.082).

The treatment was successful in 23 patients (88.5%) in the fixator group and 21 patients (91.3%) in the monorail group (p=0.384). The rate of deformities (>5°) was significantly higher in the fixator group (32% vs 4%, p<0.0001). Ten monorail and 12 external fixator patients developed nonunions (p= 0.569, Figure 5).
Five patients had amputations due to persistent bone infections (3 in the monorail group, 1 patient in the external fixator group and one patient who had firstly monorail and then Ilizarov bone transport, \( p = 0.088 \)), 3 of them were smokers.

Complete insufficiency of the bone regenerate was observed in one patient (case 15, table 2) in the monorail group and was treated with a partial diaphyseal tibial replacement.

The results of the SF-36 Health Survey (Figure 6) showed the following mean scores for the external fixator group / monorail group respectively: 66.6/55.6 \( (p = 0.084) \) for Physical Functioning, 41.7/48.9 \( (p = 0.496) \) for Physical Role Functioning, 64.2/60.4 \( (p = 0.687) \) for Bodily Pain, 66.4/58.8 \( (p = 0.588) \) for General Health, 59.4/53.3 \( (p = 0.857) \) for Vitality, 73.5/67.7 \( (p = 0.879) \) for social Functioning, 77.6/78.5 \( (p = 0.361) \) for Role-Emotional, and 74.4/69.2 \( (p = 0.916) \) for Mental Health. There was no statistically significant difference between both study groups in all categories of the SF-36.

Fifteen patients (58%) of the external fixator group returned to work. Eight of them (31%) returned to their original employment and 7 of them (27%) returned to a physically less demanding profession. Three patients (11%) were not working before and after the surgery and 8 could not work after surgery (Figure 7). Seven patients had a physically very demanding profession e.g. fireman or farmer. One of them returned to his original employment, 4 returned to a less demanding job, whereas 2 could not work after surgery.
Fifteen patients in the monorail group (63%) returned to work including 10 patients (42%) returning to their original employment and 5 (21%) returning to a physically less demanding job. Two patients (9%) were not working pre- and postoperatively (Figure 8). Seven patients had a physically demanding profession and 3 of them could not work postoperatively. Two returned to their original profession and 2 changed their job to a less demanding. The child (case 3, external fixator group) missed school for 10 weeks and returned to full time education without repeating a school year.

We have classified the sporting activities of our patients into three categories: major (e.g. football, basketball, tennis), minor (cycling, jogging, swimming) and none. Thirteen patients (50%) in the external fixator group and 10 patients (41.7%) in the monorail group resumed sporting activities (p=0.858). Of these only two monorail patients were practicing major sport activities.

All patients found the appearance of their limb acceptable. 92.3% of the external fixator and 91.7% of the monorail patients would undergo this reconstructive procedure again.
Results

Figure 5. Rates of complications in both groups.

Figure 6. Results of the SF-36 Health Survey score.
2.5 Discussion

Main advantages of the monorail method for the treatment of segmental bone defects in this study were the significant reduction of time for external fixation and the significant lower rate of deformities. Patients with external fixators only had the same healing rate and the same quality of life scores compared to patients treated with the monorail technique.

The significant reduction of deformities in the monorail group can be explained by the statically locked intramedullary nail, which maintains anatomic length and alignment during segment transport and consolidation [9].

The number of operations of the docking site was 11 in the external fixator group and 7 in the monorail group (Figure 5). In case of delayed union at the docking site removal of locking bolts or dynamisation of the external fixator was done. If insufficient healing was observed, debridement and plate osteosynthesis was indicated [16].

The number of patients with preoperative chronic infections had been significantly higher in the external fixator group (Figure 9). Two amputations were performed in 17 patients with chronic osteomyelitis (11.8%) in the external fixator group and 4 amputations out of 10 patients with osteomyelitis (40.0%) in the monorail group. The authors believe that the risk of expanding
Discussion

an infection into the medullary cavity increases with the insertion of the intramedullary nail. Furthermore, pin tract infections may spread easier along intramedullary implants [15]. The authors conclude that patients with preoperative chronic infections should be treated via external fixators only.

The rate of insufficient bone regeneration was not significantly different after segment transport with external fixators or the monorail method. This contradicts the hypothesis that consolidation of the newly regenerated bone is reduced by damage to the endosteal blood supply by nailing. Paley et al. found similar results with comparing patients who underwent lengthening using either external fixators alone or with an intramedullary nail. They suggested that the effect of revascularization after reaming and better stability provided by the intramedullary nail with earlier functional loading compensated for any damage to the medullary vascularisation [13]. Paley et al. also believe that persistent infection can be a major risk factor for bone regenerate insufficiency and should always be suspected when the cause cannot be explained by other means. The other 3 risk factors are the instability of fixator which causes heterogeneous regenerate, the high distraction rate and the nicotine abuse.

The high rate of unemployment (40%) after bone transport with both methods is ought to the severe trauma and not the procedure itself. Gopal et al. studied the outcome of patients with open tibial fractures (Gustilo grade IIIb or IIIc) and found that only 40% of them returned to work [17].
Associated injuries affect the final functional outcome and can alter the results of the SF-36 Health Survey. Case 8, table 2 with transtibial amputation, had a physical functioning score of 70; whereas case 12, table 1, with a contralateral pilon fracture, had a physical functioning score of 50 despite good healing and alignment of the extremity treated with bone transport. Most of the physical disability of case 12 was caused by the posttraumatic ankle osteoarthritis and not the extremity with the bone transport, which has been without significant symptoms. However, this observation could not reach statistical significance, probably due to a type II error on small numbers. The SF-36 scores for each of the eight components of both groups were not significantly lower than the population norm. The norms of the general population are the following: 84.52 for Physical Functioning, 81.20 for Physical Role Functioning, 75.49 for Bodily Pain, 72.21 for General Health, 61.05 for Vitality, 83.60 for Social Functioning, 81.29 for Role Emotional and 74.84 for Mental Health [1].

The main limitation of our study is the significant difference between both groups regarding the site of the defect. Femoral defects were treated more frequently with the monorail technique, mainly to avoid the bulky external fixator and patient discomfort. The other important limitation is the significantly higher rate of preoperative chronic osteomyelitis in the external fixator patients and the presence of more operative procedures before the segment bone transport. Considering the lower rate of postoperative infections and amputations in the external fixator group, the authors
recommend segment transport by external fixator in patients with chronic infections.

To our knowledge, this is the first large study comparing the monorail method with external fixators for the treatment of bone defects in the lower extremity. This entity cannot be compared with studies about simple lengthening of the lower limb [16, 18], because of the mainly posttraumatic aetiology, high chronic infection rate and more difficult surgical technique.

**External Fixator group (26 patients)**

- 15 patients returned to work
  - 8 patients returned to their original employment
  - 7 changed their job to a physically less demanding.
- 11 patients did not work
  - 3 were not working before and after surgery
  - 8 were not working after surgery

Figure 7. Employment status after surgery in the external fixator group
Monorail group (24 patients)

- 15 patients returned to work
- 9 patients did not work
  - 10 patients returned to their original employment
  - 5 changed their job to a physically less demanding
  - 2 were not working before and after surgery
  - 7 were not working after surgery

Figure 8. Employment status after surgery in the monorail group

Rate of amputations in patients with history of chronic infections

<table>
<thead>
<tr>
<th>Rate (%)</th>
<th>External Fixator</th>
<th>Monorail</th>
</tr>
</thead>
<tbody>
<tr>
<td>11.80%</td>
<td></td>
<td>40%</td>
</tr>
</tbody>
</table>

Figure 9. Rate of amputations in patients with chronic osteitis preoperatively
2.6 Conclusions

The monorail technique for segmental bone transport of the lower limb reduces the rate of deformities and the external fixation time. On the other hand, healing rates, return to profession, sports activities and quality of life are comparable after segment transport with the monorail or external fixator technique. Finally, chronic infections should be treated with external fixators only because of a lower rate of reinfection and amputations.
3. Abstract

3.1 Abstract (english version)

Background:

Segmental bone transport to treat bone defects can be performed with only an external fixator or with the monorail technique which entails combination of an external fixator and an intramedullary nail. This is the first study comparing the complication rates and long term outcomes of these methods.

Methods:

In a retrospective study, two groups of patients with either external fixators only (n=26) or monorail technique (n=24) for lower limb segment transport were compared. The mean defect length was 8.0±2.9cm and 7.7±3.3cm for the fixator and the monorail group respectively. The average follow-up period was 7.9±5.6 years. Chronic osteitis defined by positive cultures for longer than two months was present in 65.4% and 41.7% of the external fixator and monorail patients respectively. Complication rates, quality of life (SF-36) tests, ability to work and sporting activity was compared between the groups. Mann-Whiney U test and Chi square test were used for statistical analysis.
Abstract

Results:

Healing of the segment defect and of the docking site was observed in 23 (88.5%) and 21 (87.5%) of the fixator and monorail patients respectively. The external fixation time was significantly longer in the fixator group (15.9±6.1 months versus 5.9±1.5 months). Five patients underwent amputations because of persistent infections (three in the monorail group, one in the fixator group and one patient who had initial monorail transport and subsequently only an external fixator. The rate of deformities (>5° in sagittal and frontal plane) was significantly higher in the fixator group compared to the monorail group (32% versus 4%). One patient in the monorail group developed insufficient bone regeneration. No statistically significant difference was found when comparing categories of SF-36 test as well as the ability to return to work or to do sports. More than 90% of patients in both groups were satisfied with the procedure.

Conclusions:

Main advantages of the monorail method are reduction of the external fixation time and the lower rate of deformities. The authors recommend segmental transport with external fixator in patients with chronic deep infections.

Level of evidence: Therapeutic Level III.

Keywords: segmental bone transport, Ilizarov, Monorail, Callus Distraction
3.2 Zusammenfassung (german version)

Segmenttransport mittels Fixateur externe oder Monorail-Technik? Langzeitergebnisse von 50 Behandlungen.

Fragestellung:

Die Rekonstruktion von Knochendefekten ist einerseits allein mittels Fixateur externe, oder in Kombination mit einem Marknagel (Monorail-Technik) möglich. Es existieren bisher keine vergleichenden Studien größerer Kollektive zur Beantwortung der Frage, welches Verfahren zur Behandlung größerer Knochendefekte eingesetzt werden sollte.

Methodik:

Fünfzig Segmenttransporte an Femur oder Tibia wurden in die retrospektive Studie eingeschlossen. Die Behandlung war entweder nur mit einem Fixateur externe erfolgt (n= 26, „Fixateur externe Gruppe“), oder mit einer Kombination aus Marknagel und Fixateur externe, wobei der Fixateur nach abgeschlossener Distraktion entfernt wurde (n=24, „Monorail Gruppe“). Die Defektlänge betrug 8.0±2.9cm in der Fixateur externe Gruppe und 7.7±3.3cm in der Monorail Gruppe. In der Fixateur externe Gruppe hatten 17 Patienten (65.4%) und in der Monorail Gruppe 10 Patienten (41.7%) eine chronische Osteitis, definiert als Keimnachweis von länger als 2 Monaten (p=0,098). Die Anzahl an Voroperationen war in der Fixateur externe Gruppe
signifikant höher als in der Monorail Gruppe (6.0±2.6 vs. 3.2±2.9, p< 0.0001). Das mittlere Follow-up betrug 7.9±3.6 Jahre. Analysiert wurde die Rate jeweiliger Komplikationen, der SF-36 zur Analyse der Lebensqualität sowie die Berufs- und Sportfähigkeit. Die Daten zwischen den Gruppen wurden mit der Hilfe vom SPSS Programm (SPSS 15.0, SPSS Inc., Chicago, IL, USA) verglichen. P < 0.05 zeigte statistische Signifikanz.

**Ergebnisse:**

In der Fixateur externe Gruppe kam es bei 23 (88.5%) Patienten und in der Monorail Gruppe bei 21 (87.5%) Patienten zur knöchernen Ausheilung ohne Infektrezidiv (p=0.384). Bei 5 Patienten wurde im Verlauf eine Amputation aufgrund einer chronisch rezidivierenden Osteitis vorgenommen, 3 der 5 Patienten waren Raucher. Drei dieser Patienten kamen von der Monorail Gruppe, einer von der Fixateur externe Gruppe und der letzte hatte initial Segmenttarsntransport mit der Monorail Methode und bei Infektpersistenz mit einem Fixateur externe alleine (ohne intramedullären Nagel). Ein Patient in der Monorail-Gruppe entwickelte ein komplettes langstreckiges Regeneratversagen und wurde mit einem partiellen Tibiadiaphysenersatz behandelt. In der Fixateur externe Gruppe wurden zum Zeitpunkt der Nachuntersuchung bei 8 Patienten (32%) Fehlstellungen von 5° oder mehr beobachtet. Hingegen wurden in der Monorail Gruppe mit 4% signifikant seltener Fehlstellungen notiert (p<0.0001). Eine Docking-Operation wurde bei
11 Patienten in der Fixateur Gruppe und bei 7 Patienten in der Monorail-Gruppe vorgenommen (p=0.239). Operationspflichtige Pin-Infekte traten 5mal in der Fixateur-Gruppe und 2mal in der Monorail-Gruppe auf (p=0.082). In keiner der 8 SF-36 Subskalen wurden signifikante Unterschiede zwischen den beiden Gruppen gefunden. Kein signifikanter Unterschied wurde ebenfalls zwischen den Gruppen bezüglich der Berufstätigkeit und der Sportsfähigkeit notiert. 58% der Patienten der Fixateur externe Gruppe und 63% der Monorail Gruppe waren dem Abschluss der Behandlung wieder arbeitsfähig. Jeweils 92% in beiden Gruppen würden erneut eine Rekonstruktion mittels Segmenttransport gegenüber einer primären Amputation favorisieren.

**Fazit:**

Vorteil der Monorail Methode ist vornehmlich die kürzere Fixateurtragedauer, sowie die signifikant geringere Rate an Fehlstellungen und Pin-Infekten. Trotz etwas höherer präoperativer Rate an chronischen Infekten und Voroperationen war in der Fixateur-Gruppe die Anzahl an Reinfektionen und sekundären Amputationen deutlich geringer, weshalb die Autoren eine Fixateur-Behandlung bei Patienten mit chronischer Infektsituation empfehlen. Letztlich waren die Ergebnisse im SF-36 Test, sowie bezüglich der Berufs- und Sportfähigkeit vergleichbar.
4. SF-36 Health Survey questionnaire

1. In general, would you say your health is:
   - Excellent
   - Very good
   - Good
   - Fair
   - Poor

2. Compared to one year ago, how would you rate your health in general now?
   - Much better now than a year ago
   - Somewhat better now than a year ago
   - About the same as one year ago
   - Somewhat worse now than one year ago
   - Much worse now than one year ago

3. The following items are about activities you might do during a typical day. Does your health now limit you in these activities? If so, how much?
   a. Vigorous activities, such as running, lifting heavy objects, participating in strenuous sports.
      - Yes, limited a lot.
      - Yes, limited a little.
      - No, not limited at all.
   
   b. Moderate activities, such as moving a table, pushing a vacuum cleaner, bowling, or playing golf?
      - Yes, limited a lot.
      - Yes, limited a little.
      - No, not limited at all.
c. Lifting or carrying groceries.
- Yes, limited a lot.
- Yes, limited a little.
- No, not limited at all.

d. Climbing several flights of stairs.
- Yes, limited a lot.
- Yes, limited a little.
- No, not limited at all.

e. Climbing one flight of stairs.
- Yes, limited a lot.
- Yes, limited a little.
- No, not limited at all.

f. Bending, kneeling or stooping.
- Yes, limited a lot.
- Yes, limited a little.
- No, not limited at all.

SF-36 2

g. Walking more than one mile.
- Yes, limited a lot.
- Yes, limited a little.
- No, not limited at all.

h. Walking several blocks.
- Yes, limited a lot.
- Yes, limited a little.
- No, not limited at all.
i. Walking one block.
   ☐ Yes, limited a lot.
   ☐ Yes, limited a little.
   ☐ No, not limited at all.

j. Bathing or dressing yourself.
   ☐ Yes, limited a lot.
   ☐ Yes, limited a little.
   ☐ No, not limited at all.

4. During the past 4 weeks, have you had any of the following problems with your work or other regular daily activities as a result of your physical health?
   a. Cut down the amount of time you spent on work or other activities?
      ☐ Yes ☐ No
   b. Accomplished less than you would like?
      ☐ Yes ☐ No
   c. Were limited in the kind of work or other activities
      ☐ Yes ☐ No
   d. Had difficulty performing the work or other activities (for example, it took extra time)
      ☐ Yes ☐ No

5. During the past 4 weeks, have you had any of the following problems with your work or other regular daily activities as a result of any emotional problems (such as feeling depressed or anxious)?
   a. Cut down the amount of time you spent on work or other activities?
      ☐ Yes ☐ No
   b. Accomplished less than you would like
      ☐ Yes ☐ No
   c. Didn't do work or other activities as carefully as usual
      ☐ Yes ☐ No
6. During the past 4 weeks, to what extent has your physical health or emotional problems interfered with your normal social activities with family, friends, neighbors, or groups?

- Not at all
- Slightly
- Moderately
- Quite a bit
- Extremely

7. How much bodily pain have you had during the past 4 weeks?

- Not at all
- Slightly
- Moderately
- Quite a bit
- Extremely

SF-36 3

8. During the past 4 weeks, how much did pain interfere with your normal work (including both work outside the home and housework)?

- Not at all
- Slightly
- Moderately
- Quite a bit
- Extremely

9. These questions are about how you feel and how things have been with you during the past 4 weeks. For each question, please give the one answer that comes closest to the way you have been feeling. How much of the time during the past 4 weeks.
a. did you feel full of pep?
   - All of the time
   - Most of the time
   - A good bit of the time
   - Some of the time
   - A little of the time
   - None of the time

b. have you been a very nervous person?
   - All of the time
   - Most of the time
   - A good bit of the time
   - Some of the time
   - A little of the time
   - None of the time

c. have you felt so down in the dumps nothing could cheer you up?
   - All of the time
   - Most of the time
   - A good bit of the time
   - Some of the time
   - A little of the time
   - None of the time

d. have you felt calm and peaceful?
   - All of the time
   - Most of the time
   - A good bit of the time
   - Some of the time
   - A little of the time
   - None of the time
e. did you have a lot of energy?
    - All of the time
    - Most of the time
    - A good bit of the time
    - Some of the time
    - A little of the time
    - None of the time

f. have you felt downhearted and blue?
    - All of the time
    - Most of the time
    - A good bit of the time
    - Some of the time
    - A little of the time
    - None of the time

SF-36 4

g. did you feel worn out?
    - All of the time
    - Most of the time
    - A good bit of the time
    - Some of the time
    - A little of the time
    - None of the time

h. have you been a happy person?
    - All of the time
    - Most of the time
    - A good bit of the time
    - Some of the time
Appendix

☐ A little of the time
☐ None of the time

i. did you feel tired?
☐ All of the time
☐ Most of the time
☐ A good bit of the time
☐ Some of the time
☐ A little of the time
☐ None of the time

10. During the past 4 weeks, how much of the time has your physical health or emotional problems interfered with your social activities (like visiting friends, relatives, etc.)?
☐ All of the time
☐ Most of the time
☐ Some of the time
☐ A little of the time
☐ None of the time

11. How TRUE or FALSE is each of the following statements for you?

a. I seem to get sick a little easier than other people
☐ Definitely true
☐ Mostly true
☐ Don't know
☐ Mostly false
☐ Definitely false

b. I am as healthy as anybody I know
☐ Definitely true
☐ Mostly true
☐ Don't know
c. I expect my health to get worse

- Definitely true
- Mostly true
- Don't know
- Mostly false
- Definitely false

d. My health is excellent

- Definitely true
- Mostly true
- Don't know
- Mostly false
- Definitely false

The above test was from Prof. Bullinger in the German language translated and in the German population adapted (Bullinger M., Kirchberger I., Center of medical Psychology, University Hamburg Hogrefe Verlag ©, Göttingen).
5. References


6. Curriculum Vitae

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- Familienstand: Ledig

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2000-2003  Studium der Medizin, Phillips Universität Marburg
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2002-2003  Studium der Medizin, Universität Marburg, Deutschland
09. 2003  1. Staatsexamen (Note:2 – gut)

2003-2006  Nationale Kapodistriakon Universität von Athen
Stipendium der Medizin (2003-2006) wegen hervorragender Leistung
08. 2006  Gesamtnote (9/10 –sehr gut)
04.2007  Approbation Aerztekammer Niedersachsen

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06.2007-12.2007  Zentrale Notaufnahme
01.2008-12.2008  Chirurgische Normalstation
01.2009-06.2009  Unfallchirurgische Intensivstation
07.2009  Zusatzbezeichnung Notfallmedizin

SPRACHKENNTNISSE

• Griechisch
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INTERESSSEN + INTERESSANTES

- Computer: MS Office, SPSS
- Sport: Laufen

KURSE (CME)

- Strahlenschutz (2009)
- Ultraschallkurs Bewegungsapparat (2008)
- Notfallkurs (2008)
- ATLS (2007)
- Multiple Weiterbildungskurse Unfallchirurgie (2008-2009)
FORSCHUNG

Publikationen


Als Poster vom ASAMI Kongress 2009 angenommen.

Manuscripte (Under review)


Liodakis E, Kenawey M, Petri M, Krettek C, Jagodzinski M: Reconstruction of an iatrogenic acromion pseudarthrosis. *Der Unfallchirurg*

**Buchbeitrag**

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8. Erklärung nach § 2 Abs. 2 Nrn. 5 und 6

Ich erkläre, dass ich die der Medizinischen Hochschule Hannover zur Promotion eingereichte mit dem Titel „Monorail technique or external fixators for segmental bone defects of the lower limb? Long term follow-up of 50 cases.” in der Unfallchirurgischen Klinik unter der Betreuung von PD Dr. med. Stefan Hankemeier ohne sonstige Hilfe durchgeführt und bei der Abfassung der Dissertation keine anderen als die dort aufgeführten Hilfsmittel benutzt habe.

Die Gelegenheit zum vorliegenden Promotionsverfahren ist mir nicht kommerziell vermittelt worden. Insbesondere habe ich keine Organisation eingeschaltet, die gegen Entgelt Betreuerinnen und Betreuer für die Anfertigung von Dissertationen sucht oder die mir obliegenden Pflichten hinsichtlich der Prüfungsleistungen für mich ganz oder teilweise erledigt.


Hannover, 2010