

# Abstracts

## of the 1<sup>st</sup> International Congress of the ESMST Izmir

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### **SHOCK WAVE THERAPY IN ORTHOPAEDICS AND PHYSICAL PARAMETERS OF THE OSSATRON AND THE REFLECTRON**

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Acoustical shock waves have been introduced in medicine for kidney stone lithotripsy in the early 80ies. Today lithotripsy is the therapy of first choice for the sanitation of urolithiasis and more than 3 millions of patients have been treated all over the world confirming the safety and effectiveness of this non-invasive therapy. In 1986 the first animal experiments revealed that shock waves have the potential to stimulate bone formation by activation of osteoblast cells. In 1991 HMT High Medical Technologies AG initiated the development of the OssaTron, a special shock wave device for chronic orthopaedic diseases. Until today the Ossa Tron is the only orthopaedic shock wave device for the treatment of all well-known indication of the ESWT. A rapid development of the ESWT followed. In 1997 HMT started with the marketing of a new orthopaedic shock wave device – the Reflec Tronâ . This device is part of the HMT product family especially designed for orthopaedic use with a high energy dynamic and a very long lifetime of the Reflec Trode. To compare the results of clinical studies with different shock wave devices the manufacturer agreed to define parameters to describe the acoustic shock wave field (O. Wess et. al., Working Group Technical Developments – Consensus Report in High Energy Shock Waves in Medicine, C. Chaussy (ed.), Thieme Verlag, Stuttgart, 1997, p. 59 – 71). The acoustic shock wave parameters are a contribution to study the influence of the shock wave on the healing mechanism of the orthopaedic

indications and to find effective treatment parameters. In this presentation HMT will give an overview about the acoustic parameters of the Ossa Tron and Reflec Tron.

## **TREATMENT OF THE EPICONDILPATHIA RADIALIS WITH EXTRACORPOREAL SHOCK WAVE THERAPY (preliminary Results).**

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To evaluate in a preliminary study the results of treatment of radialis epicondylopathia in a heterogeneous group of patients by a shock wave therapy. 58 patients were treated with a shock wave therapy using a machine model Minilith SL1 Storz. The patients were evaluated in a prospective study. The distribution of the serie was: 74% were males and 65% effort workers, being 87% of labor origin. The patients were diagnosed by clinical signes, and the average for age was 42 years old. The treatments they had previously received were the following ones: surgery 10%, rehabilitation 58%, corticoanesthetic infiltrations 70%. In 17% no previous treatment had taken place. The average time of evolution for epicondylopathia was 9 months; so it was used a four session shock wave therapy, spaced by a period of 7 days. The number of impulses per session was 1500, using an energy of 0.03-0.04mJ/mm2. The intensity of pain was evaluated with VAS before and after concluding this treatment. The results were stratified in function of the following variables: age,work type, time of evolution, previous infiltrations, rehabilitation and previous surgery. We used for comparisons Chi square and Wilcoxon tests.

At the end of the treatment, 11% of the patients referred a reduction of intensity of pain major than 75%, and 24% among 50-75%. The variable which was statistically associated to best results was the absence of previous infiltrations. In patients who were not infiltrated, 31.3% referred a reduction of intensity of pain major than 75%, and 37.5% among 50-75%. The ones who showed a tendency to best results, although with no statistical value, were workers with sedentary activity, young patients and those with no previous surgeries.

The results of this study suggest the need to improve the criteria for patients selection, the application of more energy dose in each treatment, and to carry out this therapy earlier after patient evaluation.

## **DATA FOR 92 ORTHOPAEDIC PATIENTS TREATED WITH METHOD OF THE EXTRACORPOREAL SHOCK WAVE THERAPY AT LOW-ENERGY LEVEL**

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Indications after conservative orthopaedic treatment for a minimum of 6 months with unsatisfying results

- Shoulder (Tendinosis calcarea, impingement-syndrome)
- Heel (Plantar faciitis, calcaneus-spure, etc.)
- Ellbow (Epicondylopathia)
- Others (Tendopathia trochant., Stenos..De-Quervain, Patellapathia, Ledderhouse-syndrome, pseudarthrosis, hallux rigidus, etc.)

Reduction of symptome via treatment with extracorporeal shock wave therapy at low-energy level (all indications).

Average number of treatments per patient 4.69.

Reduction-of-symptome (%)	patients(%)	(n)
100%	20%	18

90%	25%	23
80%	20%	18
75%	30%	28
50%	3%	3
0%	1%	2

95% (n = 87) of patients experienced a reduction of symptoms higher than 75% in comparison to previous therapies.

Resistant to therapy were only 2 patients (adipositas permagna, failure of proper indication).

**CONCLUSION:**

Treatment with the method of extracorporeal shock wave therapy is a highly effective method for patients resistant versus conservative orthopaedic treatment.

**E.S.W.T OF SOFT TISSUES IN ORTHOPAEDICS - OUR FIRST 2 YEARS EXPERIENCE IN BOLOGNA**

Marco Nigrisoli, Vincenzo Bosco, Pier Paolo Zunarelli, Guglielmo Brayda, Alberto Barristini

The Service of Extracorporeal Shock Wave Therapy at the private hospitals "Villamaria" and "Toniolo" in Bologna is active since October 1995. From then till October 1997 we have treated 480 patients with soft tissue lesions which include all the indications so far recommended: rotator cuff lesions (198), knee tendon lesions (85), epicondylitis (74), calcaneal spur and plantar fasciitis (48). The mean number of shock waves per session has been 1500 - 2000 and the mean treatment number per patient has been 3 with an interval of 7 days. Pain and functional impairment were constantly evident in acute as well as in chronic diseases. In the latter physical therapy had been previously performed almost constantly with little improvement. No patient received general or local anaesthesia.

According to the individual judgement of the patient and to the clinical assessment of the operator 3 groups have been identified in order to study the results. Those cases which have been considered "excellent" (109 equal to 23%) have had a complete functional and painless recovery. A second group of "good" cases (302 equal to 63%) obtained a considerable improvement without a definitive resolution of the symptoms. In the third group of "bad" cases (69 equal to 14%) the therapy was totally ineffective. The study of each disease shows that the distribution of the 3 groups roughly corresponds to the total amount of patients with a prevalence of good and excellent results from 75% to 90%.

Such outcomes have encouraged us to extend this technique to less conventional lesions. Eleven cases of posttraumatic joint stiffness have been treated. Six of them were due to immobilization after fracture or fracture-dislocation. Five patients had had neurologic lesions with subsequent ossification of muscles and periarticular soft tissues. In the first group the result was as follows: 1 excellent, 4 good, 1 bad. In the second group all the 5 neurologic patients demonstrated a good result.

**WICH FACTORS INFLUENCE ON THE RESULT OF TREATMENT WITH ESWT - A RETROSPECTIVE STUDY OF ENTHESIOPATHY-TREATMENT OF 150 EPICONDYLITIS AND 60 HEEL SPUR PATIENTS.**

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It is known, that the success of non-union treatments depends on the level of activity. It is also known, that at the treatment of tendinosis calcarea of the shoulder there is a correlation between the level of the calcification (by Gärtner) and desintegration frequency. Up to now it is unknown, which factors influence the result of the treatment of enthesiopathy at elbow and heel.

The intention of this study was to inspect the hypothesis:

- the shorter the length of illness before therapy, the more effective is the shockwave therapy-

Additional we considered the hypothesis:

- is there a difference in the therapy success between radial and ulnar epicondylitis treatment?-

#### **MATERIAL AND METHOD:**

150 Patients with epicondylitis and 60 patients with heel spur were treated with 800 shockwaves and an energy flow density of 0,08 mJ/qmm (1600 mJ total energy per treatment). One up to three sessions were carried out in an interval of 4 weeks dependent the intermediate examination, till we got a good result. As technical equipment we used the Ossa tron of HMT. The length of the illness ranged from 3 to 100 months, average-length was 16,9 months by epicondylitis and 13,7 months by heel spurs. The follow up examination took place 12 months after the end of the therapy, containing a VAS, selfestimation of success and pain of tension.

#### **RESULTS:**

The good and very good results were shown in the following table (1):

epicondylitis radialis	78% / 117 pat. (7 pat. didn't finish therapy)
epicondylitis ulnaris	56% / 23 pat. (3 pat. didn't finish therapy)
heel spure	80% / 55 pat. (5 pat. didn't finish therapy)

- There is a significant better therapy success at epicondylitis radialis

Because of the different therapy course we used for further examinations only the radial epicondylitis results. We considered the correlation between the result of ESWT and the length of illness in the group of patients with 3 treatments. Also we considered the correlation between the number of treatments and the length of illness in the group of very good and good results (table 2). In the statistics analysis of our database we couldn't confirm the hypothesis:

- The shorter the length of illness, the more effective is the shockwave therapie

The results of the heel spur therapy shows more a contrary tendency, however it can't be shown by the statistics analysis.

<b>Epicondylitis radialis:</b>	<b>Treatments</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>Total</b>
Very good	No. of Patient	9	12	20	41
	(average length of illness)	(14,0)	(18,8)	(13,6)	
Good		7	22	21	50
		(14,8)	(11,1)	(16,6)	
Moderate		1	8	8	17
		(9)	(19)	(11,6)	
Unchanged				9	9
				(10,5)	
					117

<b>Heelspur</b>	<b>Treatments</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>Total</b>
Very good	No. of Patient	7	4	8	19
	(average length of illness)	(24,1)	(37,0)	(11,7)	
Good		7	8	10	25

	(10,7)	(8,5)	(7,6)	
Moderate		1	4	5
		(12,0)	(6,5)	
Unchanged			6	6
			(14,7)	
				55

## **ORTHOPAEDIC ESWT OF SOFT TISSUES: THE INDICATIONS AT THE ORTHOPAEDIC DEPARTMENT OF THE GENERAL HOSPITAL LINZ**

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Since 1993 we use in our hospital the extracorporeal shock wave therapy (ESWT) to treat painful ligamentous insertions. As the ESWT was at that time not used in clinical routine we did our treatments with a permission of the ethic commission. We tried to define the proper indications for that procedure in a clinical study.

Until the end of 1997 at our department 279 patients underwent ESWT with soft tissue indications. In average the patients were treated 3 times each with 1500 shock wave impulses; 75 tennis elbows, 118 tendinosis of the rotator cuff (mainly supra spinatus tendon), 36 plantar fasciitis with plantar heel spur. The rest of the indications are well documented as the ethic commission asked for and are handled as experimental treatments. All of the patients had extensive conservative treatment before they underwent ESWT (in average 5 different therapies and each 4 times, mostly local infiltration (5 times in av.) was reported).

In May 1997 we started to use the Sonocur Plus from Siemens as the routine ESWT device. Before that time we had the Osteostar from Siemens, which is a prototyp and only permitted for experimental use.

From our 75 tennis elbows we examined for that study about 2/3 and found min. 3 months after treatment about half of them satisfied (no pain or no need of further therapy). An other 20% showed improvement, but not enough or long enough to need any therapy else. From all 75 elbows 4 got worse, but only for a period shorter than 2-3 weeks.

Before May 1997 we treated the calcifying tendinitis only with low energy ESWT (0,06-0,2 mmJ/mm<sup>2</sup>). 97 shoulders with calcifying tendinitis have been examined and showed success (no pain or no need of treatment) in 59%. Another 19% have been better but not satisfied. Regarding other publications (Rompe, Loew) we changed our procedure: Since we have the possibility we still take the Osteostar to treat bigger calcifying depots (>1cm and if we think the calcified depot is the problem and not the impingement) because we can afford up to 0,60 mmJ/mm<sup>2</sup>.

From the 36 heels we got 29 into that study. 20 are painfree or don't need further therapy except they use their instep raiser, which they had before ESWT. 3 heels have been better but needed more treatment. 3 have been worse for 2-3 weeks.

We did not see a remaining problem according to ESWT. But we see the costs (time and device) which make ESWT to a therapy of the 2<sup>nd</sup> row like operations. And if we compare ESWT to other treatments we should ask about rentability and we should work on those questions as we work on details of functional scores and on basic research.

## **THE USE OF EXTRACORPOREAL SHOCK WAVE THERAPY IN THE TREATMENT OF HEEL PAIN**

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From September 1995 until October 1997, a total of 88 patients suffering from plantar calcaneal spur und plantar fasciitis, who had previously undergone conventional therapy without success, were treated with a lithotripter (MINILITH SL 1) manufactured by Storz. Before extracorporeal shock wave therapy was started, the patients received the obligatory minimum pretreatment in the form of insole supports, oral nonsteroidal anti-inflammatory drugs (NSAIDs) and/or oral steroid injections as well as physical therapy.

In the course of this study, the intensity of pain was assessed before and after the treatment as well as three, six and 12 months after completion of the therapy. The intensity of pain was classified on the basis of the visual analogue scale (0-10).

All patients underwent an average of 3,5 treatment sessions. Local anaesthesia was dispensed with in 70% of the treatments.

After completion of the treatment, 18% of the patients declared to be entirely free from pain, whereas 42% stated that their condition had improved considerably ( $\geq 5$  on the visual analogue scale). After three months, 24% of the patients treated were totally free from pain and 40% declared that their condition had improved significantly. Six months after therapy, 30% of the patients were entirely free from pain and 45% had experienced a substantial improvement in their condition.

The results proved to be unchanged one year after completion of the treatment. No serious side effects were detected as a result of the therapy.

In conclusion, it can be said that the use of extracorporeal shock wave therapy (ESWT) in the treatment of heel pain is a highly successful alternativ therapy method even for patients who were previously subjected to conventional treatment without success.

## **FDA STUDY IN THE UNITED STATES OF MUSCULO-SKELETAL SHOCK WAVE THERAPY FOR LATERAL EPICONDYLITIS AND HEEL PAIN SYNDROME**

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The FDA in the United States is currently conducting feasibility and multicenter studies for the use of Shock Wave Therapy in the treatment of epicondylitis of the elbow and heel pain syndrome. To date, feasibility studies has been completed for 20 patients who have lateral epicondylitis and 20 with heel pain syndrome. All procedures were performed under those who had symptoms for at least 6 months and have failed to respond to other forms of conservative treatment. All patients were followed for 6 weeks, 3 months, 6 months, and 1 year following the OssaTron treatment. All treatments were performed with the OssaTron spark gap type shock wave machine. The assessment at each visit included the examiner's objective evaluation by palpation, and testing of the affected area, recording the results on a 10 centimeter visual Analog Scale; as well as the subjects self assessment of pain using the same scale. The results are as follow. Of the 20 patients treated in the elbow study, 11 showed at least 50% improvement by 6 weeks; 14 showed at least 50% improvement by 3 months; 16 improved by 6 months and at 1 year 85% of the patients were satisfied with the results. One patient withdrew form the study and underwent surgery and 8 patients required a second treatment approximately 6 to 8 weeks after the first one for alleviation of pain. In the heel pain study 17 patients showed 50% or more improvement by 6 weeks; 18 patients by 3 months; 19 patients by 6 months and 1 year. Only 1 patient failed to improved 50% or more in this study. This FDA feasibility studies warrant the expansion of the study group to a multicenter pilot study with randomization program including placebo treatments. The details of the multicenter study enrolling 250 patients in each category will be discussed.

## **CLINICAL RESULTS IN EXTRACORPOREAL INDUCED LITHOTRIPSY OF TENDINOSIS CALCAREA AT THE SHOULDER**

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The studie's object was to evaluate medium-term results in application of ESMST to the shoulder for integration of this treatment into the therapy concept of tendinosis calcarea.

### **MATERIAL:**

From 05/95 to 12/96 90 patients with tendin.calc. (43 female/ 27 male) were treated. The average age was 50 years (28 to 81). In 2 - 3 sessions with an interval of 2 weeks ESWT was applicated to the shoulder. In the follow up 70 of the 90 cases were reexamined in a postapplication period of 20 months on the average.

### **RESULTS:**

37 patients were painless, 22 had light, 11 moderate and 10 intense pain in movement and stress. Painlessness was achieved in average 6 weeks after ESWT. The range of movement was similar to the contralateral healthy shoulder in 47 cases. 65 were able to dress up easy, 50 were able to work over head with no problems and 58 to lie on the treated shoulder. For 29 patients the result of ESWT is excellent, 21 good, 10 satisfacatory and for only 10 it was a failure. 57 (i.e. 81%) consider ESWT as very recommandable. Nevertheless in 3 cases of failure operative treatment was necessary.

### **DISCUSSION:**

The range of tendinous calcium pre- vs. post- application has no significant influence on clinical results. Failures occure in cases of simultaneous diseases of cervical spine or the glenohumeral joint. Success can be estimated after the second session.

### **SUMMARY:**

The use of ESWT in cases of tendin.calc. is a successful and serious therapeutic method having good functional medium-term results, when used in correct indication and after ineffective utilization of all conservative therapeutic measures.

## **A NEW TREATMENT OF CHRONIC TENDOPATHIES: THE EXTRACORPORAL SHOCK WAVE THERAPY**

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Shock waves were introduced in orthopaedics in 1991. Fragmentation of calcific deposits, cicatrization of inflamed soft tissue and oversaturation of nociceptors have been observed in insertion tendopathies. There are no published studies demonstrating the long time effect of shock waves in these pathologies.

This study performed 207 treatments of high energy shock waves in 120 cases of tendopathy from December 1995 to November 1997. Average age was 50 and history of pain 2.5 years. Intense conservative therapy without a satisfactory result for more than 4 months was required. All patients were evaluated before, 6 weeks and 6 months after one to three (average 1.7) therapies. The ADL-score was used for subjective judgement. The objective score (100-0) included clinical examination and other special tests. Pain was measured by the visual analogue scale (0-100). Result of therapy was chosen between excellent, good, fair and poor (1-4). All shock wave applications were performed in local anaesthesia. 44 erubescences and 4 mild hematomas appeared. One reversible paresthesia of a cubital nerve was observed.

Subjective assessment increased from 47 to 68, objective evaluation from 42 to 74 points and average pain decreased from 48 to 16 points. In 28% of the cases the assessment was "excellent", in 45% "good", in 19% "fair" and in 8% "poor". There was no worsening.

The shock wave therapy is a procedure showing good results without serious complications in insertion tendopathies after 6 months of application. It represents an alternative method to surgery not aggravating a later operation.

## **PROSPECTIVE COMPARISON OF SHOCK WAVE THERAPY AND NEEDLING IN CALCAREOUS TENDINITIS OF THE SHOULDER**

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### **INTRODUCTION:**

In literature needling and shock wave therapy (sw) of calcareous tendinitis is described as a conservative form of therapy. Goal of our study was to compare the effect of both methods.

### **PATIENTS AND METHODS:**

Each 15 patients with a calcium deposit of the shoulder (typ 1 or 2 according to the classification of Gärtner) and an unsuccessful conservative treatment were allocated to one of the groups:

- Shock wave therapy (2 sessions in local anaesthesia within 10 days, energy flux density 0,28 mJ/mm<sup>2</sup>, radiologically controlled positioning of the focus on the calcium deposit)
- Needling( 1 session with 10 ml of 2% Xylonest® under radiological control)

### **RESULTS:**

6 weeks after sw therapy we saw in 10/15 patients a dissolution or desintegration of the deposit. The Constant score increased from 37 to 65 points. According to the criteria of Roles and Maudsley 8/15 patients judge their result as good or very good. The portion increased after 6 month to 11/15 patients. In the 2 year control all patients are free of symptoms with a full range of motion. Further x ray controls had been rejected by the patients.

In the group treated by needling 7/15 patients suffered from 34,5 to 62 points after 6 weeks. According to the criteria of Roles and Maudsley 9/15 patients judge their results as good or very good. In 1 patient a frozen shoulder accrued that could be treated successfully by intensive conservative therapy in the hospital. The portion of patients judging their result as very good or good increased after 12 month to 4/15, after 2 years to 5 /15.

### **DISCUSSION:**

According to the effect on the calcium deposit and the portion of subjective satisfied patients we found a better outcome in shock wave therapy. Patients treated with needling suffer more often from a very painful subacromial bursitis. Further prospected controlled randomised single blind studies based on these results will follow.

## **VARIABLES INFLUENCING ANALGESIA DURING ESWL-TREATMENTS**

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Patients treated with the new third-generation electromagnetic lithotripters no longer require general or regional anesthesia. However, there is need for analgosedation.

Demographic and pathology-specific factors may influence the consumption of these drugs, as well as the occurrence of side-effects. The aim of the study was to identify these factors.

During a 7-month period we recorded demographic and stone- and therapy-related data for 152 patients (ASA I-III) undergoing ESWL-treatment on a Dornier Lithotripter U/50. Patients were induced with Propofol 1 mg/kg and Alfentanil 0.01 mg/kg.



When needed, they could administer themselves via PCA a bolus of Propofol 0.25 mg/kg and Alfentanil 0.005 mg/kg with a lock-out of 5 minutes (1). Drug-consumption and occurrence of O<sub>2</sub>-desaturation and/or ventricular premature beats (VPB) were recorded and related to the different parameters.

There is a tendency to a slightly greater need of analgesia in patients treated for distal ureteral stones compared to those with prevesical or pyelo-ureteral-junction (PUJ) localisations, although not statistically significant. Women and younger people tended to consume more Alfentanil. A significantly greater consumption occurred with an increasing number of shockwaves ( $p = 0.0001$ ) and with a greater exposed surface area of the stone ( $p = 0.0037$ , both S-N-K test), but not with an increasing energy level. SaO<sub>2</sub><90% was seen more often in people over the age of 60 ( $p = 0.5$ , 2-tailed Fisher's Exact test) and a tendency towards the same was also noted in the more obese. The occurrence of VPB was significantly higher in calyx-, pyelum- and PUJ-stones than in the more distally located ( $p = 0.001$  chi-square), but there was no correlation with O<sub>2</sub>-desaturation.

(1) Akman H., et al.: Patient-controlled analgesia during ESWL. *Türk. Anest. Ve. Cem. Mecmuasi.* 1994; 22:199-202.

## **ENGLISH EXPERIENCE OF MUSCULOSKELETAL SHOCKWAVE THERAPY**

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The use of lithotripsy in orthopaedic practice is at an early stage in the United Kingdom. We present the results of two cases where shock wave treatment has been used to treat delayed and non-union of fractures of the Ulna and Tibia in a major trauma centre, in contrast to the more traditional methods.

A 35 year old female sustained a closed mid-shaft fracture of the right ulna which was initially treated conservatively. After 20 weeks, with no signs of union, the fracture was treated with 1800 shocks at power level 3-4. Within 6 weeks of shock-wave treatment the fracture was united.

A 16 year old male sustained an open fracture of the distal left Tibia and Fibula. The injury was debrided and immobilised with an external fixator. 17 weeks after injury, the external fixator was removed and a functional brace applied. At 14 months 2000 shocks at power level 5 were applied to the un-united tibia, followed by a second course of 2000 shocks at power level 3-4 3 months later. 2 years after his initial injury, the fracture had united satisfactorily.

## **THE TREATMENT OF NON-UNION BY HIGH ENERGY SHOCK-WAVES THERAPY**

E.M. Corrado, C. de Durante, S. Russo, S. Gigliotti, B. Corrado

The Authors show their experiences in treatment of non unions by high energy shock-waves therapy (HESWT); they use electromagnetic devices (Modulith SLX and Minilith by Storz Medical).

The therapeutic approach must consider some parameters which will be discussed individually; the X ray exams and MRI allow us to evaluate the border-line situations (evident axial deviations and/or malrotation) which represent an exclusion criteria for HESWT, and more they furnish important informations for a prognostic evaluation. MRI allows to evaluate the presence of ischemic areas or local osteonecrosis near the lesion. These areas (the so called break point) represent the sites with an altered micro circle and must be treated specifically.

The number of applications and shock waves power depend on the bone size and pressure field dimension: for large bones (femur or tibia for example) we need more applications and more power than for the small ones (carpal scaphoid or metacarpal bones).

Table 1 reports the casuistry – in table 2 the results are showed with average follow-up of 2,5 months: Group A are the total fusion of the bone, Group B the partial fusion, Group C the failure (no fusion).

Tab. 1

Humerus	9
Phalanx	18
Metacarpal	15
Carpal Scaphoid	187
Hamate	1
Ulna	21
Radius	25
Femur	30
Tibia	27
Tibia (congenital)	3
Clavicula	12
TOTAL	348

Tab. 2

Total fusion	232 (66,7%)
Partial fusion	68 (19,5%)
No fusion	48 (13,8%)

## **THE INFLUENCE OF EXTRACORPORAL SHOCK WAVES ON THE GROWTH AND THE EXPRESSION FACTORS OF BONE CELLS**

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Experimental examinations have shown an influence of extracorporal high energy shock wave treatment on the regeneration of bone cells. In experiments with animals was shown that the high energy shock wave treatment can stimulate the fracture healing positively as well, without proving the working mechanisms of an effect on osteoinduction. This knowledge results in an early clinical treatment by shock wave therapy of delayed fracture healing and pseudarthrosis. The aim of this present experimental study is to examine the influence of shock waves on the growth and the metabolism of human bone cell cultures. In this controlled, blinded and randomized study of a statistically sufficient number, 120 bone cell cultures were brought to different shock wave treatments.

Human bone cells were cultivated out of pieces of femoral bone over the time of three month. These cells were put in an plastic tube with culture medium (DMEM) where they layed adherend on the bottom. For the treatment of the 120 cell cultures the impulses and the energy were modified in this way, that we've applicated 500 or 1000 or 2000 impulses with the focal energy of 0,13 or 0,18 or 0,28 mJ/mm<sup>2</sup> on the bone cells and have compared them to an untreated controlling group. Examination parameters were the number of cells and the vitality after the treatment, the doubling time and behaviour of proliferation, observed over eight days, the procollagene-I-production and the expression of alkalic phosphatase in the active cell cultures in comparison to the untreated groups.

A direct dose-effect relation in the survival rate becomes obvious. Applying low energy and low impulse rates no influence is recognizable. Proportional to the increase of the dose we see a decreasing survival up to 40% of the starting number of cells at the dose of 2000 impulses and 0,28 mJ/mm<sup>2</sup> focal energy. This decrease is compensated by an increase of the proliferation rate in the range of three days. This proliferation becomes obvious in the cell groups that were treated

with 1000 impulses and 0,18 or 0,28 mJ/mm<sup>2</sup> focal energy and also significant difference between cells in every kind of treatment. The precollagene-I-expression for the metabolism decreases less, not significantly at high doses. Summarizing all this there is no influence of the shock waves to the metabolism and synthesis of treated cell populations in comparison to the controlling group.

#### **CONCLUSION:**

Depending on the dose the treatment with extracorporeal shock waves obviously induces a stimulation of proliferation of bone cells. In the same way the shock wave treatment also causes a high mortification of bone cells in middle and high doses, but the surviving and vital cells show no influence on metabolism and the synthesis.

## **INFLUENCE OF EXTRACORPORAL SHOCK WAVES ON OSTEOGENESIS AFTER RADIATIO.**

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#### **INTRODUCTION:**

Since 8 years the application of extracorporeal shock waves is used in treatment of pseudoarthrosis. A review over the published results showed a various outcome. Depending on the energy flow intensity and number of administered shock waves some authors demonstrate good effects concerning bone healing. The application of high energy shock waves seems to be more effective than the lower energy level. Adjuvant radiotherapy used after surgical treatment of primary bone tumors of bony metastasis reduce the osteoblast activity. That leads to an infirmed tissue environment and to a decrease ingrowth pattern, so that the fixation of overbridging alloplastic implants is an important fundamental promblem. This study examined the effects of shock waves of high energy flow density level on osteogenesis after radiatio. The aim was to show that it is possible to accelerate bone healing and osteoinduction by application of high energy shock waves.

#### **MATERIAL AND METHODS:**

9 matured dogs (beagle) get a radiotherapy of the maxillary bone with 60 Gy on the upper jaw. The total radiodosis was fragmentated into 30 sessions with 2 Gy. After finishing the radiatio two teeth of the upper jaw (dentes 19 and 29) were extractred to create defined bone defects. 2 weeks after extraction the shock waves were applicated. They were administered on 2 sessions with the applicationgap of 3 weeks. 2000 shock waves per session on energy flow density level of 0,4 mJ/mm<sup>2</sup> frequency of 2 Hz. The shock waves were emitted by an electro-magnetic-shock-wave emitter (EMSE). The right side of the maxillar bone of each dog was treated, no treatment on the contralateral side, so that we were able to create an intraindividual and also interindividual study protocol. Each side of the maxillary bone area of each dog was examined by x-ray, contact-mikro-x-ray and by histological examination.

#### **RESULTS:**

The present investigation demonstrate the positive effect of extracorporeal shock waves on osteogenesis after radiotherapy by improvement of the reduced osteoblast activity. The x-ray and histological examinations demonstrate an increased density of the trabecular structure on the treated side. Now further studies should investigate which kind of parameters must be changed to optimize the above mentioned results. Regard to our results the application of ESWT after radiatio is indicated to optimize the infirme tissue environment for better ingrowth pattern of alloplastic implants.