Clinical Experience With the Use of Low-Intensity Pulsed Ultrasound (LIPUS) in the Treatment of Atypical Femoral Fractures

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Objective: The aim of this study was to report the clinical results of atypical femoral fractures (AFFs) treated with low-intensity pulsed ultrasound (LIPUS).

Materials and Methods: The data on AFFs that were surgically treated in our hospital from 2010 to 2016 was retrospectively analyzed. AFF was diagnosed based on the criteria defined by the second report of an ASBMR task force.

Results: Seven fractures in 6 cases were included in this study. Two fractures were referred to us as being nonunion. Five fractures were subtrochanteric fractures and 2 fractures were shaft fractures. Five fresh AFFs were fixed with an intramedullary nail and 2 nonunion fractures were fixed with plates. LIPUS was used in 6 fractures. Bone union was achieved in 5 fractures with the average time to union being 17 months (5–29). In 4 out of the 6 fractures treated with LIPUS, bone union was achieved after 14 months on average. In the other 2 LIPUS-treated fractures, bone union was not achieved even at 1 year after surgery.

Discussion: It is known that AFF healing tends to be very slow. Some case reports indicate that AFF healing might be accelerated by LIPUS. In the current series, the subtrochanteric fracture that was not treated with LIPUS healed at 29 months after surgery, which was much longer than the average time to union in the 5 fractures that were treated with LIPUS. Although our number of cases is small, LIPUS may be a potentially useful tool for accelerating AFF repair.

Efficacy and Limitations of Conservative Treatment for Painful Patella Partita: Positioning of an Ultrasound-Accelerated Fracture Healing Apparatus

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Objective: Generally, painful patella partita is conservatively treated, but the usefulness of a low-intensity pulsed ultrasound (LIPUS) healing apparatus is unclear. The objective of this study was to investigate the usefulness of LIPUS for conservative treatment of painful patella partita.

Subjects and Methods: The subjects included 17 patients diagnosed with painful patella partita. The subjects were divided into 2 groups: those without pain at 6 months (responsive group) and those with pain that persisted for 6 months or longer (non-responsive group). The reasons for the different responses between the 2 groups were investigated. We evaluated various factors, including age, gender, presence or absence of epiphyseal closure on plain xp at the first examination, Saupe classification, presence or absence of bone union, and type of conservative treatment. The grade of limitation of movement, the presence or absence of instruction on quadriceps femoris muscle stretch, and use of an orthosis and LIPUS were also investigated.

Results: The responsive and non-responsive groups consisted of 12 and 5 patients, respectively, and included only male patients. The average age was 13 and 16 years old in the responsive and non-responsive groups, respectively. Epiphyseal closure was present in 1 of the 12 patients in the responsive group and 3 of the 5 patients in the non-responsive group. The Saupe classifications in the responsive and in the non-responsive groups, respectively, were type I in 1 and 2 patients (3 total), type II in 6 and 1 patients (7 total), and type III in 4 and 3 patients (7 total). Bone union was achieved in 10 patients in the responsive group, whereas no patient achieved bone union and 3 patients underwent excision in the non-responsive group. Conservative treatment in the responsive and non-responsive groups, respectively, included prohibition of exercise for 7 and 2 patients (9 total) and instruction on quadriceps femoris muscle stretch for 5 and 2 patients (7 total). In addition, all of the 8 patients wearing an orthosis and 2 patients treated with LIPUS were in the responsive group.

Discussion: The findings suggest that painful Saupe type II patella partita can be improved by appropriate conservative treatment before epiphyseal closure. LIPUS may be advantageous for bone union and pain relief.

Treatment of Incomplete Jones Fractures With Low-Intensity Pulsed Ultrasound (LIPUS)

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Objective: Stress fractures of the proximal epiphysis of the fifth metatarsal bone (termed Jones fracture) frequently occur in both senior high-school-age and older contestant-level soccer players, and its incidence in Japanese soccer players is higher than that in European players. Surgery is most commonly indicated for a complete fracture, and about 3 months are required before the patient is able to return to the sport. We have performed a "Jones fracture screening" to reduce the incidence of these fractures. While surveying its frequency and promoting education on its prevalence and symptoms, we tried to discover incomplete fractures early and treat them using LIPUS without limiting their soccer practice.

Subjects and Methods: The subjects were 341 students (682 feet) from 3 senior high schools and university soccer clubs. Primary

screening for tenderness and by diagnostic ultrasound imaging was performed as a Jones fracture screening. Fifty subjects (50 feet) were positive on the ultrasonic diagnosis, and secondary screening was recommended. Forty subjects underwent radiography (secondary screening rate: 80%), and 5 subjects (5 feet) were diagnosed with incomplete Jones fractures. Conservative treatment centering on LIPUS was performed in these 5 players who still continued to participate in all soccer practices.

Results: Bone union was achieved in 2 subjects (2 feet) after about 6 months without taking a break from soccer practice. The other 3 subjects (3 feet) are at 2 months after the diagnosis and are being followed without taking a break from soccer practice.

Discussion: Incomplete Jones fractures that are discovered early by an ultrasonic check-up for bone expansion with subsequent early treatment with LIPUS may heal without taking a break from practice. No preventive method has been established for Jones fractures. This check-up may serve as a useful preventative approach, and we will make an effort to suggest it as a common practice.

An Examination of the Factors Related to a Reduction in the Use of Low-Intensity Pulsed Ultrasound (LIPUS)

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Objective: We examined the factors related to a reduction in the use of low-intensity pulsed ultrasound (LIPUS) for patients at both our hospital and other affiliated institutions.

Materials and Methods: Of 350 patients who used LIPUS at our and other affiliated institutions from May 2010 to April 2015, 279 (168 males, 111 females) were evaluated, after excluding mortalities and those with unexplained bone adhesion. Those patients with LIPUS compliance [calculated as: (number of days LIPUS was used/number of days LIPUS was available) × 100] below 80% were defined as the non-compliant group (170 patients), and those patients with a compliance rate of 80% or above were defined as the compliant group (109 patients). Factors related to a reduction in compliance were examined and included duration of use, age, sex, fracture side (right or left), and fracture site.

Results: The duration of use was longer in the non-compliant group compared with that in the compliant group (mean ± SD: 160 ± 118 days vs. 126 ± 81 days; $P = 0.01$), and the mean age was younger in the non-compliant group (42 ± 20 years vs. 50 ± 21 years; $P = 0.002$). Additionally, there was a higher ratio of females/males in the compliant group (60/49 vs. 120/50; $P = 0.008$). However, the side of the fracture was not significantly different between the groups ($P = 0.449$). Fractures of the forearm were more frequent in the non-compliant group than that in the compliant group (25/170 vs. 7/109; $P = 0.003$).

Discussion: The results suggest that the factors predictive of a reduction in the use of LIPUS are a long period of use, younger age, male gender, and use on fractures of the forearm.

Outcome of Low-Intensity Pulsed Ultrasound (LIPUS) for Opening Wedge High Tibial Osteotomy

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Objective: Opening Wedge High Tibial Osteotomy (OWHTO) for knee osteoarthritis and for osteonecrosis has reported good results. Use of low intensity pulsed ultrasound (LIPUS) after OWHTO had become an option for the treatment of OWHTO since April 2016. The purpose of this study was to examine whether LIPUS has an accelerating effect on synostosis after OWHTO.

Materials and Methods: The control subjects were 24 patients with a total of 26 knees (9 male with knees and 15 female with 17 knees treated) treated with OWHTO only. OWHTO was performed from April 2015 to March 2016 (non-LIPUS control group). The average age of the patients was 61 years. The test subjects were 25 patients with a total of 27 knees (8 male with 9 knees and 17 female with 18 knees treated) treated with OWHTO and LIPUS. OWHTO was performed from April 2016 until the present. LIPUS was started after the surgery (LIPUS + group). The average age was 64.6 years. FTA, ROM, intraoperative open angle, and the time to bone union were examined.

Results: There was no difference between the 2 groups in FTA, ROM, and open angle. Synostosis was obtained in 18 knees in the control group (no LIPUS) with an average duration of 8.4 months. The LIPUS + group had a short observation period with none of the patients experiencing bone union.

Discussion: The synostosis promoting effect of LIPUS is expected. In this study, there were no bone union cases because of the short observation period. It is necessary to extend the follow-up period, and clarify the utility of LIPUS.

Effect of Low-Intensity Pulsed Ultrasound on Bone Healing at Osteotomy Sites After Open Wedge High Tibial Osteotomy

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Objective: The purpose of this study was to evaluate the effects of low-intensity pulsed ultrasound (LIPUS) on bone healing at osteotomy sites after open wedge high tibial osteotomy (OWHTO).

Materials and Methods: Twenty-six patients underwent OWHTO without bone grafting. Thirty cases treated with LIPUS (group L) after surgery were compared with 13 cases without LIPUS treatment (group C). We divided the osteotomy gap into the lateral hinge and 4 zones on anteroposterior radiography, and the progression of gap filling was evaluated at 1, 3, and 6 months post-operatively in both groups.

Results: In group L, the lateral hinge formed a union at 3 months postoperatively in 11 knees (84.6%). At 6 months, gap filling in 10 knees (76.9%) reached to zone 2. In group C, while the lateral hinge formed a union at 3 months postoperatively in all cases. At 6 months, gap filling in 6 knees (46.1%) reached to zone 2. The progression of