High-energy focused shock waves

Pilot study of patients with **scaphoid pseudarthrosis**

HANNOVER (Germany) The diagnosis and treatment of scaphoid pseudarthrosis continue to be a major challenge. While the introduction of vascularised bone grafting such as the 1,2 ICSRA Zaidemberg graft in 1991 has led to improved clinical results in the treatment of scaphoid pseudarthrosis, delayed bone union may occur both with vascularised and non-vascularised bone transplants.

In 1969, an animal experimental study on the use of hydraulic waves for kidney stone lithotripsy was presented in the German medical journal "Der Urologe".[1] As early as in 1970, the first cohort study of 100 patients with renal calculi was published in the "British Journal of Urology".[2] Technological progress eventually led to the development of *ultrasound-generated lithotripsy*. Today, advanced system technologies enable the use of different types of shock waves – e.g. radial or focused shock waves – at different energy levels. Focused shock waves can be generated using the following three techniques:

- electrohydraulic,
- electromagnetic,
- piezoelectric.

Mechanism of action of shock wave therapy

While the exact mechanism of action of shock waves is still not fully known, there are some indications that the mechanotransduction induced by shock waves triggers a biological response. Also, stem cell activation induced during low-energy shock wave therapy may be another possible explanation for the biological effects of shock wave treatment.

Focused shock wave therapy of pseudarthrosis

The treatment of tibial and femoral non-union by extracorporeal application of focused shock waves leads to a clinically significant increase in the NO serum level, TGF-beta1, VEGF and BMP-2 serum levels and other osteogenic growth factors (evidence level 1b).[3] In the treatment of osteochondritis dissecans of the knee in an animal model, shock wave therapy has also demonstrated to produce a significant improvement in the formation of mature bone and cartilage.[4] A recent study revealed that, contrary to focused shock wave treatment, radial shock wave therapy is not able to stimulate bone healing.

In the treatment of pseudarthrosis of long tubular bones, extracorporeal shock wave therapy is equivalent in effectiveness to the intramedullary surgical technique (evidence level 1b).

Fig. 1: Thesis: High-energy focused shock wave therapy reduces pain and leads to bony consolidation of the scaphoid non-union.

Fig. 2: Four-month follow-up after 1,2 ICSRA graft with persistent pain.

Focused shock wave therapy of scaphoid non-union

Shock wave application to the carpus has not been described so far.

Based on the available data on the positive effect of focused shock wave therapy on long tubular bones, we established the following hypothesis: High-energy focused shock waves applied to the carpus lead to bony consolidation of the scaphoid non-union (Fig. 2).

In a cohort analysis conducted at two shock wave therapy centres in Hannover, Germany, we included 21 patients (76% males, 30% active smokers) with a mean age of 36±15 years in this pilot cohort study.

Fig. 3: Condition after two therapy sessions with focused shock waves (5740 shocks), seven months after 1,2 ICSRA graft.

The majority of patients (71%) had an initial type B1-3 fracture according to Herbert's classification scheme. The patients in the study had undergone different treatment procedures:

- no primary or secondary surgical treatment (n=9),
- primary conservative treatment, secondary Matti-Russe procedure with iliac crest graft (n=9) or vascularised 1,2 ICSRA graft (n=1),
- primary Matti-Russe procedure, secondary STT arthrodesis (n=1),
- other treatments (n=2).

A total of 48 percent of the injuries had been treated under the statutory accident insurance and prevention scheme.

Results of the scaphoid pseudarthrosis study

An average of 2.1 treatments with focused shock waves (Storz Duolith system, 5000 shocks, 94% high-energy waves) were performed on an outpatient basis at an average of five months after the last surgery (Figs. 2-3).

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In 95 percent of the cases treated, radiological evidence confirmed consolidation of the non-union or implanted graft (follow-up at 21±9 months).

No side effects were observed. Patient satisfaction was 1.9 based on a rating scale from 1 (very satisfied) to 6 (very dissatisfied). Pain intensity on the VAS was 1.6, and the DASH score was 11±19 (0=excellent). The Michigan Hand Outcome score was 84 on the affected side and 95 on the healthy side (100=excellent). The follow-up examination conducted after shock wave therapy of scaphoid non-union revealed that the treatment results in terms of the functional outcome (DASH score) were equivalent to those achieved by direct scaphoid screw fixation in cases of uncomplicated primary scaphoid fracture and significantly better than those obtained with the Matti-Russe procedure (Table 1).

Conclusion

High-energy focused shock wave application performed as a two-session treatment is an effective therapy option for manifest scaphoid pseudarthrosis with excellent clinical results. Even when reconstructive surgery fails to achieve bony union, focused shock wave therapy may be able to result in the consolidation of the pseudarthrosis. Randomised controlled studies need to be conducted to assess the importance of focused shock wave therapy and compare its significance with that of reconstructive surgery options. ■

A list of references can be obtained from the author.

Entity	Treatment	Follow-up	Reference	DASH
Non-displaced type B fracture	Herbert screw	8 weeks	Bedi et al. 2007	6
	3.0 mm cannulated screw	3.2 years	Patillo et at. 2010	7
Scaphoid pseudarthrosis	Adjustable plate osteosynthesis	6 months	Leixnering et al. 2011	28
	Non-vascularised graft + mini-Herbert screw	3.5 years	Megerle et al. 2008	12
	Matti-Russe procedure	8.8 years	Kolodziej et al. 2006	43
	Matti-Russe procedure	6.5 years	Dacho et al. 2004	15
	Focused shock wave therapy	2.1 years	Knobloch et al. 2011	9
SNAC	CLHT arthrodesis	5 years	Winkler et al. 2010	15
	Proximal row carpectomy	10 years	Richou et al. 2010	31
	STT arthrodesis	3 years	Kalb et al. 2001	29

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