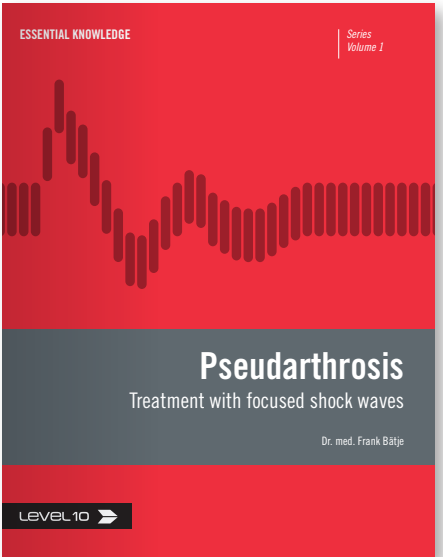
ESSENTIAL KNOWLEDGE
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Pseudarthrosis
Treatment with focused shock waves
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LEVEL10

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AETIOLOGY

Pseudarthrosis – from the ancient Greek words "pseudes" (false) and "arthros" (joint) – refers to the failure to heal of a broken bone or an osteotomy. A fracture, osteotomy or surgical stiffening of a joint is generally followed by osseous healing. The time it takes for stable bony fusion to occur depends on various factors:

| Type of bone (long narrow bones, vertebral bodies, etc.);
| Location of fracture (diaphyseal, metaphyseal, etc.);
| Form of fracture (transverse fracture, spiral fracture, etc.);
| Nature of traumatological care
(internal fixation, external fixation, conservative, etc.).

If there is certainty that bony consolidation failed to occur, we speak of a pseudarthrosis (i.e. a nonunion).

Some forms of fracture are more typical than others and are therefore conducive to standardized osteosynthesis procedures. Rarer fracture types are subject to a wider range of treatment methods and are more likely to postoperatively develop into non- or malunions. The incidence of bone-healing problems or genuine pseudarthrosis differs considerably from bone to bone, even where conditions are comparable (primary specialist traumatological care, high medical standards, patients in averagely good health, etc.). For example, pseudarthrosis occurs more frequently after fractures of the medial third of the clavicle than at the lateral malleolus. Following arthrodesis it is more likely to develop at the upper than the lower ankle joint.

The guidelines of the German-speaking International Society for Extracorporeal Shock Wave Therapy (DIGEST) recommend that therapists choose the electrohydraulic and electromagnetic systems to treat bone-healing problems, as there is a good deal of evidence to support them.

Based on the literature, treatment of pseudarthrosis with electromagnetic and electrohydraulic shock waves is recommended.

Recommendation for treatment by DIGEST[4]

Electrohydraulic
Single treatment, with second or third treatment possible after 3-6 months
Frequency:
1-4 Hz, 3,000 pulses on average, energy flux density (EFD):
0.3-0.4 mJ/mm²

Electromagnetic
3-4 treatments at intervals of 4-7 days
Frequency:
1-4 Hz, 4,000 pulses, energy flux density (EFD):
0.4-0.7 mJ/mm² (long bones), 0.1 mJ/mm² (scaphoid bone)

Piezoelectric
No relevant literature available

Radial pressure wave therapy
No relevant literature available

FOCUSED SHOCK WAVES VS. RADIAL PRESSURE WAVES

Focused shock waves are (in physical terms) the genuine shock waves that converge into a focal zone in which energy cf a preset flux density is released. Modern devices allow variable penetration depths making it possible, for example, to treat a deep femoral fracture just as individually as a superficially located olecranon fracture. The size of the focal zone (e.g. that of a bean or cigarette filter) varies between devices.

Fig. 14
Focused handpiece

Since radial pressure waves are ballistically generated and hence divergent, they reach only relatively superficial locations. With regard to energy flux density, they are consistently low in energy and, as such, have not yet played any part in the treatment of bone-healing problems.

Fig. 15
Radial handpiece

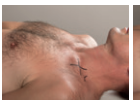

Fig. 39 (left)
Marking indicating the thoracic application direction.

Fig. 40 (right)
Treatment of the clavicle from the ventrocaudal direction at 30° tilt.

Fig. 41
Measurement of oxygen saturation (pulsoxymetry) during ongoing treatment.

FIFTH METATARSAL / JONES FRACTURE | *Table 5*

Energy mJ / mm²	0.35-0.45
Pulses	3,000 per application direction
Application directions	Dorsal / plantar
Number of sessions	2
Stand-off	II

A Jones fracture can be treated from both the dorsal and plantar direction in order to access the bone across its entire diameter. As the bone calibre is relatively low, equipment designed for use in practices is preferable to a large device.

Fig. 42 (left)
3,000 per application direction

Fig. 43 (right)
Treatment of the base of the fifth metatarsal from the dorsolateral direction, applying 3,000 pulses.

ARTHRODESIS OF THE METATARSOPHALANGEAL JOINTS, FIRST RAY | *Table 6*

Energy mJ / mm²	0.35-0.45
Pulses	3,000 per application direction
Application directions	Dorsal / plantar
Number of sessions	2
Stand-off	II

Fig. 44 (left)
Marking indicating the dorsal application direction.

Fig. 45 (right)
Treatment of the first ray from the dorsal direction, applying 3,000 pulses.