Novel treatment (new drug/intervention; established drug/procedure in new situation)

Immediate alleviation of chronic pain by bone drilling and probable involvement of bone tissue in pain sensitisation

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Three patients presented with severe spontaneous pain, allodynia and numbness on the lateral side of the left heel, foot and/or toe due to L5 and/or S1 root injury, as a result of repeated failed back surgeries including Love's surgery and laminaectomy (failed back surgery syndrome). The neuropathic pain in the lower extremities did not respond to somatic nerve block, lumbar-sympathetic ganglion block, spinal cord stimulation, and/or medications. At the spots in the foot showing the most severe allodynia, bones were drilled with fluoroscopic assistance. Spontaneous pain diminished immediately and allodynia was completely resolved. Visual analogue scale score decreased immediately after bone drilling. The analgesic effect was maintained for 30–45 weeks. In three patients, drilling until the marrow cavity of the bones at painful sites effectively relieved chronic neuropathic pain with lasting analgesic effect.

BACKGROUND

Drilling of the vertebrae has recently been used to relieve vertebral compression fracture pain. During attempted vertebroplasty in patients with vertebral compression fracture, Kobashi *et al*¹ accidentally found that drilling of the vertebral body alone elicited analgesia, even though injection of bone cement into vertebral marrow failed due to some reasons. Subsequently, this method was shown to be effective for pain management in osteospondylosis or osteoarthritis.² A recent uncontrolled study reported the effectiveness of vertebral body drilling to be 87.5%.³ Bone drilling (BD) has been incorporated in *The Guideline of Therapeutics for Pain Clinic* edited by Japan Society of Pain Clinicians.⁴

We found that drilling of foot bone also provides excellent analgesia for neuropathic pain in the foot caused by injured nerve root injury in three patients with failed back surgery syndrome (FBSS). Neuropathic pain often occurs after nerve injury, and the underlying mechanisms are complex. The painful area is usually heterotopic: lumbar nerve root injury usually induces lower limb pain (sciatica), but not lumbar pain.

CASE PRESENTATION

Between 2009 and 2010, three patients presented at our department with intractable chronic neuropathic pain in the lower extremities. All three patients had a similar history of repeated failed backbone surgeries including Love's surgery and laminaectomy for lumbar disc hernia. Their conditions deteriorated furthermore after the respective surgeries, and they developed FBSS. All three patients had severe spontaneous pain, allodynia and severe numbness on the lateral side of the heel, foot and/or toe, due to L5 and/or S1 root injury (table 1). The pain was considered to be pure neuropathic pain, because the painful sites were consistent with the innervations(s) of the nerve root(s), and

all three patients had no history of injury or inflammation at the painful site(s). Slight motor weakness in the leg was seen and ipsilateral Achilles tendon reflex (ATR) was very weak or nil in each patient.

In all three patients, the neuropathic pain did not respond to a variety of treatments for FBSS, including trigger point injection (TPI) with a regional anaesthetic, several kinds of somatic nerve block (SNB), lumbar-sympathetic ganglion block (LGB), spinal cord stimulation (SCS) and/or medications (non-steroidal anti-inflammatory drugs, morphine, and gabapentin). BD in the painful areas of the foot showing allodynia was attempted for pain relief, according to the guideline.⁴ Prior to BD, the background, objective, expected outcome, possible side effects and possible harmful events were explained to the patient, and informed consent was obtained.

First, the spots in the foot showing the most severe allodynia were identified in each patient, which included the calcaneus, cuboideus, metatarsal bones and proximal bones (table 1). After infiltration anaesthesia with 1% lidocaine (1 ml/spot) at the spots, bones were drilled with fluoroscopic assistance using an 18-gauge needle until the marrow was reached. When the cortex was penetrated, marrow was aspirated from an attached syringe. A small amount of contrast medium was injected to verify that the needle tip was within the marrow. After stopping spontaneous backflow of marrow blood from the needle, the needle was removed. The wound was compressed for several hours (figure 1).

The effects of BD were similar in all three patients. Spontaneous pain diminished immediately, and allodynia was completely resolved. Visual analogue scale score decreased immediately after BD. No adverse events were noted. However, severe numbness remained. Motor weakness and ATR stayed unchanged. The analgesic effect was kept for 30–45 weeks after BD and extinguished gradually.

Table 1 Clinical data and BD results of three patients

Case	1	2	3
Age; gender	36 years; female	23 years; male	49 years; female
Body weight; height	55 kg; 1.61 m	65 kg; 1.68 m	52 kg; 1.58 m
Diagnosis	Disc hernia (L5/S)	Disc hernia (L5/S)	Disc hernia (L4/5)
Surgeries	Love's surgery, laminaectomy	Love's surgery, laminaectomy	Love's surgery, laminaectomies (twice)
Duration from injury	1 year	2 years	2 years
Duration after surgeries	41 weeks	114 weeks	87 weeks
Injured root(s)	Right S1	Left L5, S1	Right L5
Drilled bones	Calcaneus, cuboideus, 5th metatarsal bone, 5th proximal bone	Calcaneus, 5th metatarsal bone	Calcaneus, 2nd and 4th metatarsal bones
VAS*			
Before BD	82 mm	76 mm	77 mm
immediately after BD	36 mm	19 mm	12 mm
2 weeks after BD	22 mm	20 mm	10 mm
20 weeks after BD	45 mm	33 mm	24 mm
30 weeks after BD	48 mm	40 mm	37 mm
At recurrence	48 mm	42 mm	55 mm
Duration of the effect†	30 weeks	44 weeks	38 weeks
Severe numbness	No effect	No effect	No effect
ATR	Unchanged (very weak)	Unchanged (nil)	Unchanged (very weak)
Slight motor weakness	Unchanged	Unchanged	Unchanged

*Visual analogue scale score for spontaneous pain. Allodynia was completely resolved.

†The analgesic effect was judged to be extinguished when allodynia recurred.

ATR, Achilles tendon reflex, BD, bone drilling.

Allodynia recurred, when the bone pores had refilled. Then the patients again received BD and again similar results have been observed.

OUTCOME AND FOLLOW-UP

BD analgesia was evident in all three patients and may be a novel therapy for chronic pain. However, the pain relief mechanism is mysterious. Even though the nerve root was injured, BD alleviated the pain. The results strongly suggest certain involvement of the local bone in pain. However, numbness remained, suggesting independence from the bone. The results strongly suggest certain involvement of the local bone in pain, but not numbness that may be induced by nervous involvement. According to the literature,^{1–3} the effect maintains several months or a few years until the bone hole was filled in, and while BD into the marrow had an analgesic effect, BD within the cortex had no effect.

DISCUSSION

Little information was available from our three cases: immediate analgesia from BD, no response to LGB and SCS, and no effect on numbness. According to past reports, BD analgesia lasts until the holes are filled (several weeks or a few years), and has to be repeated.^{1–3} In the present cases, allodynia and spontaneous pain recurred 30–45 weeks after BD. Release of an increased bone marrow pressure has been speculated to contribute to quick analgesia. Patients had local pain when pressure was exerted on the syringe while injecting contrast medium into the marrow. This phenomenon suggests that marrow pressure elevation may produce pain. Also, contrast medium did not relieve pain. However, the rich capillaries in the marrow should allow easy pressure diffusion (figure 1). Therefore,

it remains unknown that how an injured nerve increases marrow pressure persistently. Measuring marrow pressure involves making a hole, which will release the pressure. Therefore, a controlled study is difficult. Nevertheless, the hypothesis of osseous involvement attracts interest, because chemical mediators, receptors and ion channels cannot explain the quick analgesia.

Simple devices are required for BD. A conventional needle can penetrate small bones, a marrow tap needle is used for hard bones, and a drilling machine may be used for large bones. In osteoporotic patients, careful drilling is necessary because a needle pierces easily and injures tissues behind the bone. Probable complications of BD are haemorrhage, infection, ectopic tissue injury and fracture.

A placebo effect is not uncommonly encountered in pain treatment. In placebo effects, immediate relief of chronic pain is not unusual but sustained relief is unlikely. In our three cases, a session of BD conferred sustained analgesic effect, even on allodynia, for several months. This phenomenon is clearly not a placebo effect. Furthermore, all three patients had been treated with TPI, SNB, stellate ganglion block and SCS; none had any effect. If there were a surgical placebo effect, it would have been stronger with SCS that requires a skin incision and more invasive procedures than drilling (puncturing) with a needle. That is why we believe that the BD effect could not have been a placebo effect.

In three patients, drilling until the marrow cavity of the bones at painful sites effectively relieved chronic neuropathic pain with lasting analgesic effect, suggesting that BD may be a novel therapy for some chronic pains. The efficacy and safety of this procedure should be proven by randomised controlled trials, and further investigation is required to clarify the mechanism underlying between chronic pain and BD.

Figure 1 Bone drilling (BD) for chronic pain. In cases 1 (A–C), 2 (D, E) and 3 (F, G), the calcaneus (A, D), cuboideus (B), metatarsal bone (E–G) and proximal bone (C) were drilled. In case 2, the calcaneus was drilled at two spots (arrowhead in D indicates the former spot). Contrast medium leaking into the surrounding tissue stayed for over 10 min (open arrows), whereas that injected within the marrow diffused promptly into the vein and each vein was quickly silhouetted (filled arrows).

Learning points

- Relevance of pain sensitisation and bone tissue.
- Effectiveness of BD on chronic pain.
- Bone marrow pressure and pain.

Competing interests None.

Patient consent Obtained.

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