Spinal Cord (2008) 46, 756–757
 1362-4393/08 $32.00
www.nature.com/sc

CASE REPORT

Vestibular stimulation can relieve central pain of spinal origin

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Study design: Single-blind, placebo-controlled case report.
Setting: Center for Brain and Cognition, University of California, San Diego, CA, USA.
Objective and results: We present the case of a 64-year-old woman with right-sided central pain following transverse myelitis of her cervical spinal cord in 2002. We investigated whether her pain could be improved beyond a placebo response by cold caloric vestibular stimulation. She had very little response to two placebo procedures but felt her pain to be markedly lowered in her neck and upper limb by vestibular stimulation. This reduction lasted around 10 days, during which she reported that her pain in these areas was the lowest they had been for years.
Conclusions: Her pattern of pain relief is very similar to that reported by patients with central pain arising after thalamic stroke who have reported relief from vestibular stimulation. On the basis of thermosensory disinhibition hypothesis of central pain, we suggest that vestibular stimulation has this beneficial effect because of the intimate anatomical connections between the parieto-insular vestibular cortex and the thermosensory cortex in the dorsal posterior insula.
Spinal Cord (2008) **46,** 756–757; doi:10.1038/sc.2008.47; published online 3 June 2008

Keywords: spinal cord injury; myelitis; central pain; vestibular; analgesia

Introduction

A particularly difficult variety of pain that needs to be treated in post-spinal cord injury is the central pain that arises from spinothalamic tract damage.[1] We recently found that some patients with central pain arising after hemispheric strokes can obtain sustained relief from caloric vestibular stimulation (CVS).[2,3] Given that the pain in these patients and the pain following damage to the spinothalamic tract in the spinal cord are both proposed to arise from a disruption of cold thermoperception,[1,4,5] we carried out a single-blind, placebo-controlled trial of cold CVS in a patient with pain following myelitis of her cervical spinal cord.

Case report

UCSD's institutional review board gave ethical approval. A 64-year-old right-handed woman who had transverse myelitis of her cervical spinal cord in 2002 gave signed consent to participate. She had presented with pain across the neck, difficulty in walking and numbness in both hands. Shortly thereafter, she developed pain, which she describes as tightness, affecting the right side of her body from the neck down. Although the other symptoms gradually resolved, the pain has persisted and worsened over the years. A magnetic resonance imaging (MRI) scan confirmed two discrete patches of inflammation at C2 and C5. Her MRI brain scan was normal.

She described cold allodynia of the right arm and leg and impaired perception of cold on the right side. Over the years, she had tried nonsteroidals, amitriptyline, oxycodone and pregablin without any relief. When we saw her, she was on gabapentin 300 mg t.d.s. with only slight benefit. She rated her overall pain on a scale of 0 (no pain) to 10 (most intense imaginable) as being 6.5 (Table 1).

Over a 2-day period, she underwent two placebo procedures and ice-cold CVS of both ears. On day 1, she had body-temperature water irrigated into her right ear canal. This behaviurally mimics CVS but has no biological effect. She subsequently rated her overall pain as 6. An hour later, she underwent right CVS. Afterward, she reported that the pain was 5 overall and had particularly fallen in her neck (6–3.5) and hand (5.5–4.5).

On the next day, her pain overall was 5.5 but was still reduced below normal in her neck (3) and hand (4). She then underwent a second placebo procedure in which she was asked to place her left hand on a thermal grill for three periods of 30 s. This is a device in which interlaced warm and cool bars create the sensory illusion of burning thermal pain.[1,5] Our aim was to mimic the unpleasant nature of cold

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Received 20 February 2008; revised 10 April 2008; accepted 14 April 2008; published online 3 June 2008

Table 1 Ratings of pain intensity by patient at different locations and time-points, on a scale of 0 (no pain) to 10 (most intense pain imaginable)

	Neck	*Hand*	*Waist*	*Foot*	*Overall*
Day 1 baseline	6	5.5	6	7.5	6.5
Post right ear tepid	6	5.5	5.5	6.5	6
Post right CVS	3.5	4.5	5.5	6	5
Day 2 baseline	3	4	5	6.5	5.5
Post thermal grill	2.5	4	5.5	6	5.5
Post left CVS	0.5	3	4	5.5	4.5
Day 3 baseline	1	3.5	5	6	4

Abbreviation: CVS, caloric vestibular stimulation.

CVS. However, her pain ratings were barely altered and remained overall as 5.5. After an hour, she underwent left CVS. Again, she felt the greatest reduction in her neck (0.5) and hand (3) with her overall pain falling to 4.5. The following day, she returned and rated her pain overall as 4 with the pain in her neck (1) and hand (3.5) still significantly reduced from normal. The patient reported that her pain was reduced for about 10 days after CVS and that she was continuing with it herself.

Discussion

The thermosensory disinhibition hypothesis proposes that central pain arises from the loss of the central inhibition of pain by cooling. This occurs because temperatures below 25 °C activate both cold thermoreceptors (Aδ fibers) and also C-nociceptors. These inputs pass in the spinothalamic tract to the thalamus, where the C-fiber input goes to the anterior cingulate cortex (ACC) and the Aδ fiber input passes to the thermosensory cortex in the dorsal posterior insula (dpIns).[1,4,5]

Normally, when Aδ-fibers activate dpIns, it acts (through the brainstem) to suppress the perception of pain at the ACC. However, when the temperature falls below 15 °C, the C activity predominates over the Aδ activity. Therefore, the ACC is no longer suppressed by dpIns, and potentially harmful cold temperatures are perceived as painful. Consequently, lesions of the spinothalamocortical pathway terminating in dpIns can disinhibit the ACC and cause pain.[1,4,5] This also explains the mechanism underlying the aforementioned thermal grill illusion, as the warm (40 °C) bars reduce the Aδ thermoreceptive activity to unmask the C-fiber activation by the cool (20 °C) bars.[1,5]

We propose that CVS reduces central pain by activating the parieto-insular vestibular cortex.[3] As this area is anatomically adjacent to dpIns, it may cross-activate it to suppress the ACC, or given both these cortical areas share pathways in the brainstem this may be the mechanism by which pain is suppressed. The stroke patients who responded also noted differential relief in the upper body and arm compared with the leg,[2,3] which may reflect the somatopic organization of the ACC.[6] With repeated irrigation, these patients gained greater relief in their lower limb and, in some cases, only need CVS every couple of weeks to keep their pain down.[2]

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