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CLINICAL REPORT

Spinal cord stimulation for a woman with complex regional pain syndrome who wished to get pregnant

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Abstract A woman with complex regional pain syndrome (CRPS) in the right lower extremity who wished to discontinue medications to get pregnant underwent implantation of a spinal cord stimulation system (SCS). An electrode lead was placed at $Th_{10–11}$ in the epidural space, accessed via the $L_{2–3}$ interspace with a paramedian approach, and a pulse generator was implanted in the left buttock. She kept the SCS on 24 h a day. After she had experienced several chemical abortions, finally she got pregnant via artificial insemination. She had an uneventful delivery of a healthy baby by cesarean resection under spinal anesthesia. In a patient with CRPS who has an implanted SCS system and wishes to get pregnant, the electrode lead into the low thoracic epidural space should be accessed via the high lumbar intervertebral space in consideration of a future requirement for spinal or epidural anesthesia for cesarean section. The generator should be placed in the buttock to prevent impairment of the SCS system being caused by the enlarged abdomen during pregnancy. Although we were apprehensive of adverse effects owing to the electromagnetic field force and change of blood flow in the pelvic viscera, our patient had a successful delivery. SCS is a favorable option for patients with CRPS who wish to get pregnant.

Keywords Spinal cord stimulation · Complex regional pain syndrome · Pregnancy · Delivery

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Introduction

Complex regional pain syndrome (CRPS) is a chronic pain disorder and is often difficult to treat. Multimodal and multidisciplinary interventions including occupational therapy, physiotherapy, pharmacotherapy, psychological therapy, and interventional therapies are recommended for the treatment of chronic pain disorders like CRPS [1]. Although anticonvulsants, antidepressants, opioids, *N*-methyl-D-aspartate (NMDA) receptor antagonists, and other drugs are used as pharmacotherapies for CRPS, many of them have adverse effects on fetuses (see "Discussion"). On the other hand, although spinal cord stimulation (SCS) for CRPS leads to long-term pain reduction and improvements in quality of life and has thus been established as an effective treatment [2], the manufacturers of the devices used do not recommend the use of SCS during pregnancy because the safety of SCS for the embryo/fetus remains unclear. CRPS is considered to mainly affect women aged 25 to 55 years [3]. Thus, it is expected that the current trend towards later-in-life pregnancy will result in an increase in the number of female CRPS patients who wish to get pregnant. We report the case of a woman with CRPS who had a successful delivery of a healthy baby after SCS implantation was performed to allow her to stop receiving various medications during pregnancy.

Case report

A 30-year-old woman who had received arthroscopic partial limbectomy for osteoarthritis secondary to right acetabular hypoplasia subsequently developed pain, coldness, swelling, skin color changes, and hyperalgesia in her right lower extremity. Four years after the surgery, she visited

our outpatient clinic and was diagnosed with CRPS. Initially, she was treated with block therapies (epidural injections) and oral dextromethorphan. These therapies resulted in a decrease in her pain relief score (PRS) from 10 to 6 (initial pain 10, pain free 0). After several months, oral ketamine was added because intravenous ketamine had been effective. This combination treatment reduced her PRS to 5, and she deemed the pain control satisfactory. At the age of 35 she wished to get pregnant; however, she was afraid of the adverse effects of the medications on the fetus. We referred her for SCS treatment so that she could discontinue the medications. We explained that although the effects of SCS on conception and pregnancy were unknown, it would be better for her fetus than her current pharmacotherapy, and we obtained her informed consent for the use of SCS. After a successful one-week trial of SCS, the SCS system was permanently implanted. The tip of an electrode lead with 4 electrodes (Pisces^{TM} Quad Model 3487A; Medtronic, Minneapolis, MN, USA) was placed on the right dorsal cord at $Th_{10–11}$ in the epidural space, which was accessed via the $L_{2–3}$ interspace using a left paramedian approach. A pulse generator (Itrel 3^{TM} neurostimulator; Medtronic) connected to the quad lead was implanted into the left buttock (the initial SCS conditions were: amplitude 3.1 V, pulse width 300 μs, rate 18 Hz) (Fig. 1). After the SCS implantation, the block therapies and pharmacotherapy were discontinued. Her PRS decreased to 3 with SCS alone. In the first year after the SCS implantation she turned the stimulator on during her waking hours and turned it off during sleep, but from the second year onwards she left it on 24 h a day. Before the implantation of the SCS at the age of 32 she had experienced a chemical abortion of a natural conceptus. After the implantation of the SCS she underwent two further chemical abortions of natural conceptuses, at the ages of 35 and 37, and, at the age of 39, she underwent another abortion in the second month of a pregnancy resulting from artificial insemination. Finally, when she was 40 years old, after a pregnancy achieved through artificial insemination (SCS conditions during pregnancy: amplitude 4.1 V, pulse width 450 μs, rate 21 Hz) she had a successful delivery of a healthy female baby by cesarean section. She wished to have her baby via cesarean section as she had difficulty achieving flexion with her right hip joint. The cesarean section was performed uneventfully under spinal anesthesia via a right paramedian approach to the $L_{3–4}$ interspace.

Discussion

In the United States Food and Drug Administration's pregnancy drug category system, most anticonvulsants and antidepressants, as well as dextromethorphan, are allocated to Category C (Animal reproduction studies have shown that they have adverse effects on the fetus, but there have been no adequate and well-controlled human studies), whereas ketamine belongs to Category B (Controlled reproductive studies have been performed on animals and did not indicate a risk to the fetus. No adequate and well-controlled studies have been performed on pregnant

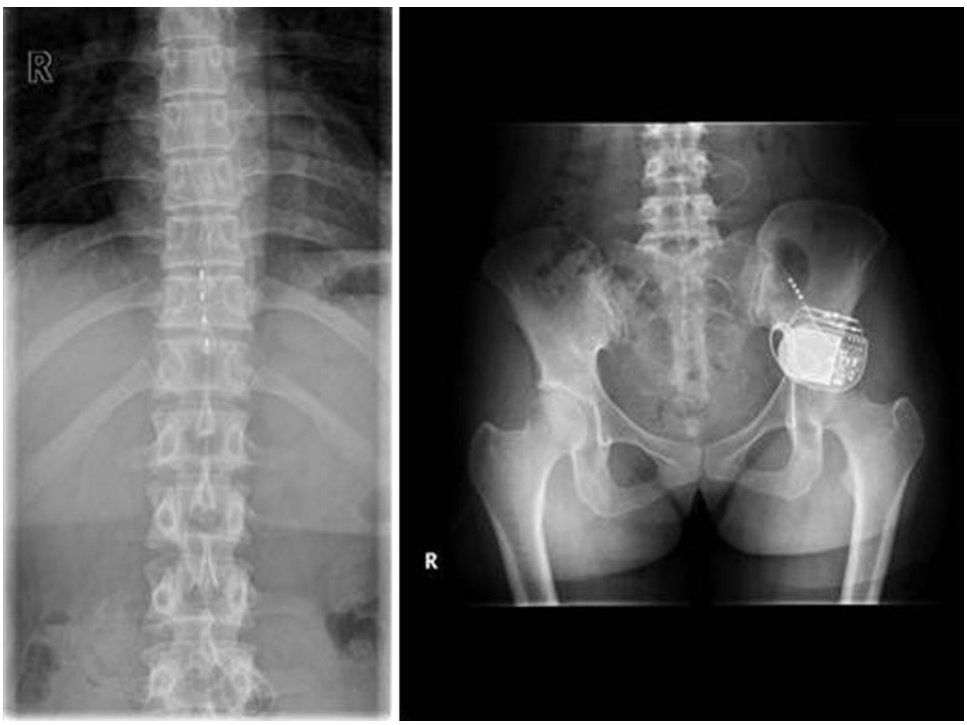

Fig. 1 Roentgenogram of spinal cord stimulation system. The tip of an electrode lead with 4 electrodes was placed on the right dorsal cord at $Th_{10–11}$ in the epidural space. The pulse generator was implanted in the patient's left buttock

women). Thus, because our patient wanted to discontinue her medications before getting pregnant we proposed the implantation of an SCS system.

Although SCS is effective; i.e., it reduces pain and improves quality of life, in patients with CRPS [4], the effects and safety of SCS on conception have never been studied. It is supposed that SCS mainly improves microcirculatory blood flow through the antidromic activation of spinal afferent neurons and the inhibition of sympathetic efferents; thus, SCS has also been applied for the treatment of arteriosclerosis obliterans and angina pectoris [5]. Although SCS might have some effects on conception by also inducing changes in the blood flow of the pelvic viscera, such change in the blood flow has never been investigated.

The extremely low-frequency electromagnetic field (EMF) forces generated by SCS might be problematic for conception. Li et al. [6] reported that the risk of miscarriage increased with exposure to an increasing maximum EMF level greater than 16 mG (1.6 μT), and the relationship was stronger for early miscarriages (<10 weeks of gestation). Bracken et al. [7] reported that neither exposure to an EMF greater than 2 mG (0.2 μT) nor the use of an electrically heated bed during pregnancy was related to the risk of low birth-weight infants or fetal growth retardation. The World Health Organization has stated that there is no proof that exposure to EMF increases the risk of harmful effects on pregnancy, except for increasing the risk of miscarriage. Considering the very weak EMF in our patient (<0.05 μT, given the distance from the spine to the uterus was 0.25 m and the magnetic permeability of body tissue is equivalent to that of water) calculated from the low-voltage amplitude (<12 V) generated by SCS and the closeness between the negative and positive electrodes, the EMF is considered to have had little effect on the pelvic viscera region.

Segal reported the first case of a woman with CRPS who underwent implantation of a cervical SCS system with a generator in the upper gluteal region in order to discontinue her medications. She had a successful vaginal delivery of a healthy female baby without turning off the SCS during pregnancy or delivery [8]. In the second case, Hanson and Goodman [9] reported a woman with a cervical SCS whose baby was delivered with epidural analgesia for labor pain management. However, they did not mention whether she kept the SCS on during pregnancy. Saxena and Eljamel [10] reported a woman who got pregnant 9 years after the implantation of a high thoracic SCS. However, she developed acute mechanically induced pain at the junction of the epidural lead and lead extender (LE) because of overstretching caused by the enlargement of her abdomen during pregnancy. Therefore the LE wire was surgically cut in the 28th week of gestation. Bernardini et al. [11] reported two cases. In the first case, the patient got pregnant after the implantation of a low thoracic SCS with a generator placed in the buttock. She kept the SCS turned off during pregnancy and had a vaginal delivery of a healthy baby. In the second case, although the patient underwent implantation of a cervical SCS with a generator placed in the buttock, she did not activate the SCS from 8 weeks of gestation. She had a healthy baby delivered via cesarean section under general anesthesia.

The main features of our case were as follows: (1) the electrode lead was implanted into the low thoracic epidural space via the high lumbar intervertebral space, (2) the generator was installed in the patient's buttock, (3) the SCS system was kept on during pregnancy, (4) the patient got pregnant via artificial insemination, (5) the patient had experienced several abortions, and (6) her baby was delivered via cesarean section under spinal anesthesia. Although we were apprehensive about the adverse effects on the fetus of the lower thoracic SCS close to the pelvic viscera, our case was the first in which a healthy baby was successfully delivered after a low thoracic SCS system had been kept on throughout pregnancy. When an SCS system is employed in a CRPS patient who wishes to get pregnant, the electrode lead should be accessed via the high lumbar intervertebral space, with consideration given to the possibility of the future requirement of spinal or epidural anesthesia for cesarean section. Furthermore, the generator should be placed in the buttock to prevent impairment of the SCS system being caused by enlargement of the abdomen during pregnancy. Although our patient had undergone several chemical abortions, we think that they were not associated with the SCS because she had also undergone such procedures before the implantation of the SCS.

In conclusion, we report the case of a woman with CRPS who had a successful delivery of a healthy baby while using an SCS system instead of her medications in order to allow her to get pregnant. We believe that SCS is a favorable option for chronic pain management during pregnancy for women with CRPS. Further case accumulation is necessary to ensure the safety of SCS during pregnancy.

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