

SACRAL NEUROMODULATION: A CADAVERIC STUDY ON EFFICACY OF SURFACE MARKING AND BONY LANDMARKS

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Abstract

Neuromodulation is the fundamental concept of delivering electrical charges to the nervous system by placing some form of stimulating electrode adjacent to the target neural tissue. Sacral neuromodulation (SNM) is a form of peripheral nerve stimulation that applies low-intensity chronic stimulation to a sacral spinal nerve (usually S3). Available systems for SNM incorporate a basic final assembly of an electrode lead connected to an implanted pulse generator (IPG). To locate the sacral nerves during the procedure, knowledge of surface markings and the

bony landmarks in the sacral region is very useful.

The procedure has been reported to fail in some cases. This study was used to answer this question by determining the reliability of certain anatomical landmarks. The needles were placed to each needle tip in connection to the upper part of the Sacral 3 foramen could be assessed. If the bone is visible, each foramen can be distinguished. For the upper part of the Sacral 3 foramen, the distance from the tip of each needle was assessed. The needle's entry into the foramen was also noted. From the tip of the coccyx

to the level of S3 bilaterally all of the dimensions were measured as well as from the middle ridge of the sacrum of the S3 lateral aspect to the foramina on either side and reported. The tip of the coccyx to the level of S3 (TC-S-S3) is 9.29 ± 0.55 and the middle ridge of the sacrum of the S3 lateral measurement (MSR-LS3) is 2.31 ± 0.08 . In the female cadaver tip of the coccyx to the level of S3 (TC-S-S3) is 9.27 ± 0.2 and middle ridge of the sacrum of the S3 lateral measurement (MSR-LS3) is 2.15 ± 0.07 . In the male cadaver tip of the coccyx to the level of S3 (TC-S-S3) is 9.15 ± 0.44 and the middle ridge of the sacrum of the S3 lateral measurement (MSR-LS3) is 2.09 ± 0.07 . For in-office blind percutaneous nerve examination, a distance of 9 cm from the tip of the coccyx is an acceptable starting point (PNE). However, because coccyx length varies, caution should be exercised; also, sensory-motor response is required to validate appropriate positioning.

Keywords

Sacral neuromodulation, cadaveric study, Sacral nerves, surface markings, bony landmarks

Introduction

Sacral spinal neuromodulation (SNM) has established itself as a treatment for functional problems of the pelvic organs, including urinary and anorectal reasons. It's a procedure in which an implantable neurostimulator stimulates the sacral nerve, which regulates the bladder, intestine, and pelvic floor, as well as the muscles that control their function. The nerves that supply the bladder, bowels, urinary and anal sphincters, and pelvic floor muscles are modulated by electrical stimulation. This regulates and enhances the person to perceive the sensation of bladder fullness and the desire to empty the bladder, spontaneously and completely. Through an external programmer, both the physician and the patient can change the frequency and intensity of the neurostimulator's impulses. To locate the sacral nerves during the procedure, knowledge of surface markings and the bony landmarks in the sacral region is very useful. Sacral neuromodulation is a highly effective therapy option that was recognized by the FDA in 1997 as a suggested treatment for a variety of pelvic-related diseases (e.g., overactive bladder and chronic non-obstructive urine retention) [1]. Various studies have suggested the stimulation of Sacral 3 (S3) to produce desirable results, as S3 has

minimal influence on the nerve supply of the lower limbs [2].

SNM increases sphincter action by stimulating efferent neurons, and afferent nerves control reflexes, therefore it is important for the recovery of functions in the pelvic structures [1,3]. Because stimulation is performed using anatomical markers, the results of this therapy vary greatly even within the same patient. This could be owing to the difficulty of properly appreciating landmarks and pinpointing their exact location. If the sacral foramina through which the sacral nerves emerge are correctly identified and the electrode is put appropriately, patients will benefit greatly.

If the needle is placed incorrectly in the foramina, it may cause undesirable stimulation of the higher-up nerves, making the required neuromodulation harder to achieve. The greater sciatic notch must be palpated to execute this technique; however, for many people, this is difficult, hence some experts recommend using fluoroscopy to find and place the lead. However, because fluoroscopy is time-consuming and can be avoided, a detailed study and thorough understanding of the geometry of S3 in relation to the surrounding bony landmarks may lessen relying on it. The problem of how surface

marking is used to identify these nerves remains unanswered.

Fluoroscopic techniques have been employed and are thought to be extremely safe. The SNM lead is implanted in stages or via percutaneous nerve assessment after aseptic measures have been taken [4-8]. There is a considerable likelihood of variation between examiners, particularly in the lumbar spine, which includes the spinal segments [9-10]. This enables simpler palpations, such as the sacroiliac osseous bone landmarks [11]. According to Haas et al., no single study has been conducted to demonstrate the reliability of the commonly used static palpation. The current work was carried out to fill this gap by describing the geometric characteristics and position of the S3 foramen with several pelvic bone landmarks. This study is a pilot study to find whether continuing the study further would be meaningful.

Materials and Methods:

It's a cross-sectional study. Ten cadavers (five male and five female) were used and dissected in the department of Anatomy after convenience sampling. Descriptive statistics are reported as standard deviation (SD), mean, and range.

Inclusion criteria:

The sacral area was intact.

Exclusion Criteria:

Sacral injuries

Sacral region anomalies

	Number	Mean	Range
TC-S-S3	10	9.29±0.55	8.5-9.9
MSR-LS3	10	2.31±0.08	2.1-2.4

Materials and methods:

The study was done in the Department of Anatomy, Jaipur National University Institute of Medical Sciences and Research Center, Jaipur. The study was conducted from Dec 2020 to November 2021. The needles were placed so as to each needle tip in connection to the upper part of the Sacral 3 foramen could be assessed. If the bone is visible, each foramen can be identified. For the upper part of the Sacral 3 foramen, the distance from the tip of each needle was assessed. The needle's entry into the foramen was also noted. All dimensions were measured and reported from the tip of the coccyx to the level of S3 bilaterally, as well as from the central ridge of the sacrum of the S3 lateral aspect to the foramina on each side. All the dimensions were measured using a digital caliper.

Result:

Table 1: Tip of the coccyx to the level of S3 (TC-S-S3) and middle ridge of the sacrum of the S3 lateral measurement (MSR-LS3):

Table 2: In Female cadaver tip of the coccyx to the level of S3 (TC-S-S3) and middle ridge of the sacrum of the S3 lateral measurement (MSR-LS3):

	Number	Mean	Range
TC-S-S3	5	9.27±0.2	9.1-9.5
MSR-LS3	5	2.15±0.07	2-2.25

Table 3: In male cadaver tip of the coccyx to the level of S3 (TC-S-S3) and middle ridge of the sacrum of the S3 lateral measurement (MSR-LS3):

	Number	Mean	Range
TC-S-S3	5	9.15±0.44	8.9-9.5
MSR-LS3	5	2.09±0.07	2-2.45

Discussion:

Sacral nerve stimulation is used for a number of varying pathologies which

range from that concerned with urinary bladder to the pathologies concerned with fecal inconsistencies and also in the field of obstetrics and gynecology. This modality of the treatment was introduced first in the year 1994^{16,17}. The procedure is known to not only improve the symptoms in patients but also improve the quality of life¹⁸⁻²⁰.

In the study conducted by Nicolette et al. mean tip of the coccyx to the superior aspect of S3 was found to be 9.3 ± 0.9 cm.⁶ In males it was found to be 9.4 ± 1.0 cm and in females, it was found to be 9.2 ± 0.7 cm. The middle sacral ridge to the lateral aspect of S3 was found to be 2.3 ± 0.2 cm. In males, it was found to be 2.3 ± 0.2 cm and in females, it was found to be 2.3 ± 0.2 cm.

Although it's a fair estimate, one has to understand the fact that the length of the coccyx differs from person to person. Adjacent foramina proximity to each other and the variations in emerging of the nerve are a few things to be remembered while performing the procedures. Based on the present study findings, a distance of 9 cm from the tip of the coccyx and 2 cm lateral to the midline is a reasonable starting landmark for in-office blind percutaneous nerve evaluation (PNE). However, given the variability in coccyx length and proximity of adjacent foramina, extra caution, and reliability on nerve-

stimulation sensory-motor response, is necessary. When patients have an ambiguous or unsatisfactory sensory-motor response, providers should be suspicious of improper needle placement into the foramen. We also recommend that, during PNE, the patient be asked open-ended questions about sensation to prevent leading the patient to a specific response. If a clear response is not obtained, the physician must choose between finishing stage 1 implantation or using fluoroscopy. Additionally, the sacroiliac joint (SIJ) shows strong potential as an S3 foramen landmark and should be studied further for its application in sonographic assistance of PNE.

Conclusion:

For in-office blind percutaneous nerve examination, a distance of 9 cm from the tip of the coccyx is an acceptable starting point. However, because coccyx length varies, caution should be exercised; also, sensory-motor response is required to validate appropriate positioning. This study helps in understanding the importance of the difference in the measurements in our population. Further studies will be carried out to understand the measurements better in our population. Further studies will be carried out to

understand the measurements better in our population and probably this will be taken up as a thesis topic for the doctor of philosophy by the first author.

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