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# Interpectoral Block: Where does the Solution Spread to? An MRI Study in Volunteers

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## Abstract

**Objective:** Interpectoral block appears to be equivalent to serratus block in providing analgesia following breast cancer surgery. One proposed mechanism of action of interpectoral block is the lateral spread of local anesthetic into the axillary compartment to anesthetize the intercostal nerves. The main objective of this prospective magnetic resonance imaging (MRI) study was to assess the spread of 20 ml of sodium chloride injected into the interpectoral space in healthy volunteers.

**Methods:** A catheter was inserted into the interpectoral compartment under ultrasound guidance in 12 healthy volunteers. Immediately before starting the MRI, 20 ml of sodium chloride was slowly injected through the interpectoral catheter. Two MRI sequences were performed in the sagittal plane (T2 short TI inversion recovery and 3D T2-SPACE). The spread of sodium chloride into the axillary compartment was assessed and quoted by a radiologist.

**Results:** We included 12 volunteers (8 females and 4 males, median age 46 years). In all of the volunteers the sodium chloride remained in the interpectoral compartment. However, it spread to sub-cutaneous tissue in eight of the volunteers.

**Conclusions:** Our study confirmed that in healthy volunteers, no connection exists between interpectoral and axillary compartments. Therefore, the analgesic effect of interpectoral block is not mediated by participation of the lateral cutaneous branches of the intercostal nerves.

***Keywords:*** *Interpectoral Block; MRI; Breast Cancer Surgery; Analgesia*

## Introduction

Breast surgery is often associated with post-operative pain and discomfort. Regional analgesia can provide adequate pain relief following breast surgery. Breast tissue is innervated by the intercostal nerves T2 to T6 [1] and regional analgesia can be achieved by blocking the intercostal nerves either in the vicinity of their roots (paravertebral block [2,3]) or more distally in the axillary compartment [4]. Axillary compartment block consists of injecting local anesthetic (LA) around the serratus muscle, and a variety of different approaches have been described [5-8].

Pectoral nerve block can also be used to provide breast tissue analgesia. The lateral and medial pectoral nerves arise from the brachial plexus with different variations and innervate mainly both the major and minor pectoralis muscles [9]. They do not innervate the mammary gland. Surprisingly, Wallaert., *et al.* reported four cases of excellent analgesia after breast cancer surgery, using a catheter inserted between the major and minor pectoralis muscles [10]. A recent study found that interpectoral block appeared to be equivalent to serratus block in providing analgesia following ambulatory breast cancer surgery [11]. The mechanism of action of interpectoral block remains questionable, and several hypotheses have been proposed. One theory involves the lateral spread of LA from the interpectoral space to the axillary compartment, where the lateral cutaneous branches of the intercostal nerves are located [12]. This has been corroborated by another study using a volume of LA varying between 15 to 20 ml [11].

This theory would suggest that the axillary and interpectoral compartments are in relation to each other. To test this hypothesis, we carried out a prospective study. Our main objective was to use magnetic resonance imaging (MRI) to assess the spread of 20 ml of sodium chloride injected into the interpectoral space of healthy volunteers. Our second objective was to assess the volunteers' tolerance to catheter insertion.

## Materials and Methods

Twelve members of our theatre team volunteered to participate in the present study. Informed written consent was collected from the volunteers after they had been provided with a detailed explanation of the study protocol. The president of the local ethics committee of our institute confirmed that the present study was in accordance with the local ethics policy.

Exclusion criteria for volunteers were as follows: less than 18 years of age, presenting with a contraindication to MRI, a physical American Society of Anesthesiologists (ASA) status of III or higher, pregnancy, innate or acquired coagulation disorders, and local infection at the puncture point.

All catheters were inserted in the recovery room of the theatre by the same anesthesiologist (RF). Each volunteer was supine, with the arms positioned along the body and standard monitoring was set up. The side of catheter insertion was randomized (six left and six right catheterizations) using sealed envelopes. After skin disinfection and positioning of a sterile drape, a local anesthesia of the puncture point was performed with 10 mg (1 ml) of lidocaine. All catheters were inserted under ultrasound guidance (Aloka, Hitachi, Vélizy-Villacoublay, France) using the technique described by Blanco., *et al* [13]. A linear high frequency (10 - 12 MHz) probe was used for all procedures and was covered with a sterile sheath. The interpectoral compartment was located and the pectoral artery was identified before commencing the puncture. The needle (18G, 50mm) was then introduced and advanced using an in-plane approach, ultrasound guidance was used for the entire procedure. Once the tip of the needle reached the interpectoral space, a "pigtail" distal end catheter (SonoLong Curl Echo™, Pajunk, Geisingen, Germany) was introduced 3 cm beyond the tip of the needle. At the end of the procedure, the catheter was secured with a sterile dressing. Immediately following catheter insertion, volunteers were asked to evaluate pain during the procedure. Pain was assessed using a numeric scale between 0 and 10 (0 being no pain and 10 being the worst pain imaginable).

The volunteer then walked to the MRI unit, where they were placed in a supine position with the arms along the body. Immediately before starting the MRI, 20 ml of sodium chloride (9 $g.L^{-1}$) was slowly injected through the interpectoral catheter. We considered the maximal spread would occur during fluid injection (i.e. maximal pressure through the syringe) and MR imaging should be started within 10 minutes following injection. The catheter was then removed to avoid artifacts on the MRI.

The MR imaging was performed with a 1.5T whole-body system (MAGNETOM Aera, Siemens System, Erlangen, Germany). The anatomical area was centered with a body and cervix phased-array coil to contain the upper thoracic outlet space. Two MRI sequences were performed in the sagittal plane. One was a T2 short TI inversion recovery (STIR - weighted) sequence with free-breathing (repetition time msec/echo time msec [11205.29; 58] with 4 excitations; a 3 mm section thickness and a 0.10 mm gap; 150° flip angle; 157 x 320 matrix size; a 72 cm x 35 cm field of view), 320 slides were acquired.

A 3D T2-SPACE sequence in a sagittal plane with reconstruction on a coronal and axial plane was also performed (repetition time msec/echo time msec [3481.19; 129]; a 1.45 mm section thickness and a 0 mm gap; 2 excitations; 160° flip angle; 320 x 269 matrix size; a 68.7 cm x 31.5 cm field of view).

Acquisitions were performed with navigator-triggered prospective acquisition correction (PACE) on the diaphragmatic expiratory position to limit breath artifacts.

All MRI images were recorded and reviewed by our institute's radiologist several days after the procedure. The quality of the MR imaging was quoted using a three-point scale (1 being of high quality, 2 being of the correct quality and 3 being of poor quality). The spread of sodium chloride into both the interpectoral and axillary compartments was assessed and quoted as 0 for no spread or 1 for positive spread. The spread into the axillary compartment was considered negative when the sodium chloride remained anterior to the axillary arteriovenous pedicle. An eventual sub-cutaneous spread of sodium chloride was also noted.

### Statistical analysis

The primary endpoint was the rate of subjects with no sodium chloride distribution into the axillary compartment. The following hypothesis was used for sample size calculation: p0 = 70% of the maximal number of subjects with no sodium chloride distribution into the axillary compartment for whom axillary and interpectoral compartments could be considered as related, p1 = 95% of the acceptable number of subjects with no sodium chloride distribution into the axillary compartment for whom axillary and interpectoral compartments could be considered as unrelated. Using a Fleming design (with alpha = 10% and beta = 10%, and with p0 = 70% and p1 = 95%) it was necessary to include 12 eligible subjects. If at least 12 subjects did not present sodium chloride distribution into the axillary compartment, the axillary and interpectoral compartments could be considered as unrelated.

Data are represented as number and median (extremes) for qualitative and quantitative variables, respectively.

## Results

We included 12 volunteers (8 females and 4 males). All but one of the volunteers (ASA status of 2) had an ASA physical status of 1. The median age, weight and height were 46 (24 - 67) years, 67 (46-82) kg and 169 (160 - 173) cm, respectively (Table 1). A catheter was inserted into the left and right interpectoral compartments equitably. The median pain score during catheter insertion was 1/10 (0 - 5). Eight volunteers reported a pain score of 0 or 1 (Table 1).

| | Sex | Age (yr) | Weight (kg) | Height (cm) | ASA | Side | NS |
|---|---|---|---|---|---|---|---|
| 1 | F | 46 | 60 | 160 | 1 | Left | 1 |
| 2 | F | 24 | 53 | 167 | 1 | Right | 1 |
| 3 | F | 42 | 46 | 160 | 1 | Right | 0 |
| 4 | F | 38 | 62 | 163 | 1 | Left | 1 |
| 5 | F | 57 | 71 | 170 | 1 | Left | 5 |
| 6 | M | 52 | 64 | 170 | 1 | Right | 3 |
| 7 | F | 44 | 70 | 172 | 1 | Left | 2 |
| 8 | M | 47 | 56 | 173 | 1 | Left | 0 |
| 9 | F | 42 | 72 | 165 | 1 | Right | 2 |
| 10 | M | 67 | 80 | 173 | 1 | Right | 0 |
| 11 | M | 59 | 82 | 170 | 1 | Left | 1 |
| 12 | F | 46 | 74 | 168 | 2 | Right | 1 |

***Table 1:*** *Demographic characteristics of the 12 volunteers, the side of catheter insertion and pain score (numeric scale between 0 being no pain and 10 being worst pain imaginable). F: Female, M: Male; NS: Numeric Scale.*

Two-thirds of the images were considered as being of high or correct quality (Table 2). For the remaining cases, some artifacts related to breath during MRI sequencing led to a poor-quality quotation, but this did not affect the final analysis. The sodium chloride remained in the interpectoral compartment in all of the volunteers (Table 2). None of the volunteers showed spread of the sodium chloride into the axillary compartment (Figures 1 and 2). However, the sodium chloride spread to sub-cutaneous tissue in eight of the volunteers.

| | Quality of the exam | Interpectoral spread | Axillary spread | Sub-cutaneous spread |
|---|---|---|---|---|
| 1 | 3 | 1 | 0 | 0 |
| 2 | 2 | 1 | 0 | 1 |
| 3 | 2 | 1 | 0 | 1 |
| 4 | 1 | 1 | 0 | 1 |
| 5 | 1 | 1 | 0 | 0 |
| 6 | 2 | 1 | 0 | 1 |
| 7 | 1 | 1 | 0 | 1 |
| 8 | 2 | 1 | 0 | 1 |
| 9 | 3 | 1 | 0 | 1 |
| 10 | 1 | 1 | 0 | 0 |
| 11 | 3 | 1 | 0 | 1 |
| 12 | 3 | 1 | 0 | 0 |

***Table 2:*** *Quality of MRI, and spread of sodium chloride into the interpectoral compartment, axillary compartment or sub-cutaneous tissue in the 12 volunteers. The quality of the examination was assessed using a three-point scale (1 being high quality imaging, 2 being the correct quality of imaging and 3 being poor quality imaging). The spread of sodium chloride was quoted as 0 (no spread) or 1 (positive spread).*

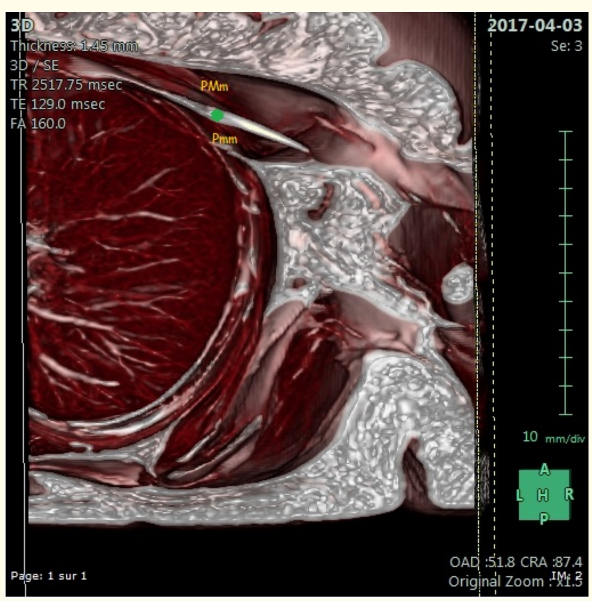


***Figure 1:*** *Typical 3D transversal MRI of an interpectoral compartment. The green star identifies the spread of sodium chloride, showing no extension to the axillary compartment. PMm and Pmm represent the pectoralis major and pectoralis minor muscles, respectively.*

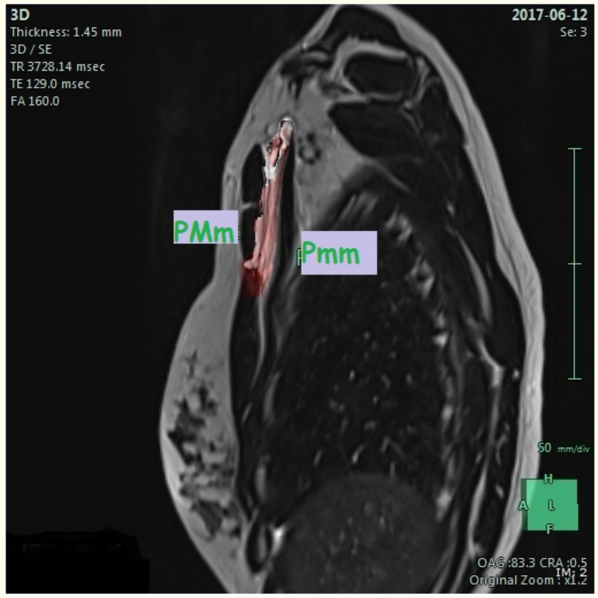


***Figure 2:*** *Typical 3D sagittal MRI of both axillary and interpectoral compartments. The fluid remained in the interpectoral compartment, with no spread into the axillary crease. PMm and Pmm represent the pectoralis major and pectoralis minor muscles, respectively.*

## Discussion

Our study confirms that in healthy volunteers, no connection exists between interpectoral and axillary compartments. Moreover, it provides new insights into the comprehensive mechanism of the spread of fluids injected between the major and minor pectoralis muscles.

A recent review article highlighted that no randomized studies of the analgesic effect of interpectoral block have been carried out [14]. The authors stated that evidence is needed to support the theoretical mechanism of chest wall analgesia after interpectoral block. Recently, Abdallah., *et al.* reported early analgesic benefits of interpectoral block, with similar effectiveness to serratus fascial plane block in reducing post-operative in-hospital opioid consumption and the classic opioid-related side effect, post-operative nausea and vomiting (PONV), following ambulatory breast cancer surgery [11]. The matched cohort method used in this study limits its impact. However, interpectoral block still seems an attractive technique for post-operative analgesia after breast surgery.

The mechanism by which interpectoral block produces breast tissue analgesia remains unclear and several hypotheses have been proposed: reduction of post-surgical muscular spasm in the pectoralis major and minor muscles, importance of the sensory component of these nerves, communication with the anterior branches of the intercostal nerves, and lateral spread to the terminal branches of the intercostal nerves [11]. The absence of a connection between both interpectoral and axillary compartments, as revealed by our study, may rule out the participation of the lateral cutaneous branches of the intercostal nerves. However, the surgery itself may split the underlying fascia that separates both compartments, and a spread of fluid into the axillary compartment could occur. Intramuscular has variations in spread direction depending on septa, positioning, volume, and giving pectoral block in a patient pre incision and post-surgical has great impact on such distribution due to a lot of dissection, especially when there is extensive excision. The present study did not aim to assess this hypothesis. Therefore, further investigation is warranted to study whether surgery has an impact on the connection between interpectoral and axillary compartments.

The usual amount of LA injected during interpectoral block is 10 ml [13]. In the present study we decided to inject 20 ml of sodium chloride to assess the effect of increasing the volume. Our study confirmed that a larger volume of fluid does not appear to have any advantages concerning the spread of fluid, as a sub-cutaneous diffusion of sodium chloride was noted in 8 out of the 12 volunteers.

Finally, it is interesting to note that the insertion of a catheter into the interpectoral compartment was well tolerated in all volunteers, with no other analgesia used other than a sub-cutaneous local anesthesia of the puncture point.

The main limitation of the present study included the number of volunteers and the absence of comparison to real patients post-surgical to predict real distribution.

## Conclusion

Our study confirms the absence of a connection between interpectoral and axillary compartments. Therefore, the analgesic effect of interpectoral block does not seem related to an action on the intercostal nerves. Further study is warranted to better understand the mechanism of action of this technique.

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## Conflict of Interest

The authors do not declare any conflict of interest in relation with the present article.

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