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Original Paper

## Pain Caused by the Pectus Bar Implant after the Nuss Procedure for Pectus Excavatum among Junior High and High School Children

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### Abstract

In this study, we aimed to clarify the pain caused by the bar implant and its duration after the Nuss procedure for pectus excavatum.

A semi-structured interview was conducted with eleven mothers and their junior high and high school children (twenty-two interviewees in total).

As a result, the following seven pains and their duration were clarified.

- ① Severe pain immediately after surgery and during hospitalization (Ten days after surgery),
- ② Pain when changing posture that continues for about three months,
- ③ Pain caused by restrictions on daily physical activities that continues for about three months,
- ④ Pain associated with whole-body vibration that continues for about three months,
- ⑤ Pain due to upper limb movement that continues for about six months,
- ⑥ Pain due to contact and impact that continues for about one year,
- ⑦ Pain or discomfort due to the bar implant that remains for one year or more,

In most of the pain categories, mothers described the duration of pain as being much longer than their children.

However, most mothers stated they were satisfied with the results, and that the occurrence of pain does not negate the necessity of this surgery.

### Introduction

Pectus excavatum is a congenital chest wall disorder associated with anterior chest deformity and depression, occurring in approximately one in every 800-1,000 children, causing the prolonged anxiety of both children and their families due to a marked cosmetic defect with psychological trauma and limitations of physical performance. Since the development of the Nuss procedure [1] in 1998, which is known as a minimally invasive surgical procedure and uses thoracoscopy combined with the appropriate placement of a stainless steel pectus bar (bar) for at least 2 years to achieve pectus excavatum correction, the number of patients who receive this surgery has been increasing [2]. This method of treatment facilitates minimal blood loss during surgery, a minimal recovery time after surgery [1], and improvement in QOL with high levels of postoperative satisfaction [3].

In Japan, children who have undergone the Nuss procedure are discharged after 7-10 hospital days and

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return home or to school. In order to prevent complications (bar migration, pain, and infection), the bar should be stabilized. Children should adhere to the postoperative restrictions regarding daily physical activities such as not turning over in bed for 1 month after surgery, no twisting at the chest, no slouching at the waist, no jogging or light exercise, and no heavy lifting or strenuous physical activity for 2 months after surgery. Our study revealed that children and their mothers encounter many problems in daily living. One of the main problems for junior high and high school children and their mothers was chest pain due to the bar implant and its associated psychological distress, compared to younger children [4].

This procedure is most commonly applied to children at 5-6 years of age[1] to avoid psychological repercussions [2] due to the cosmetic defect of deformity and depression after entering school or poor surgical results. Children of 12-13 years of age are in the secondary period to decide to receive surgery for those who have not had a chance at an earlier age. Recently, the mean age on receiving surgery has been gradually rising, and the cases of 16-year-old or more children are reported [2,5]. In the near future, patients of junior high and high school children are expected to increase. Jillian R et al. [3] conducted an interview survey involving four 12- to 14-year-old children and their mothers, and reported that children suffered from pain or discomfort 4-6 weeks after surgery. However, there is no survey report of children older than 14 years regarding the situation or period of experiencing pain. When subjects are older than 16 years or have a relatively large physique, this procedure sometimes requires the use of two bars or incision in the rib bone for pectus excavatum correction based on the degree of deformation. It is speculated that they have a stronger, more persistent pain than 5- to 6-year-old children [6,7], and various problems occur in daily life. Since the hospitalization period is becoming shorter, physicians are required to support children with understanding the expected pain after discharge.

In this study, we aimed to clarify the pain caused by the bar implant and its duration after the Nuss procedure for pectus excavatum.

## Methods

1. Subjects: Eleven mothers and their junior high and high school children who received the Nuss procedure at the pediatric surgery department of A Hospital, and were hospitalized for bar removal after a 2-year bar implantation period or visited the hospital for follow-up.

2. Data collection methods: A semi-structured interview was conducted for 30-60 minutes about “daily activities during the period of bar implantation” on an individual basis. After obtaining consent, contents of interviews were recorded with an IC recorder. When consent was not obtained, contents of interviews were transcribed.

3. Data collection period: August 2008 - May 2009

4. Analysis: After preparing verbatim records of the interviews, we extracted meaningful sentences describing pain during bar implantation and the period, and categorized them by separating the children’s and mothers’ responses according to the analysis method.

5. Verification: To eliminate bias, interviews were conducted by nurses with experience of pectus excavatum patients. If questions arose during the analysis, they were repeatedly discussed by the researchers and data were verified by confirming with the test subjects.

6. Ethical considerations: Written informed consent was obtained separately from the children and their mothers after explaining the objectives of this study, their right to refuse participation, privacy protection, benefits, risks, and publication of the study results. Regarding the interview with children, we respected the will of children by asking them if they desired to undergo the interview in the presence of their mothers, and told them that the interview would be discontinued if they developed pain or felt anxious. This study was approved by Kawasaki University of Medical Welfare's ethical committee (NO105).

Results

1. Subject attributes (Table 1)

Table 1 Subject attributes

Age when investigating	Sex	Situation of entering school on bar implantation	Bar insertion period(months)	Coexisting illness
14	Male	Junior high school	24	Aught
14	Male	Junior high school	25	Aught
15	Male	Junior high school	24	Aught
16	Male	Junior high school →High school	24	Aught
17	Female	Junior high school →High school	25	Aught
17	Male	High school	25	Aught
18	Male	High school	24	Aught
18	Male	High school	25	Aught
18	Male	High school	25	Having of bar migration from 2 to 1
18	Male	High school	25	Aught
19	Male	High school→university	24	Aught

The subjects consisted of 10 males and 1 female aged 14-19 at the time of the survey. Six of them were junior high and 5 of them were high school students on bar implantation. One high school student developed complications due to bar migration.

2. Pectus excavatum clinical pathway in A Hospital (Fig. 1)

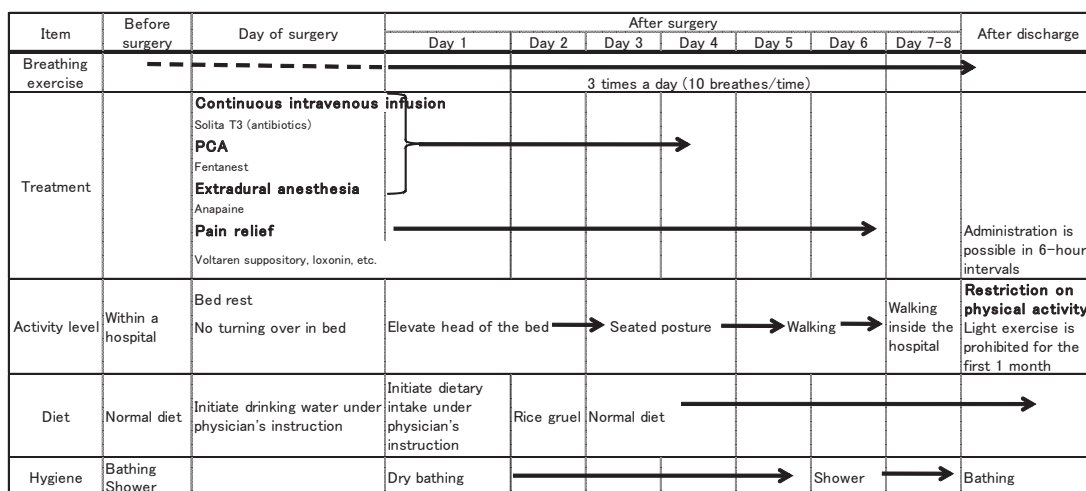


Fig. 1 Clinical pathway of the Nuss procedure for pectus excavatum in A Hospital

Standardized treatment and nursing care employing the clinical pathway were provided for children in A Hospital. Breathing exercise was started preoperatively with the use of breathing apparatus, and it was continued from the first postoperative day to even after discharge. From the day of surgery, complication-preventive measures (antibiotics) and anesthetic management (continuous intravenous infusion, extradural anesthesia, and suppository administration) were performed. Activity levels gradually increased from bed rest (day of surgery) to the start of walking (Day 5), and patients were discharged on Day 10. They had been advised at the time of discharge about restrictions on daily physical activities as well as at 1 and 3 months after discharge.

### 3. Postoperative pain and its period described by children and their mothers (Fig. 2)

Postoperative pain described by children and their mothers was divided into 7 categories. Its contents and the period of pain are described below. [ ] and < > indicate categories and raw data, respectively.

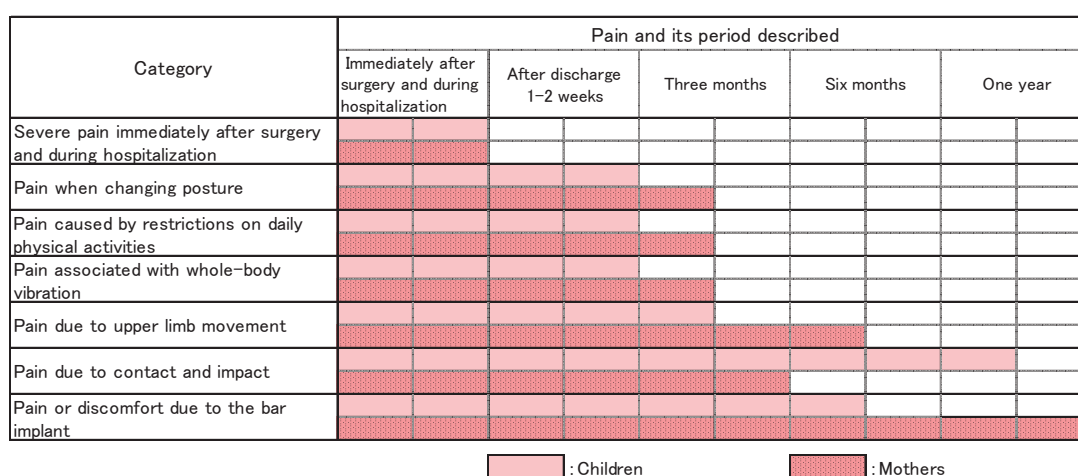


Fig. 2 Postoperative pain and its period described by children and their mothers

Regarding [Severe pain immediately after surgery and during hospitalization], both children and their mothers answered that <It was hopelessly painful after surgery>. Especially, all the mothers stated <I had not been told that the pain would be so severe. If I had known this, I may have refused the surgery for my child>; the pain was so severe that it may have affected their judgement of surgery.

About [Pain when changing posture], all the children answered <I couldn't get out of the bed or futon by myself for 1-2 weeks>, and also added <I couldn't turn over in bed> and <I had difficulty in breathing when sleeping in a lateral position because the implanted bar hit my chest>. Mothers had watched their children, and stated <They couldn't get up normally, so they tried to get up by rolling their body while saying "It hurts!">. They looked to be in pain for over 3 months>.

Regarding [Pain associated with whole-body vibration], children answered <I felt pain when coughing, sneezing, or laughing soon after the surgery>, and <I had difficulty in going up and down stairs (for over 3 months)>. Mothers answered <In addition to that, they had difficulty in getting in or out of a car for 6 months>.

Concerning [Pain due to upper limb movement], children answered <I couldn't lift my arms because of pain for some time, and I couldn't even dress myself. I felt no strength in my hands, and sometimes felt numbness>. Mothers also answered <They seemed unable to lift their arms due to tension and pain near the bar insertion point for 6 months>.

Regarding [Pain caused by restrictions on daily physical activities], children answered <It was hard to stay in the same position because extra pressure was applied to my body>. Mothers stated <Because they couldn't bend backwards and physical activity was restricted for 3 months, they complained that extra pressure was applied to different parts of the body>.

Regarding [Pain due to contact and impact], children described various episodes in various situations such as <I felt pain when something hit my chest even after 3 months>, <I had a throbbing pain around the bar implant when I entered cold water in a swimming pool after 6 months>, <I felt pain when laying down on a wooden floor with a blanket underneath in a lateral position even after 1 year>, and <I experienced a striking pain when I had a fight with my friend or practiced Karate>. Mothers described their feelings of anxiety that their children did not tell them about the accidents that had occurred, such as <I was surprised when I heard later that my child had fainted because of anemia and hit their chest at 3 or 4 months after surgery> and <My child's friend told me that he/she looked to be in pain when bumping into someone. However, my child didn't tell me about it, just saying "I'm fine", so I was very worried>.

About [Pain or discomfort due to the bar implant], children talked about their situations, saying <I had chest pain when I took a deep breath immediately after surgery> and <I felt pain at the implant site when pressure was applied to my body even after some time>. Mothers stated <They complained about discomfort for about 1 year>, <He/she was carried on a stretcher twice at school due to severe pain>, <He/she complained about chest pain even after 1 year. Later, I was surprised to hear the doctor say "Intensive exercises have caused the muscle fibers to become entangled with the bar">.

#### 4. Others (Positive opinions)

Most of the mothers were satisfied with their decision to consent to the surgery and its results, and stated <There were many problems, but he/she is now free from pain and restrictions of physical activity after overcoming this period. The concavity of the chest has also been resolved, so he/she looks brighter now>, <There were many concerns, but my child and I are satisfied with the surgery>, and <I can now understand how my child felt embarrassed about his/her concave chest. They told me this after recovery. I also found out later that he/she cared about causing us anxiety and didn't tell me about the pain>.

#### Discussion

With the bar implant, children experienced pain caused by various factors in diverse situations for over a year after implantation, and experienced severe pain immediately after surgery. Regarding pain and discomfort due to the bar implant, we identified the following possible cases: severe pain associated with breathing, sneezing, and coughing immediately after surgery, pain that occurs a few months after surgery with an unknown cause, and pain caused by the muscle fibers becoming entangled with the bar. In addition, for pain caused by physical activity, the following cases are presented: persistent pain associated with daily physical activities such as getting out of bed or changing the posture for 1-2 weeks after discharge, pain associated with whole-body vibration caused by going up and down stairs, and pain due to lifting the arms even after 6 months. Furthermore, it was clarified that most accident-related pain was associated with contact or collision in school life, and children felt pain even after 1 year.

Pain in junior high or high school children persisted for a relatively prolonged period compared to that in preprimary or primary school children investigated by us [8]. In addition, the duration of pain in junior high or high school children was reportedly long compared to that in 12-14-year-old children (4-6 weeks) [3]. Uemura et al [6].reported that "Since the chest wall of younger children is still very malleable, the correction of chest wall deformity is possible; however, in older children, their rigid sternum or ribs may not be easily corrected", and he noted that the Nuss procedure for pectus excavatum patients over 18

years of age involves many problems. His report suggests that more pronounced pain is associated with an increased age in patients up to 18 years old in Japan.

Pain is defined as a complex perception in which multiple variables interact in a complex way that varies across individual psychological situations, such as involving emotion and attention [9]. Since the Nuss procedure generates significant stress over the deformed cartilage due to the insertion of the bar under the sternum [10], it is a well-known fact that patients develop severe postoperative pain. Various measures have been taken to control postoperative pain during hospitalization [5,6]. However, this study revealed the presence of long-term pain after discharge, and so effective guidance on analgesic use to control pain after discharge may be needed. Attention also has to be paid to psychological pain. By giving information on pain which is likely to occur after discharge and its duration as a predictor to children and their mothers, it may be possible to reduce the pain generated from psychological anxiety.

Since most subjects in this study were male, their activities such as spending time with friends or club activities may have been more energetic. However, the complication of bar migration, which may pose the greatest risk, occurred in only 1 patient. Although the reason for this migration was not clarified, the instructions on discharge need to be presented more specifically: the importance of restrictions on physical activity and maintaining a favorable posture, how to spend school life, and the way of helping their friends understand the risks.

In most of the pain categories, mothers described the duration of pain as being much longer than their children. In the category of pain and discomfort due to the bar implant, mothers stated that the pain lasted for 6 months longer than their children. Pectus excavatum is defined as a congenital chest wall disorder. We suggest that mothers blame themselves for that fact that their child has to endure much suffering due to receiving the surgery, and considered the child's trifling matters as abnormalities. One of the reasons for this may be related to the mother-child bond. However, most mothers stated they were satisfied with the results, and that the occurrence of pain does not negate the necessity of this surgery. We need to provide comprehensive care to achieve a higher QOL.

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