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ORIGINAL ARTICLE

Infantile umbilical hernia tape fixation method without compression materials

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Abstract

Background: Compression therapy using compression material is often used for umbilical hernias in infants; however, there are problems regarding its use, such as appearance and cost. In our hospital, we use the tape fixation method without compression materials. We report the effectiveness of this method, its significance in measuring the degree of hernia bulge before treatment, and parent satisfaction with the treatment.

Methods: We analyzed 77 cases of umbilical hernias (41 boys and 36 girls, mean age 52.7 ± 18.3 days) that were treated with the tape fixation method at the Department of Pediatrics of our hospital. Hernia size was classified based on the height of the bulge: mild (<1 cm), moderate (1≦ and <3 cm), or severe (>3 cm). Treatment duration was compared between the groups using the Steel–Dwass test. After the treatment, a questionnaire was mailed to the parents to assess the treatment satisfaction.

Results: Seventy-three patients (94.8%) achieved closure of the hernia orifice, with no excess skin and a well-shaped umbilicus. The duration of treatment was significantly shorter, with the following order: mild (18.5 ± 8.2 days), moderate (25.0 ± 11.9 days), and severe cases (47.8 ± 11.7 days). According to the questionnaire, 97.5% of the parents were satisfied with the treatment.

Conclusions: Our tape fixation method without compression material achieved a high closure rate and a good shape of the umbilicus. In addition, we noted that the height of the hernia bulge can be used as a guide to estimate the duration of treatment.

KEYWORDS
compression material, hernia bulge, infant, tape fixation, umbilical hernia

1 | INTRODUCTION

Infantile umbilical hernia is a common condition that occurs in 10%–20% of all infants,[1] and previous studies reported that spontaneous observation shows a cure rate of 80% by 2 years of age[2] and 85% by 6 years of age.[3] Spontaneous observation has the advantage of not requiring any treatment; however, it also has a disadvantage, such as in cases when the hernia orifice does not close or the umbilical protrusion remains after closure. Therefore, compression therapy has been proposed as a conservative treatment and is reported in several studies.[2,4–8]

Compression therapy has the advantages of early closure compared with spontaneous observation[4,7,9,10] and a high rate of hernia

closure[2,4,5,8–10]; however, it has its disadvantages, such as increasing the burden of care on the guardian, including outpatient visits and bathing, and the possibility of skin damage due to compression fixation. Many facilities and reports have used cotton balls or other compression materials in addition to tape during compression therapy.[2,5,6,10,11] The compression material is spherical and may cause widening of the umbilical caliber during compression and of the umbilical caliber and fossa after closure. In addition, excess skin may also be a problem.[5,9] In such cases, even if the hernia orifice is closed by compression therapy, there are cosmetic problems, and the surgical technique needs to be devised when the patients are transferred to surgery.[12] Although umbilical hernia strangulation is usually very rare,[13] there is a risk of medically induced hernia strangulation when compression therapy uses compression materials, such as cotton balls.[14,15] If there is no improvement with observation or compression therapy, surgical treatment is an option. However, although it can improve the appearance, there is a surgical burden and a risk of postoperative complications, such as infection.[16]

Previously, cotton ball and sponge compressions were performed at our hospital. Although they closed the hernia, they caused the excess skin and the umbilical fossa to expand, which posed a problem in terms of appearance. In addition, considering the risk of hernia incarceration, a new compression therapy using tape without compression materials was performed. In this report, we describe the innovation of the tape-only compression therapy that is used in our hospital, the results of this treatment, and the satisfaction of the patients' parents after treatment. In the guidelines for the treatment of umbilical and epigastric hernias,[17] hernias are classified according to the size of the defect in the hernia orifice. However, since it is difficult to measure directly from the body surface, we investigated whether the height of the hernia bulge could be used as a reference.

2 | MATERIALS AND METHODS

2.1 | Patients

Patients with infantile umbilical hernia who visited the Department of Pediatrics at Misawa City Hospital from March 2012 to October 2014 and who underwent the tape fixation method were included in this study. The total number of patients was 77 (41 boys and 36 girls, mean age 52.7 ± 18.3 days). This study was conducted in accordance with the Declaration of Helsinki, and consent was obtained from all the patients' guardians.

2.2 | Treatment plan

The parents of the children were informed about the options of spontaneous observation and active treatment. When they requested for treatment, the options of conservative treatment and surgical treatment were explained to them, and their consent was obtained for the tape fixation method before initiating treatment. The parents were also informed about the possible complications, such as skin rash due to tape application and vomiting due to abdominal pressure. If skin rash was observed, the treatment was temporarily discontinued. To prevent vomiting, we instructed the parents to hold the patient's head up after feeding and to maintain the right lateral supine position.

2.3 | The tape fixation method

In the new tape fixation method developed in our hospital, the distended skin and peritoneum are returned to the back of the umbilical orifice, and the right and left sides of the umbilical fossa are fixed together to prevent the hernia content from prolapsing. The details are shown in Figure 1. The fixation was performed by medical staff using a medical-grade adhesive tape called 3M™ Micropore™ Skin Tone Surgical Tape [Minnesota, USA], and the patient was evaluated once a week at an outpatient hospital. The treatment was completed when the umbilical protrusion from the abdominal wall was removed, the hernia orifice was manually confirmed to be closed, and the umbilical shape showed a "longitudinal" and "deep umbilical fossa," with "upper and lower hoods." If the umbilicus swelled again after the end of treatment, the same fixation was performed, and the treatment period was extended.

The patients were permitted to be bathed while the tape was applied, and if the tape came off at home, the parents were instructed to remove the edge of the tape to an extent where the pressure on the umbilical area did not loosen.

2.4 | Questionnaire

A questionnaire was mailed to each home after umbilical hernia treatment. This questionnaire was administered in October 2015 with a period of approximately 2 weeks. The items are shown in Table 1. We asked the parents to describe the degree of the hernia bulge at the start of treatment, whether they wanted to stop the treatment due to adverse events, their satisfaction with the umbilical hernia treatment, and their satisfaction with the shape of the umbilicus after the treatment. They were asked to select the degree of hernia bulge at the beginning of treatment from <1 cm, 1≦ and <3 cm, and more than 3 cm and if they strongly agreed, agreed, and strongly disagreed on whether they wanted to stop the treatment due to adverse events. The degree of satisfaction with the treatment and the shape of the umbilical shape were selected from the following four levels: satisfied, slightly satisfied, slightly dissatisfied, and dissatisfied.

2.5 | Statistical analysis

Data collection was performed retrospectively based on the patients' medical records. The size of the hernia was classified by the medical staff into three levels according to the height of the bulge

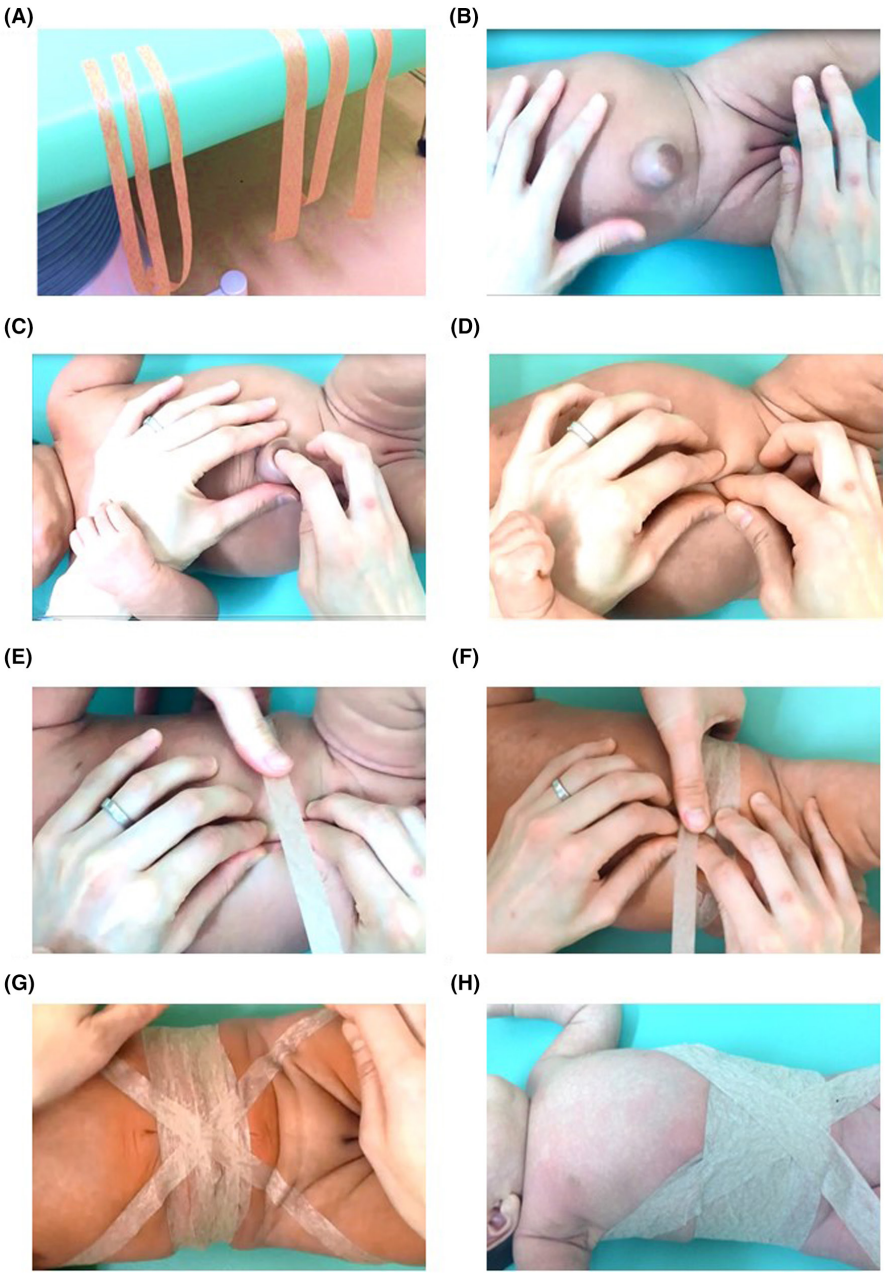

FIGURE 1 Compression Therapy using tape without compression material. Tape used (12 mm and 25 mm in width; Skin Tone Surgical Tape®, 3 M [Minnesota, USA]) (A). Place the child on the bed (B). Push the hernia contents deep into the hernia with your finger or a cotton swab (C), quickly retract the skin on both sides to the midline (D), and fix the center with a 12.5-mm wide tape (E). Then, to create a hood above and below the umbilicus, pull the upper tape downward in an inverted U-shape, and apply the lower tape while pulling upward in a U-shape (F). To reinforce the tape applied to the abdomen, add a large cross around the navel (G), and apply a 25-mm wide tape to cover the gap between the 12.5-mm wide tape and the wrinkles on the midline (H).

TABLE 1 Questionnaire items.

Number	Question (answer options)
1	Degree of hernia bulge at the start of treatment (<1 cm, 1≦ and <3 cm, 3 cm≦)
2	Whether you wanted to stop the treatment due to side effects (e.g., skin rash, and vomiting) (Strongly agree, Agree, Strongly disagree)
3	Satisfaction with the treatment (Satisfied, Slightly satisfied, Slightly dissatisfied, Dissatisfied)
4	Satisfaction with the shape of the umbilicus after treatment (Satisfied, Slightly satisfied, Slightly dissatisfied, Dissatisfied)

from the abdominal wall: mild (<1 cm), moderate (1–3 cm), and severe (>3 cm) (Figure 2A– C). The duration of treatment was compared between the groups using the Steel–Dwass test. We set the level of statistical significance at $\alpha = 0.05$. All statistical analyses were performed using JMP® Pro 15 (SAS Institute Inc., Cary, NC, USA).

3 | RESULTS

3.1 | Umbilical hernia treatment results

In the size category, 38 cases were mild (21 boys and 17 girls, mean age 48.4 ± 15.4 days), 30 cases were moderate (13 boys and 17 girls,

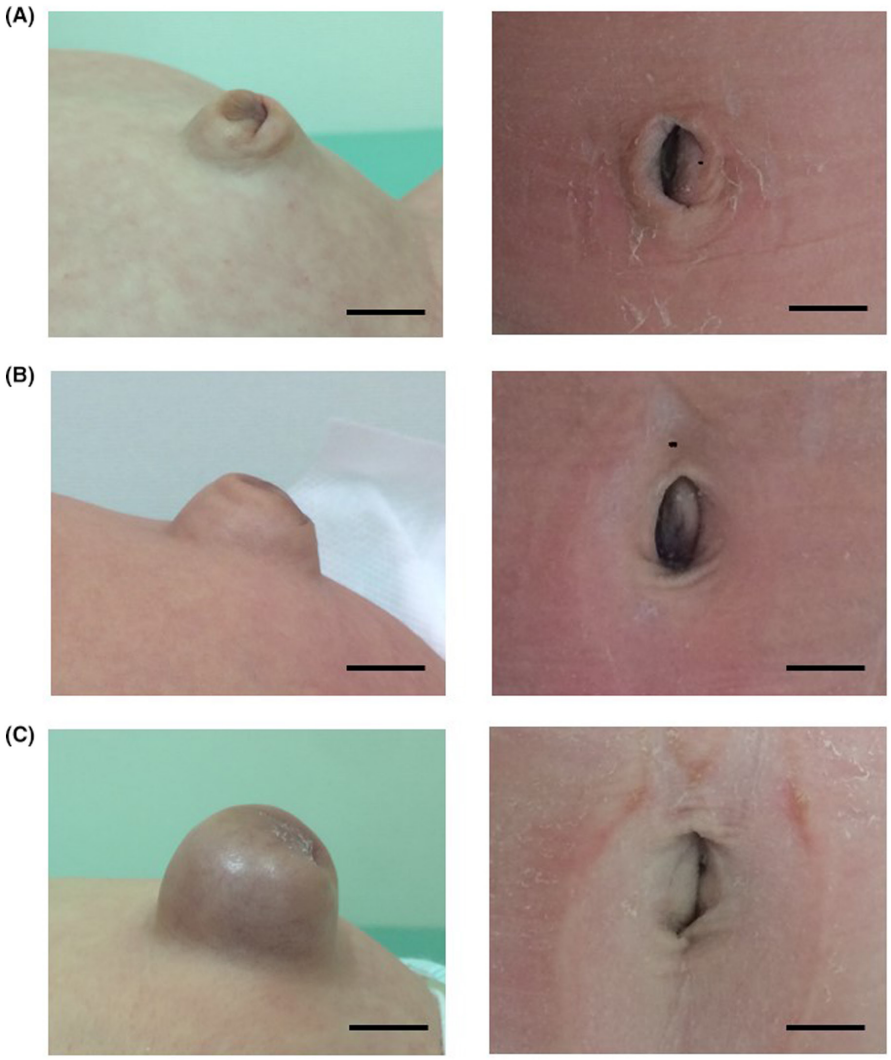

FIGURE 2 Degree of umbilical hernia bulge at the beginning of treatment. Scale bar 1 cm. (A) Mild (<1 cm) (left: at the beginning of treatment, right: after treatment). (B) Moderate (1≦ and <3 cm) (left: at the beginning of treatment, right: after treatment). (C) Severe (≧3 cm) (left: at the beginning of treatment, right: after treatment).

mean age 57.9 ± 22.1 days), and nine cases were severe (7 boys and 2 girls, mean age 53.7 ± 11.8 days). There was no significant difference in sex ($p = 0.22$) or age at the beginning of treatment ($p = 0.14$) between the sizes.

Of the 77 patients, 73 achieved closure of the hernia orifice (94.8%), including 37/38 mild (97.4%), 30/30 moderate (100%), and 6/9 severe (66.7%) cases. At the end of compression, a "longitudinal" and "deep" umbilical fossa with "upper and lower hoods" was achieved in all cases. The overall duration of treatment was 23.6 ± 12.8 days. The duration of treatment was significantly shorter with the following order: mild (18.5 ± 8.2 days), moderate (25.0 ± 11.9 days), and severe (47.8 ± 11.7 days) cases (Figure 3). Refixation was required in two mild cases, five moderate cases, and two severe cases.

Three out of the four patients whose treatment was discontinued before the closure of the hernia orifices were severe cases. The treatment was discontinued due to skin rash and failure to close the hernia orifices after 35, 47, and 51 days of treatment, respectively. Subsequently, all three cases were deemed suitable for surgical treatment after 1 year of age. The fourth case was a mild case where the parents did not want to continue the treatment because of their anxiety about vomiting, and we were unable to follow the patient's progress.

The following adverse events were observed: 77 patients (100%) with erythema in the tape application area, 11 patients (14.3%) with skin rash, and one patient (1%) with frequent vomiting. Of the 11 patients with skin rash, eight were treated with dimethyl isopropyl azulene ointment, and tape fixation was continued. No other adverse events, including hernia incarceration, were observed.

3.2 | Questionnaire results

Questionnaires were mailed to the parents of the 73 patients with umbilical hernia closure, and 40 parents responded (54.8% response rate). The aggregate results are shown in Figure 4. The parents responded to the questionnaire about the height of the umbilicus at the time of the diagnosis and were able to perform a self-assessment. Regarding the request for discontinuing the treatment due to adverse events, 32 parents (80%) answered "strongly disagree." The level of satisfaction with the treatment was "satisfied" and "slightly satisfied" in 39 parents (97.5%) and

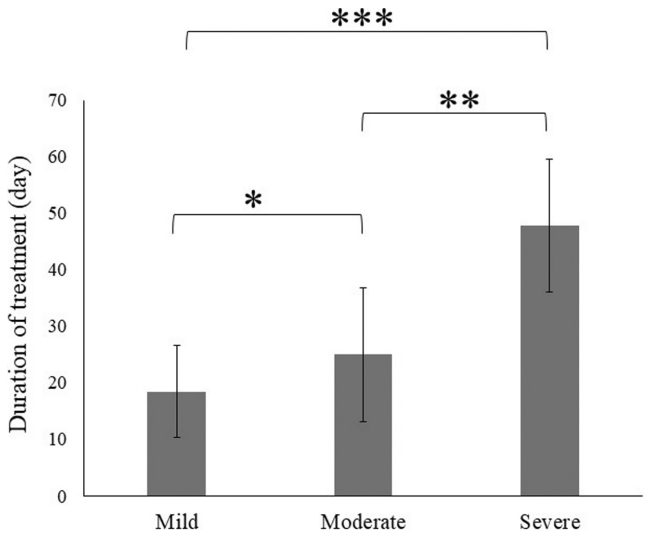

FIGURE 3 Relationship between number of days of treatment and degree of hernia bulge. The duration of treatment was 18.5 ± 8.2 days for mild, 25.0 ± 11.9 days for moderate, and 47.8 ± 11.7 days for severe degree of hernia bulge. Significant differences are observed between the Mild vs. Moderate (*$p < 0.05$), Mild vs. Severe (***$p < 0.001$), and Moderate vs. Severe (**$p < 0.01$) groups, with shorter treatment durations in the order of Mild, Moderate, and Severe.

"satisfied" and "slightly satisfied" with the shape of the umbilicus in 37 parents (92.5%).

4 | DISCUSSION

Essentially, after the umbilical cord is dislodged during the neonatal period, closure is obtained by the adhesion of the scar tissue and transverse abdominal fascia at the umbilical ring. If they do not form and the umbilical ring fails to close, an umbilical hernia develops.[18] The key to effective umbilical hernia treatment is to prevent the intestine from passing through the umbilical ring, thereby forming a scar at the umbilical ring and closing the hernia orifice. Spontaneous closure of infantile umbilical hernias is expected[2,3]; however, there is a report reviewing the safety of spontaneous observation in asymptomatic hernias up to 4–5 years of age, regardless of the size of the hernia defect.[19] Compression therapy provides early closure compared with spontaneous observation,[4,7] and the closure rate of the hernia orifice is high[2,4,5,8–10]; hence, it is applied in many institutions.[5] The method in our hospital is performed by returning the distended skin and peritoneum to the back of the umbilical orifice and then fixing the surrounding skin of the umbilical fossa together to create a condition wherein the hernia contents do not prolapse without using compression materials.

In previous reports, 79.8%–100% of cases were found to be closed using compression therapy, and the duration of treatment was about 2 to 6 months.[2,4,5,8–11] In this study, hernia orifice closure was achieved in 94.8% of patients, and the average treatment time was 23.6 days. The duration of treatment was considerably shorter

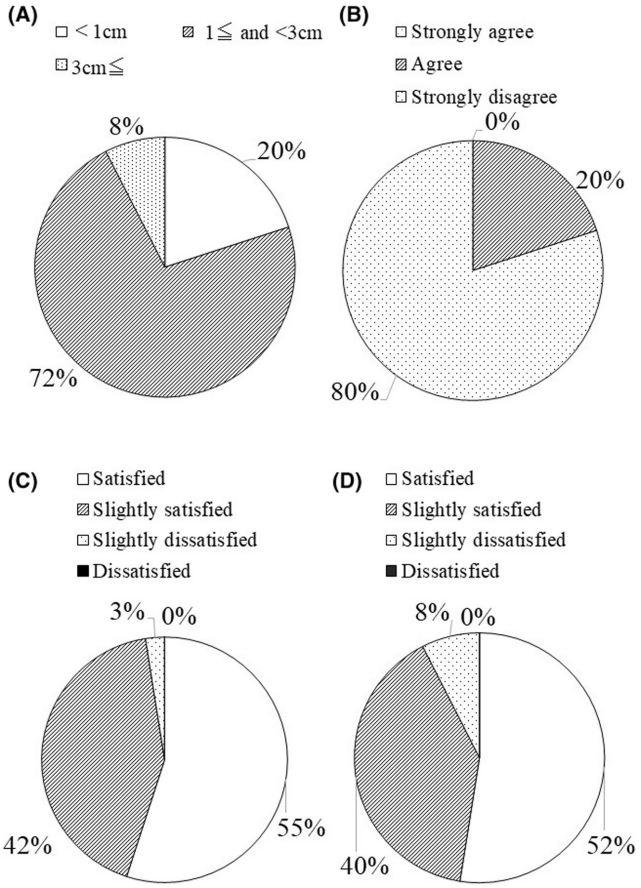

FIGURE 4 Questionnaire results. Forty individuals responded to the questionnaires, reporting the following: (A) At the beginning of treatment, 8 respondents reported a mild degree of umbilical hernia bulge (<1 cm), 29 reported a moderate degree (1≦ and <3 cm), and 3 reported a severe degree (≧3 cm). (B) When asked whether they wanted to discontinue treatment due to side effects such as skin rash or vomiting, 22 respondents reported being satisfied, 17 reported being slightly satisfied, 1 reported being slightly dissatisfied, and 0 reported being dissatisfied. (C) When asked about their overall satisfaction with the umbilical hernia treatment, 0 respondents answered strongly agree, 8 answered agree, and 32 answered strongly disagree. (D) Regarding the satisfaction with the shape of the umbilicus after treatment, 21 respondents reported being satisfied, 16 reported being slightly satisfied, 3 reported being slightly dissatisfied, and 0 reported being dissatisfied.

compared with the findings of previous studies. Compared with other methods that use cotton balls or other compression materials, it is possible that the tape fixation method achieved a stronger fixation, which resulted in a shorter treatment period. Nevertheless, additional studies are needed to determine the actual benefit of our tape fixation method without the use of compression materials. The fact that we decided to discontinue the treatment when the appearance corresponded to a "deep umbilical fossa with upper and lower hoods" in terms of appearance, rather than at the closure of the hernia orifice, suggested that closure may have been achieved earlier than previously reported. The umbilical fossa is generally round during this period and becomes oval as the child grows; hence,

it is debatable whether or not a vertical umbilical fossa should be aimed for during infancy. However, the aim of achieving a vertical umbilical fossa may have had some therapeutic advantages in this case, such as achieving strong compression with tape and possibly eliminating the problem of excess skin. The advantages and disadvantages of our treatment in achieving a "deep umbilical fossa with upper and lower hoods" in infancy should be discussed further. As for the duration of treatment, although generalization was limited because spontaneous observation cases were not used as controls, the duration of treatment significantly depended on the degree of hernia bulge. At the time of the initial examination, the parents were informed about the expected duration of treatment according to the degree of hernia bulge. In addition, measuring the degree of hernia bulge was simpler and easier to evaluate directly as compared to measuring the hernia orifices. The results of the questionnaire indicated that the evaluation could be done by the parents, and they could efficiently understand the treatment period. For severe cases, although the number of patients was small, the treatment results were relatively low at 66.7%. It has been reported that early surgery is preferable in cases of giant umbilical hernia,[12] and a careful decision should be made on whether to continue the tape fixation method or to propose surgery.

In a survey conducted by Taniguchi et al.[5] at the Society of Pediatric Surgeons of Japan, 17 facilities performed compression therapy, 15 of which used cotton balls, three used sponges, and one used urethane foam as a compression material in addition to tape. In a questionnaire survey of pediatric surgeons reported by Oshio et al.[6] 144 of 161 cases (89%) used compression materials, such as gauze balls and sponges. Although these materials can promote closure of the hernia, they may result in a circular shape of the umbilical fossa, and there is a risk of inappropriate closure due to the displacement of the compression material, which may result in the strangulation of the umbilical hernia.[14,15] Taniguchi et al.[5] also reported that excess skin was found in 9.0% of patients with elastic tape and fixation materials and in 17.3% of patients with waterproof film and fixation materials in a multicenter questionnaire. In this study, excess skin was not found in any of the cases where closure was obtained, and umbilical hernia incarceration was also not observed. Compared with previous reports, the results of our method are favorable and may have an advantage in terms of appearance. Although there were cases of mild excess skin during follow-up, a good umbilical shape was obtained by extending the fixation period. Even in cases with excess skin, improvement may be achieved by extending the compression period using our method.

Craig et al.[20] analyzed 147 adult women's umbilical photographs and reported that a well-formed umbilicus has "upper and lower hoods". Although the umbilicus grows longitudinally and the depth of the umbilical fossa increases with subcutaneous fat, its width remains almost the same from infancy to childhood.[21] The goal of surgical treatment of umbilical hernias is to create a "long and deep umbilical fossa".[22,23] Therefore, in addition to the "upper and lower hoods," aiming for a "longitudinal" and "deep umbilical fossa" is considered to be a more satisfactory fixation method in terms of appearance. In all cases where closure was achieved, we were able to achieve a "deep" and "longitudinal" umbilical fossa with "upper and lower hoods" without any excess skin. Zenitani et al. reported high satisfaction with the "deep umbilical fossa with upper and lower hoods" in their postoperative questionnaire survey on umbilical hernia.[24] The tape fixation method we devised was specifically aimed at achieving a "deep" and "longitudinal" umbilical fossa with "upper and lower hoods" in appearance as well as hernia closure. Therefore, the purpose of the questionnaire survey was to investigate the satisfaction with its treatment goals and methods, and the results suggested that our method led to a high level of parental satisfaction. The response rate for this questionnaire was 54.8%. If the guardians may have had negative opinions, they may have not responded to the questionnaire, which limits the interpretation of the results. An additional limitation is that the satisfaction was evaluated at the 4th to the 42nd month post-treatment stage in this study, which is earlier than the 2 years of age that is the standard for follow-up observations. There was also a possibility of variation in the evaluations due to the different time periods evaluated in the questionnaire. Thus, the conditions for achieving a well-formed umbilicus and whether it does not cause hernia incarceration in our method need to be studied in the future.

Erythema at the site of tape application, skin irritation, and vomiting were observed as adverse events during the treatment period. In response to question B, "Whether you wanted to stop the treatment due to side effects," 20% of the family members said they wanted to stop treatment. Using this tape fixation method, 100% of the patients had an adverse reaction with erythema, and skin rash also occurred in 14.3% of the patients; this was similar to previous reports.[4] It is thought that parents may still feel uneasy even when the medical staff consider the symptoms to be minor skin conditions that do not require treatment; therefore, it is necessary to provide more detailed explanations and responses to the parents' concerns. To prevent skin rash, the following measures were taken: Skin tugging was avoided when applying the tape, covering the wrinkles on the midline with 25-mm wide tape to prevent water from entering the wrinkles, replacing the tape every week at an outpatient hospital instead of changing it at home to minimize skin irritation when removing it, and holding the skin on the adhesive surface when removing it and folding the tape at 180 degrees while holding the skin on the adhesive surface in a protective manner. In this study, the rash was observed only on the caudal side of the umbilicus where the left and right skin were matched. The lack of adhesion between the skin and tape may be caused by factors such as skin texture, skin thickness, or the child's abdominal pressure. This can happen because the adhesive surface of the skin can open up to the left and right during breathing or when there is an increase in abdominal pressure." In the future, it will be necessary to adjust the number of fixing tapes and improve the application method in order to reduce skin erythema and rash. Vomiting was also observed in children who had aerophagia and vomited before treatment. We did not observe any vomiting in the children who had no abdominal distension after our method. For children who were likely to vomit, instructions

on how to burp along with sufficient explanation at the beginning of treatment and questioning about the status of vomiting during treatment helped eliminate the anxiety of the parents and motivate them to continue treatment.

The tape fixation method we devised can achieve the same rate of closure as the compression therapy without using compression materials. The advantages of our method include the possibility of shorter treatment periods and less excess skin. In addition, no medical hernia strangulation was observed in the patients in this study. The tape fixation method we used may reduce the incidence of medical hernia strangulation; however, the small number of patients in this study and the rarity of the actual incidence require additional study to accurately determine the incidence. Since the hernia orifice generally closes after the umbilicus is indented, it is important to properly confirm the closure of the hernia orifice manually once a good umbilical appearance is formed. This is because there are cases, such as a midline abdominal wall hernia, wherein the hernia orifice is difficult to close, and surgery may be required in the future.[25]

4.1 | Conclusion

This study suggested that the tape fixation method, without using compression materials, can achieve a high rate of closure of the hernia orifice and umbilical fossa with a high degree of satisfaction in terms of appearance. Furthermore, the duration of closure treatment was found to be proportional to the height of the hernia bulge, which may allow for easier estimation of the duration of treatment.

AUTHOR CONTRIBUTIONS

K.T. and Y.S. contributed to the conception and design of this study; K.T. performed the statistical analysis and drafted the manuscript; Y.S., K.Y., K.T., K.Y., S.O., and S.E. critically reviewed the manuscript and supervised the whole study process. All authors have read and approved the final manuscript.

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CONFLICT OF INTEREST STATEMENT

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ETHICS APPROVAL STATEMENT

This study was approved by the Ethics Committee of the Misawa City Hospital (ethics permission number: 2022-5).

PATIENT CONSENT STATEMENT

Consent was obtained from all patients' guardians.

CLINICAL TRIAL REGISTRATION

None.

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