

Preventing recurrence after surgical repair of pressure injuries in patients with spinal cord injury: Effects of a presurgical and postsurgical wheelchair seating intervention by experts

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ABSTRACT

Objective: Pressure injuries in people with spinal cord injury or dysfunction (SCI/D) are known to have a high recurrence rate. As a countermeasure, we perform surgery after adjusting the wheelchair and cushion with the intervention of a seating expert. The effectiveness of seating interventions in postsurgical recurrence prevention was examined.

Materials and methods: In this retrospective analysis, the participants were 19 patients with SCI/D who underwent pressure injury surgical treatment in the gluteal region from 2005 to 2018. The patients with conventional rehabilitation were assigned to Group 1 (n = 8), and those with seating intervention by experts in addition to conventional rehabilitation were assigned to Group 2 (n = 11). The main outcome measure was the presence or absence of recurrence 3 years after the surgery. The recurrence rate was compared between the two groups.

Results: The recurrence rates were 18% with seating intervention and 75% without; there was a significant difference (p = 0.025). The recurrence odds ratio was 13.5.

Conclusion: This study suggests that presurgical seating evaluation and assessment by experts, postsurgical rehabilitation based on presurgical evaluation and assessment, and routine follow-up and seating adjustment according to changes are efficacious for preventing postsurgical pressure injury recurrence in patients with SCI/D.

1. Introduction

Gluteal pressure injuries in patients with spinal cord injury or dysfunction (SCI/D) often occur in a wheelchair or sitting position [1–3]. Studies show that pressure injuries in patients with SCI/D are known to have a high recurrence rate [2,4,5]. Many of these pressure injuries require surgical management. Surgical repair of pressure injuries in SCI/D patients seems to have high postsurgical complication and recurrence rates [6–8]. Much of the past literature describing postsurgical recurrence of pressure injuries has focused on surgical technique [9–12]. To help prevent the postsurgical recurrence of pressure injuries that occur in the sitting position, we believe it is essential to adopt appropriate wheelchair, pressure relieving cushions, and to

acquire and practice effective pressure relief behaviors.

1.1. Seating evaluation/adjustments

Seating requires various adjustments related to the sitting position for people who spend a lot of time in chairs and wheelchairs [13–15]. Seating assessment must be performed not only by evaluation of sitting ability, wheelchair type and size of each part, angle adjustment, and selection of cushions, but also by evaluating the sitting position in every aspect of life. Specialized knowledge and techniques are required to cover all matters. Seating technology in Europe and North America is based on an international standard that comprises sitting position measurement and the evaluation of suitability on seating systems and is

Abbreviations: SCI/D, spinal cord injury or dysfunction.

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implemented as a course of regular rehabilitation. Wheelchair seating and evaluation of seating behavior for the prevention of pressure injuries has recently been emphasized in Japan. The Seating Consultants Association was established in 2003 to train seating consultants, who are medical experts with basic knowledge and skills regarding the physical and social fitness of chair and wheelchair users, and to evaluate them based on the sitting ability classification [16]. The preventive management guidelines of the Japanese Society of Pressure Ulcers have also started to include items related to seating [17]. We hypothesized that postsurgical recurrence of pressure injuries in patients with SCI/D could be reduced by performing physical function measurement, selecting optimum wheelchairs and cushions, and conducting pressure relief training by a seating specialist.

1.2. Countermeasures for postsurgical recurrence

As a countermeasure for recurrence after surgical repair of pressure injuries in patients with SCI/D, new protocol for seating evaluation/adjustments and education was implemented in 2016. The new protocol includes pre- and post-surgical interventions by the seating specialists (Fig. 1). This new protocol was implemented as a best practice change.

The biggest difference from the conventional protocol was the pre-surgical seating assessment and the preparation of the optimum wheelchair and cushion based on the assessment. Best fitted wheelchair and cushion were selected by seating experts based on detailed body measurement, range of motion measurement and sitting evaluation. After the surgery, learning and practice of safe wheelchair transfer and effective pressure relief were conducted under the supervision of a seating expert. After discharge, in the new protocol, in addition to the routine wound examination, seating assessment and wheelchair maintenance were conducted. Series of seating assessment and interventions were conducted in cooperation with a rehabilitation hospital with seating experts. This study examined the postsurgical recurrence prevention effect of seating interventions by experts on pressure injuries in patients with SCI/D.

2. Materials and methods

2.1. Study design

This was a retrospective analysis based on review of medical records. This study was a joint effort between a single acute care hospital and a rehabilitation hospital with seating experts. The presence of recurrence in the surgical site was examined as the main outcome measure. The study was conformed to the ethical guidelines of the Declaration of Helsinki and approved by the Centralized Institutional Review Board (reference number 21A044).

For this study, 19 SCI/D patients who underwent surgical repair of stage III or IV pressure injury in the gluteal region in the years from 2005 to 2018 and completed follow-up for more than three years were included. All patients had lower limb paralysis resulting from SCI/D and used wheelchairs on a daily basis. There were 22 patients who underwent surgery within the research period. Three patients (n = 3) were not included in the survey because they did not come to the regular outpatient clinic. The following were retrospectively investigated from the medical records: age at surgery, sex, presence of diabetes mellitus, level of spinal cord injury, wound location, surgical procedure, post-surgical rest period, with or without seating intervention, follow-up period, and presence of pressure injury recurrence. Recurrence was defined as local recurrence at the surgical site, which occurred after postsurgical wound healing during the observation period. Pressure injury development at sites other than the surgical site was not defined as recurrence. The definition of recurrence was decided with reference to previous reports [6,7].

Cases from 2005 through 2015 reflecting the old protocol were assigned to Group1 (n = 8), and Cases from 2016 to 2018 reflecting the new protocol where seating specialists purposefully invoked a new best practice were assigned to Group2 (n = 11). The postsurgical recurrence rate 3 years after surgery was compared between these two groups in different timeframes.

In cases of recurrence (including both group), the period from pressure injury surgery to pressure injury recurrence was investigated. In addition, the recurrence rate of pressure injury was investigated by surgical method.

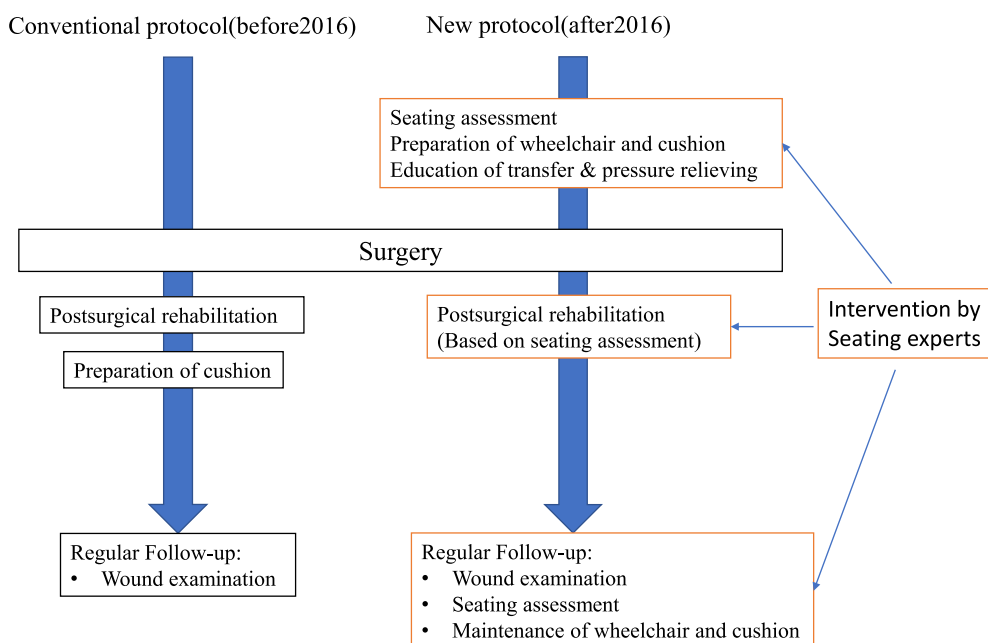


Fig. 1. Since 2016, a new protocol has been implemented to prevent postsurgical recurrence. In the new protocol, detailed physical function measurements were performed before surgery with the intervention of a seating expert, and pressure relieving equipment was prepared. Seating specialists also intervened in postsurgical rehabilitation and outpatient care.

2.2. Procedure

2.2.1. Surgery

General peri-surgical preparation and inpatient care of the pressure injury surgical site were performed for all cases. Surgical methods were selected depending on the location and depth of the wound, and all surgeries were performed under general anesthesia. Cases in Group 1 were operated by Surgeon A except for one case. Surgeon B operated one case in Group 1 and all cases in Group 2. For up to 3 weeks after the surgery, the patient was on the bed, head-up was limited to 30°, and the sitting position was prohibited. If 3 weeks had passed and there was no abnormality in the wound, the patient was started in a wheelchair sitting position once a day for approximately 20 min.

2.3. Seating intervention, rehabilitation (Table 1)

In all cases, conventional rehabilitation such as muscle strength maintenance and joint exercises were performed immediately after the surgery. In Group 1, sitting training was started three weeks after the surgery and wheelchair transfer and pressure relief were practiced. At this time, cushions were selected and adjusted. Home refurbishment was done when needed. All therapies were performed by general rehabilitation therapists. No cases in Group 1 were given new wheelchairs. In group 2, seating experts conducted seating evaluations and assessments prior to surgery. Sitting posture and wheelchair suitability, physical functions, seating pressure, technique of transfer, and pressure relieving were assessed. Information on daily living patterns and the home environment was also obtained to identify points to be corrected. Based on these evaluations, proper assessments of wheelchairs and cushions prior to surgery were made, new wheelchairs were ordered when necessary, and precise cushions were purchased. The evaluation results from the location of pressure injuries as well as the patients' physical functions were used, and the most suitable transfer to wheelchairs, along with pressure-relieving techniques, was proposed. Moreover, when the postsurgical rest periods were finished, patients were promptly transferred to a rehabilitation hospital where seating experts worked to enable them to perform rehabilitation specializing in seating. At the rehabilitation hospital, patients received therapy and education for a longer period. This allowed for more efficient acquisition of movement and knowledge.

2.4. Follow-up

After being discharged from the hospital, both groups received regular follow-up to check the wound. In group 2, in addition to wound check-ups, seating was adjusted according to the situation.

2.5. Data evaluation

The main outcome measure was the postsurgical recurrence rate 3 years after surgery. This was compared between group 1 and group 2. Data analysis was performed using statistical analysis software (Stat Flex ver. 6, Artech Co., Osaka, Japan). Fisher's exact test was used to analyze the occurrence of postsurgical recurrence. P values of <0.05 were considered significant. The odds were calculated from the recurrence rate of each group, and the odds ratio was shown. No statistical analysis was performed on recurrence rates by surgical procedure, only comparisons were made.

3. Results

3.1. Patients' characteristics (Table 2)

Nineteen patients, 16 males and 3 females, with an average age of 54.9 years (range 26–78 years), were enrolled in the study. Patients with thoracic spinal cord injury were the most common, and pressure injuries

in the ischial region were the most common. The average follow-up period was 73.9 months (range 36–142 months). Comparing Group 1 and Group 2, most of the items had similar numbers, but the total observation period was longer in group 1.

3.2. Postsurgical recurrence rate at 36 months

Three years after the surgery, the recurrence rate was 42% overall. The recurrence rates were 75% in Group 1 and 18% in Group 2; the difference was significant ($p = 0.025$). The recurrence odds ratio was 13.5 (Table 3). In cases with the seating intervention, the recurrence rate decreased as hypothesized.

3.3. Time to recurrence

During the entire observation period (a total of 142 months), recurrence was seen in 10 of 19 cases (52.6%).

The average period from surgery to recurrence was 2 years and 2 months. Recurrences occurred more than 1 year after surgery in more than half of the cases, 20% of the recurrence occurred over 3 years after surgery (Table 4).

3.4. Recurrence rate by surgical method

Cases that underwent skin grafting tended to show higher recurrence rates than other surgical methods (Table 5).

Table 1
Details of seating intervention.

	group1	group2
Presurgical intervention		1 Pelvic mobility assessment in Supine position 2 Assessment of sitting posture 3 Body size measurement 4 Sitting pressure measurement 5 Back pressure measurement Preparation of pressure relieving device: →Wheelchair, cushion selection/adjustment Home refurbishment: →entrance ramps, bathroom height, Flooring and carpet materials selection/adjustment Based on results of ①–⑤ by seating experts
Postsurgical intervention	Postsurgical rehabilitation /Strength, range of motion training ●Transfer technique ●Pressure relieving technique ●Education Preparation of pressure relieving device: →Cushion selection/adjustment Home refurbishment: →adjustment of entrance ramps, height of bathroom etc.	Postsurgical rehabilitation ●Strength, range of motion training ●Transfer technique ●Pressure relieving technique ●Education Based on results of ①–⑤ by seating experts @ Rehabilitation hospital
Follow-up	●Wound examination ● Every 1–3months	●Wound examination ●Assessment of sitting posture ●Sitting pressure measurement ●Back pressure measurement ●Maintenance of wheelchair, pressure relieving devices ●Every 1–3months

Table 2
Patients' characteristics.

	Group1_ (n=8)	Group2_ (n=11)	All (n=19)
Age (years)	54.4 (41-66)	53.2 (26-78)	54.9 (26-78)
Sex			
male	8	8	16
female	0	3	3
Diabetes mellitus	2	1	3
Level of injury			
C	2	3	5
Th	4	6	10
L	0	1	1
SB	0	1	1
others	2	0	2
Wound location			
Ischial region	5	6	11
Coccygeal region	2	2	4
Sacral region	1	3	4
Surgical procedure			
Gluteal musculocutaneous flap	3	6	9
Gluteal fasciocutaneous flap	2	2	4
Posterior thigh flap	1	1	2
Split-thickness skin graft	2	2	4
Rest period (days)	21	21	21
Follow up period (months)	93.3 (36-142)	60.3 (36-85)	73.9 (36-142) 92 2 1

Abbreviations: C, cervical cord; T, thoracic cord; L, lumbar cord; SB, spina bifida. *others: Cerebral spinal cord disease or cause unknown.

Table 3
Recurrence rates of the two groups and the odds ratio (36 months after surgery).

	Recurrence	No recurrence	Recurrence rate (%)	P value	Odds ratio
Group 1 (without seating intervention)	6	2	75	0.025	13.5
Group 2 (with seating intervention)	2	9	18		
Overall	8	11	42		

Table 4
Time to recurrence (including all recurrent cases).

Time (months)	Cases (n = 10)
<6	3
6–12	1
12–24	2
24–36	2
>36	2

Avg. 26.1 months.
Over 1 year after surgery 60%.
Over 3 years after surgery 20%.

4. Discussion

4.1. Preventive effect of seating intervention on pressure injury recurrence

There were significantly fewer recurrences in the seating intervention group than in the non-intervention group. Moreover, the study showed that the recurrence risk for the non-intervention group was approximately 13 times higher than that for the intervention group.

The result of this study does not prove a direct cause and effect

Table 5
Recurrence rate by surgical method (including all cases).

Method	Cases (n = 19)	Recurrence (n = 10)	Recurrence rate (%)
Posterior thigh flap	2	1	50
Gluteal musculocutaneous flap	9	4	44
Gluteal fasciocutaneous flap	4	2	50
Split-thickness skin graft	4	3	85

relationship between seating intervention and pressure injury recurrences, but rather imply a correlation between the intervention and reduction of pressure injury recurrence. Seating intervention by experts may contribute to some extent to the prevention of postsurgical pressure injury recurrences.

Some reports mentioned that not only proper surgical technique, but also patient compliance, professional postsurgical support, and sufficient pressure relief are imperative for successful surgical repair of pressure injuries [7,18,19]. Other reports have stated that pressure injury recurrences decreased when physical therapists and engineers jointly intervened [20–23]. Because engineers possess a thorough knowledge of healthcare devices and environmental improvements, they supervised managing and operating contact pressure devices along with selecting, fitting, and adjusting appropriate wheelchairs and cushions. These reports contained similar functions as those of the seating experts in the present study, and their results in decreasing the number of pressure injury occurrences and recurrences corresponded with the present ones.

We believe that conducting routine presurgical seating evaluation and assessment offers tremendous advantages, because it enables patients to begin postsurgical activities in a safe sitting environment where less stress on the surgical site can occur. The purpose of postsurgical rehabilitation is improving patients' physical ability, and they learn to transfer from beds to wheelchairs and to lessen pressure. However, when learning and practicing effective pressure relief, it is crucial that patients understand its importance. The risk factors for pressure injury recurrence for spinal cord injury patients include a lack of knowledge [7,8]. Some reports also indicate that providing guidance and pre-programmed pressure injury preventive education to individual patients is effective [24–26]. Pressure injury prevention education based on the theory of seating by experts seems to be easy for patients to understand, and it can help to learn and practice effective transfer methods and pressure-relief behaviors. Another report states that monthly education on pressure injuries in addition to routine follow-up examinations contributes to preventing pressure injury recurrence [27]. This indicates the importance of confirming and updating this knowledge about pressure injuries. The new protocol we are practicing is based on these reports and is designed to provide in-depth expert seating assessment and coordination, patient education, long-term follow-up and device maintenance.

4.2. Time to until recurrence

For many spinal cord injury patients, pressure injury recurrences occur many years after surgery. Watanabe et al. reported long-term surgical case study results of ischial pressure injuries for spinal cord injury patients [28]. Their report showed that 65% of all recurrence cases occurred within two years, and almost 30% of recurrences occurred after five years. We also confirmed this situation with other reports [28,29]. Studies with a short observation period reported extremely low recurrence rates [10], whereas when the observation period was longer, pressure injury recurrence rates increased (Table 6).

The present study showed that 20% of the recurrences occurred more than three years after surgery, and some recurrences occurred seven years after surgery. Further observation may show an increase in the

Table 6
Pressure injury recurrence rate according to past reports.

Study	Follow-up time (months)	Recurrence (%)
Sorensen et al. (1994)	60	40
Murota et al. (1996)	126	74.2
Singh et al. (2013)	14	5.4
Watanabe et al. (2015)	88	33

recurrence rates for the group with seating intervention. In order to reduce the late recurrence, Group 2 received regular seating evaluations and maintenance of wheelchair and pressure relieving equipment in addition to the conventional wound examinations every 1–3 months. The recurrence rate increases many years after surgery may be the result of long-term deterioration that includes patients' body shapes and changes in physical ability, as well as in wheelchairs and cushions. Therefore, routine, and long-term follow-ups are essential after pressure injury surgeries for spinal cord injury patients, including seating evaluation and assessment.

4.3. Recurrence rates depending on surgical techniques

Previous reports showed no difference in recurrence rates based on the type of surgical technique [28,30]. In the present study, statistical comparison was difficult due to the small number of study subjects for each surgical technique, but high recurrence rates were seen in cases of split-thickness skin grafts. Thin layers of split skin grafts may not tolerate sitting position pressure, and they are not appropriate for surgical repair of pressure injuries associated with sitting positions.

4.4. Limitations

It is recognized that there are many biases in retrospective analysis. Furthermore, in this study, comparisons are made between two groups with different time sequences, and there are many biases due to this. These biases may have influenced the results of this study. Differences in the surgeons who performed surgery and the paramedics involved in the treatment between the two groups, and advances in clinical knowledge and improvement of pressure relieving devices such as mattress and cushions overtime may have affected the results. With the implementation of the new protocol, opportunities of therapies and communication have increased, and as a result more attention may have been paid to patients in Group 2. The increase of "attention" may have affected behavior and outcomes.

5. Conclusions

This study suggests that presurgical seating evaluation and assessment by professionals, postsurgical rehabilitation based on presurgical evaluation and assessment, routine progress observation, and seating adjustment according to changes are efficacious for preventing post-surgical pressure injury recurrence in spinal cord-injured patients. However, recurrence rates in the group with seating intervention may increase with longer term follow-up; therefore, long-term routine follow-up is imperative.

Founding

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Declaration of competing interest

The authors have no conflicts of interest directly relevant to the

content of this article.

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