

The Effects of Add-on Self-Care Therapy on Epidural Catheter Analgesia and Quality of Life in Patients after Surgical Stabilization of Multiple Rib Fractures

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Abstract

Background: Epidural (EPI) catheter analgesia is frequently prescribed as a regional analgesic technique to patients with multiple rib fractures (MRF) following surgical stabilization of rib fractures (SSRF). We aimed to study the effect of add-on self-care therapy on recovery and quality of life (QoL) in patients on EPI analgesia after SSRF.

Methods: A total of 267 patients with MRF and on EPI catheter analgesia post SSRF were recruited, and assigned to one of two groups in a random fashion: intervention group received education on self-care therapy, while the control group did not. Incentive spirometry (IS) volumes, Pain scores, oxygen saturation (SpO₂), respiratory rate, hospital length of stay (LoS) and QoL were evaluated.

Results: Compared to control group, the intervention group showed significantly improved pain scores, IS volume, respiratory rate and SpO₂. Hospital LoS was shorter for the intervention group than control. Overall QoL assessments in the intervention group were also significantly better than control patients.

Conclusion: Education on self-care therapy significantly benefits pain management, recovery and QoL for MRF patients on EPI catheter analgesia after SSRF operation.

1. Background

Thoracic trauma often leads to multiple rib fractures (MRF), occurring in more than 60% cases [1]. In 2004, a statistical report claimed that rib fractures inflicted 300,000 patients in the US [2], and the number increased to over 350,000 incidences in 2017 [3]. Surgical stabilization of rib fractures (SSRF) can be used to prevent rib displacement and shortening, lower the risk of non-union, and ameliorate fracture pain. More importantly, SSRF can facilitate ventilation with less dependence on ventilators, shorten length of stay, and reduce the incidence of complications including mortality, pneumonia, and disability [4, 5]. MRF are frequently encountered in injuries resulted from high energy mechanisms [6]. As a direct result of MRF, pain is primarily associated with reduced respiratory effort, causing atelectasis, difficulties to clear secretions, and decreased vital capacity. Effective management of pain in MRF not only improves symptoms, but also reduces splinting and risks for secondary respiratory complications [7].

In patients with MRF, local or regional analgesic techniques, in comparison with systemic analgesia, have proved to yield fewer adverse effects and greater efficacy [8, 9]. Currently, Epidural (EPI) catheter analgesia is a most commonly studied regional analgesic technique [10], and recommended by the Eastern Association for the Surgery of Trauma and Trauma Anesthesiology Society [11].

However, studies have also pointed out various side effects intrinsically linked to EPI analgesia, and compromised patients' general well-being, such as decreased quality of life (QoL) [10, 12, 13]. Social behaviors are also greatly hindered by the side effects, often manifesting as social isolation, disrupted social role, or even depression. Hence, besides standard therapies, additional strategies to control side

effects associated with EPI are crucial for improving the general well-being of patients with MRF patients in clinical care.

The self-care theory, first introduced in 1959 by Dorothea Orem, has been demonstrated to reduce side effects of medical treatments and improve QoL among patients of various diseases [14–16]. It contains descriptions regarding the role of the nurse to help individuals who experiences inabilities in self-care. The Orem system seeks to meet the self-care demands of the patient when the patient and/or family is not yet capable of providing care. The benefits of self-care education are widely practiced around the globe, yet few studies have addressed its systematic effect on side effect control and QoL in patients with MRF.

In this clinical study, we recruited MRF patients, who were on EPI catheter analgesia after SSRF, and evaluated the overall effect of self-care education on their incentive spirometry (IS) volumes, pain scores, oxygen saturation (SpO₂), respiratory rate, hospital length of stay (LoS) and QoL.

2. Methods

2.1. Participants

Patients were all recruited from those admitted into Quanzhou First Hospital Affiliated to Fujian Medical University. This investigation obtained approval from the Ethics Review Board of Quanzhou First Hospital Affiliated to Fujian Medical University. All recruited individuals provided written informed consent forms, and data were de-identified completely to secure the confidentiality for the patients.

The study population consisted of 267 patients, who were subjected to thorough assessments including chest 3D-CT and met the inclusion and exclusion criteria for undergoing SSRF in Quanzhou First Hospital Affiliated to Fujian Medical University from June 2016 to June 2019.

Inclusion criteria: 1) MRF (4 or more fractured ribs) with bicortical displacement; 2) intractable pain with visual analogue scale over 6 after conservative therapies; 3) 18 years or older [17]. Exclusion criteria: 1) multiple trauma to body parts other than chest with an abbreviated injury scale over 3; 2) serious head trauma with a Glasgow coma scale lower than 14; 3) mechanically ventilated; 4) massive hemothorax or injury to the trachea or bronchus with requirement for immediate surgery; 5) coagulopathy; 6) dementia.

2.2. SSRF technique

The standard SSRF procedure used in our clinical study combined open reduction internal fixation (ORIF) with video-assisted thoracoscopic surgery (VATS), employing a muscle-sparing approach without need for thoracotomy [18]. Furthermore, to avoid iatrogenic injuries resulted from manipulation and/or drilling, a safe pleural space was created. In patients with chest tubes, VATS was conducted using a 30-degree 5-mm thoracoscope through the wound of thoracostomy. In patients without chest tubes, a 1-cm port was generated at the fifth intercostal space along the anterior axillary line. Subsequently, ORIF was conducted using a non-precontoured universal 3.5-mm metal locking plate [19]. VATS was employed after ORIF to

assess screw penetration through the parietal pleura. A second VATS port was generated in the case of leakage of air through lung laceration for repair and resection using a linear cutter stapler [20]. Direct VATS visualization was utilized then to guide the chest tube placement. In patients who had unstable sternal fracture, for instance distraction or segmental fracture, ORIF of the sternal fracture was conducted simultaneously with the use of a pre-contoured locking plate [21]. Following SSRF, the MRF patients were hospitalized in the Intensive Care Unit (ICU) with endotracheal tubes.

2.3. EPI catheter analgesia

Generally, patients who required EPI had a pharmacologic thromboprophylaxis (PTP) hold for 12 hrs prior to the procedure as a safe window, then PTP was provided once per day as 40 mg enoxaparin sodium. EPI was infused continuously through a fixed electronic infusion device using portless tubing, with the head of bed of the patient being in a 25 degrees elevation. EPI analgesia was achieved as 0.1% bupivacaine combined with 5 µg/mL fentanyl at a rate of 4 mL/hr throughout the study. IS was strongly encouraged up to 10 times each hour while patients were awake.

2.4. Intervention

The 267 patients were assigned using a permuted randomization method stratified to their pain scores at baseline, with 133 in the control group and 134 in the intervention group. Patients in the intervention group were briefly informed about the overall design of self-education. A self-care package, including muscular progressive relaxation and music, was adopted from a prior study [22]. The demographics were assessed first and the initial QoL score was obtained based on the severity of emesis and nausea. The following education section consisted of 12-sessions (45–60 minutes each). Videos and slides were employed to emphasize two major aspects, namely muscular progressive relaxation and distraction. To relieve emesis and nausea, patients in the intervention group were trained with muscular progressive relaxation technique as a measure for self-care. Listening to music before, during, and after the EPI analgesia to distract the mind was used as another self-care measure. We on a regular basis instructed on integrated music appreciation, the finger massage, and meditation classes. On the other hand, patients in the control group did not receive the above education on self-care therapy.

2.5. Data collection and measures

Pain was scored on a standard 0–10 numeric rating scale (NRS), with 0 for no pain at all and 10 for the most severe pain. IS volume, SpO₂, and respiratory rate were examined at hospital admission (baseline) and collected by bedside nurses who were unaware of the group assignment. QoL questionnaire with the modified European Organization for Research and Treatment of Cancer (EORTC) quality of life questionnaire QLQ-C30 version 3.0 was answered by all enrolled patients. In the 5 functioning scales (Physical, Role, Emotional, Cognitive, and Social), higher scores indicate better quality of life; for 1 symptom scale (Nausea/Vomiting) and 2 single-item scales (Appetite Loss and Diarrhea), higher scores indicate poorer quality of life. Patients were asked to self-assess fatigue with the use of the validated 20-item multidimensional Fatigue Assessment Questionnaire covering dimensions of physical, cognitive and affective fatigue. The degree of fatigue was evaluated by integrating appropriate items (0 = none, 1 =

mild, 2 = moderate and 3 = strong), with high values indicating higher degree of fatigue. The questionnaire was collected at hospital admission (baseline) and by bedside nurses who were unaware of the group assignment. At time of patient discharge, total time of EPI analgesia and hospital LoS were also recorded.

2.6. Data analysis

All data were analysed with the use of the SPSS 23.0 software. Normally distributed data were shown as mean \pm standard deviation (SD), while non-normally distributed data were shown as median and interquartile range. The difference between groups regarding each parameter was determined using student *t* test or *chi* square test. A *p* value < 0.05 was considered significantly different.

3. Results

From June 2016 to June 2019, 267 MRF patients who underwent SSRF and received EPI analgesia met the criteria for inclusion as well as exclusion. The recruited patients were assigned to two groups, with 134 in intervention and 133 in control groups, respectively (Fig. 1). Demographic data of patients in both groups were presented in Table 1, and there was no obvious difference between the two study groups.

Table 1
Patient demographics at admission.

Demographics	Intervention (n = 134)	Control (n = 133)
Age, year, median (interquartile range)	39 (26–57)	42 (24–60)
Male, n	78	71
Number of fractured ribs, median (interquartile range)	5 (4–9)	6 (4–8)

Pain was evaluated in terms of NRS. As listed in Table 2, pain scores dramatically reduced from admission to discharge in both groups (* *p* < 0.05), implicating the beneficial effects of EPI analgesia. Moreover, at hospital discharge, pain scores of the intervention group were markedly lower than those of the control group (Table 2, # *p* < 0.05), suggesting self-care was effective in terms of pain control during EPI analgesia. Furthermore, IS volume, SpO₂, and respiratory rate were also assessed (Table 2). IS volumes displayed a similar trend of change as pain scores, with notable improvements from admission to discharge in both study groups (Table 2, * *p* < 0.05). Further improvement of IS volume was observed at discharge in the intervention group in comparison with the control group (Table 2, # *p* < 0.05). Similar effects were observed in respiratory rate and SpO₂ as well. Of note, no significantly differences could be found between the two groups at admission in all the above parameters (Table 2, \$ *p* > 0.05).

Table 2
Pain scores and functional parameters of patients at admission and discharge.

	Intervention (n = 134)		Control (n = 133)	
	Admission	Discharge	Admission	Discharge
Pain scores	8 (5–10)	3 (2–5) *	9 (6–10) \$	6 (4–7) *#
IS volume (mL)	681 (379–1123)	1106 (524–1467) *	654 (392–1260) \$	894 (486–1316) *#
Respiratory rate (per min)	25 (13–37)	17 (11–32) *	24 (12–40) \$	20 (14–33) *#
SpO2	0.93 (0.88–0.98)	0.98 (0.95–1.00) *	0.92 (0.89–0.99) \$	0.96 (0.94–0.99) *#
IS, incentive spirometry; SpO2, oxygen saturation. Data shown as median (interquartile range). * $p < 0.05$ intra-group comparison between admission and discharge; \$ $p > 0.05$, inter-group comparison at admission; # $p < 0.05$, inter-group comparison at discharge.				

Next, QLQ-C30 scales were listed in Table 3. Again, no significant differences could be found at admission between the two groups in all parameters assessed (Table 3, \$ $p > 0.05$). We found marked improvements of physical function, cognitive function and nausea/vomiting, from admission to discharge in both groups (Table 3, all * $p < 0.05$). On the other hand, in the entire study period, global QoL, emotional function and appetite loss were significantly improved in the intervention group, whereas no such change were observed in the control group. This resulted a significant advantage in these parameters in the intervention group over that of the control group (Table 3, # $p < 0.05$).

Table 3
Quality of life (QoL) parameters of patients at admission and discharge.

	Intervention (n = 134)		Control (n = 133)	
	Admission	Discharge	Admission	Discharge
Global QoL	58.4 ± 18.5	54.5 ± 15.7 *	60.1 ± 19.3 \$	58.2 ± 16.4 #
Physical function	83.6 ± 18.2	78.6 ± 14.9 *	82.1 ± 21.5 \$	74.3 ± 18.9 **
Emotional function	65.2 ± 17.6	67.3 ± 18.1 *	64.4 ± 16.3 \$	66.8 ± 17.2 #
Role function	73.5 ± 19.4	74.1 ± 21.2	75.6 ± 17.7 \$	75.9 ± 18.1 &
Cognitive function	81.4 ± 13.7	87.2 ± 14.9 *	82.0 ± 16.2 \$	85.3 ± 12.8 **
Social function	74.1 ± 16.2	75.6 ± 14.5	73.2 ± 15.8 \$	75.3 ± 13.7 &
Nausea/vomiting	13.2 ± 2.1	10.8 ± 2.3 *	13.5 ± 1.9 \$	12.1 ± 2.0 **
Appetite loss	7.3 ± 1.6	6.2 ± 1.7 *	7.5 ± 1.9 \$	7.2 ± 2.0 #
Diarrhea	12.6 ± 1.3	11.8 ± 2.1	12.9 ± 1.6 \$	12.1 ± 1.7 &
Data shown as mean ± SD. * $p < 0.05$ intra-group comparison between admission and discharge; \$ $p > 0.05$, inter-group comparison at admission; # $p < 0.05$, & $p > 0.05$, inter-group comparison at discharge.				

Fatigue parameters were further assessed in Table 4. With the exception of affective fatigue, the other two parameters, namely physical and cognitive fatigue were significantly improved in both study groups from admission to discharge (Table 4, * $p < 0.05$). Expectedly, total fatigue was much improved in both groups in the study period as well (Table 4, * $p < 0.05$). Importantly, at time of discharge, total and physical fatigue parameters of the intervention group were improved by a significantly larger extent than those in the control group (Table 4, # $p < 0.05$), whereas no differences could be seen for affective and cognitive fatigue at the same time point (Table 4, & $p > 0.05$).

Table 4
Fatigue parameters of patients at admission and discharge.

	Intervention (n = 134)		Control (n = 133)	
	Admission	Discharge	Admission	Discharge
Total fatigue	42.3 ± 13.2	34.7 ± 11.4 *	41.8 ± 14.6 \$	38.2 ± 14.1 **
Physical fatigue	46.1 ± 15.3	41.4 ± 13.7 *	47.1 ± 12.6 \$	43.1 ± 12.1 **
Affective fatigue	34.5 ± 9.3	33.6 ± 10.2	34.8 ± 10.4 \$	32.7 ± 8.6 &
Cognitive fatigue	32.3 ± 11.2	30.5 ± 9.4 *	32.9 ± 8.7 \$	29.8 ± 9.5 *&
Data shown as mean ± SD. * $p < 0.05$ intra-group comparison between admission and discharge; \$ $p > 0.05$, inter-group comparison at admission; # $p < 0.05$, & $p > 0.05$, inter-group comparison at discharge.				

At last, the total time of EPI catheter analgesia and hospital LoS were compared between the two groups of MRF patients after their SSRF surgery (Table 5). Significantly shorten EPI time and LoS were found in the intervention group than control group (both * $p < 0.05$).

Table 5
Time of EPI analgesia and hospital LoS at discharge.

	Intervention (n = 134)	Control (n = 133)
EPI time (hour)	24.3 (19.6–34.1)	31.7 (22.1–34.8) *
Hospital LoS (day)	12 (9–15)	15 (10–17) *
Data shown as median (interquartile range). * $p < 0.05$ inter-group comparison at discharge.		

4. Discussion

The current clinical study sought to evaluate the efficacy of self-care measures on the pain management and QoL of MRF patients after SSRF. Rib fractures, one of the leading causes for hospitalization, are often caused by blunt chest trauma. Rib fractures lead to disability and severe pain, and patients with rib fractures frequently develop chest wall deformity or pneumonia. Previous randomized controlled studies demonstrated that SSRF has advantages over conservative treatments for patients with respiratory failure and flail chest [23]. Meta-analyses and reviews also demonstrated that SSRF could shorten length of ICU/hospital stay, tracheostomy rate, and duration of ventilation. The indications for SSRF have been well established based on expert consensus. On the other hand, poor pain control resulted in impedance of the patient's active mobilization due to the persistent pain in spite of optimized medical treatments using non-steroid anti-inflammatory drugs and morphine mimetics. Locoregional pain relief with para-vertebral blockade or EPI analgesia is not suitable for prolonged used, ye rib fractures are often still unstable and painful at 4–6 days post the initial trauma [24].

In the current study, we found that after SSRF, pain scores of MRF patients with the self-care intervention were more profoundly improved than control patients without self-care. At pulmonary function level, IS volume, respiratory rate and SpO₂ of intervention group patients were also consistently improved by larger extents than those of the control group. There results demonstrated that the self-care intervention could enhance pain management of EPI analgesia and pulmonary function recovery for MRF patients after SSRF operation.

Next, using the QLQ-C30 checklist, we evaluated several QoL parameters and physiological symptoms, such as physical function, emotional function, role function, cognitive function, social function, nausea/vomiting, appetite loss and diarrhea. In the control group, only physical function, cognitive function and nausea/vomiting were improved at time of hospital discharge. On the other hand, in the intervention group, not only global QoL, physical function, emotional function, cognitive function, nausea/vomiting and appetite loss were improved, but the improvement of these symptom was more pronounced than control group. Comparison between the control and intervention groups revealed that

the self-care measures could largely elevate the patients' QoL, at least during their hospital LoS immediately after SSRF. Moreover, intervention group patients also reported significantly improved physical and total fatigue, compared to control patients, suggesting the efficacy of self-care measures in alleviating fatigue after SSRF.

Orem's self-care theory states that the self-care education course is composed of distraction, nutrition optimization, and muscular progressive relaxation [14]. Muscle relaxation was particularly effective for improving both psychological and pharmacologic vomiting/nausea complications as a result of various medical treatments [25, 26]. Consistent with this notion, in our study experimental subjects were instructed to relax muscles with deep breath and finger massage, which demonstrated significant benefits against vomiting/nausea and fatigue following SSRF.

Another widely-accepted measure for side effect relief was distraction [27, 28]. We therefore designed our self-care education course to include meditation and music appreciation, to distract the mind of patients with MRF. The MRF patients who practiced distraction were more calm, positive and with improved physical functions compared with the control subjects. Our findings supported the benefits of distraction in side effect relief during EPI analgesia in MRF patients.

The aim of self-care, a non-pharmacological procedure, is to enhance psychological as well as states of patients via educational processes [29]. With the aid of self-care education, improved clinical conditions of patients as well as reduced expenses of hospitalization can be achieved. Our records, showing shorter EPI time and hospital LoS for MRF patients who practiced self-care than those did not, certainly echoes this notion.

Conclusion

In summary, we have shown that self-care measures make significant contribution to improve pain management, recovery of pulmonary function, QoL and fatigue for patients receiving SSRF operation after suffering from MRF. However, self-care measure has its own limitations. Many external variables influence the self-care capability of an individual, such as growth stage, age, cultural/social awareness, income, resources, and life experiences [22]. Due to all these factors, the ultimate effect of self-care measures on different individuals could vary. Although in MRF patients, the self-care measures improved the QoL, the self-care education requires time commitment as well as many resources, which are not available to all patients.

Abbreviations

Epidural (EPI); multiple rib fractures (MRF); surgical stabilization of rib fractures (SSRF); quality of life (QoL); Incentive spirometry (IS); oxygen saturation (SpO₂); hospital length of stay (LoS)

Declarations

Ethics approval and consent to participate

This investigation obtained approval from the Ethics Review Board of Quanzhou First Hospital Affiliated to Fujian Medical University.

Consent for publication

All of the authors have consented to publication of this research.

Availability of data and material

All data generated or analysed during this study are included in this published article.

Competing interests

The authors declare that they have no competing interests.

Authors' contributions

Biyu Wu, Biyan Huang: Data collection and analysis

Chunmei Wu: Data collection

Yijin Hong: Project development and manuscript writing

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Figures

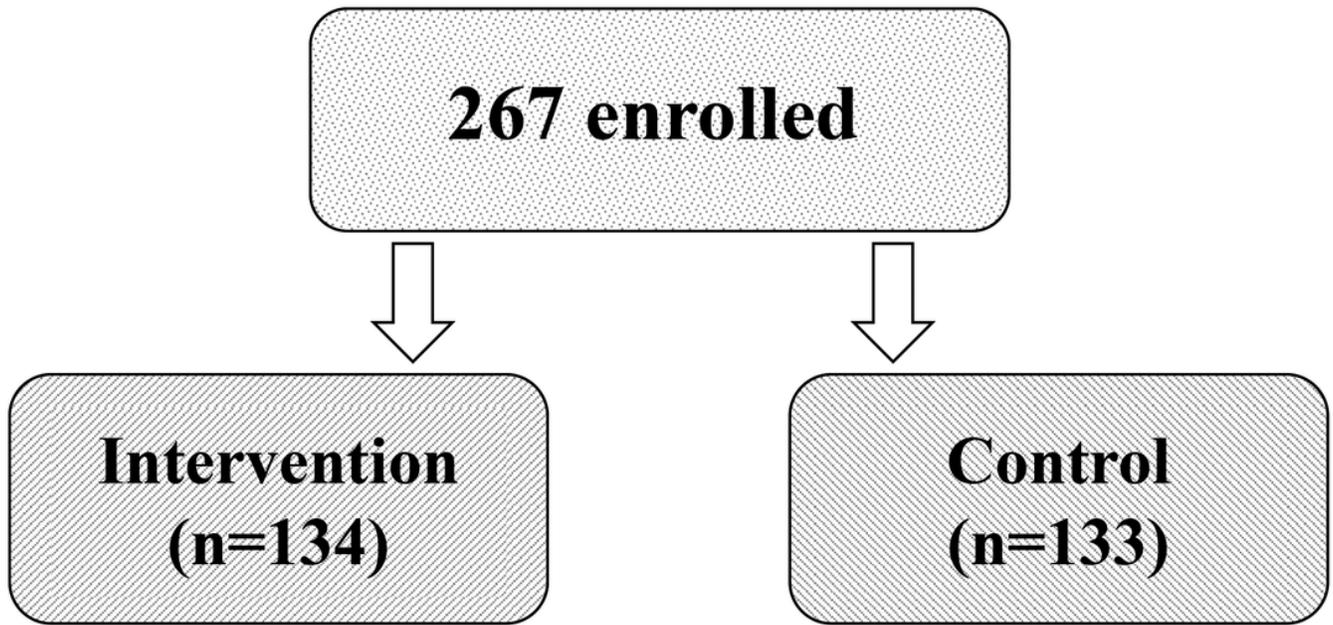


Figure 1

Flow chart of the study.