Original Article

Noninvasive positive pressure ventilation (NPPV) for elderly patients after abdominal surgery

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Abstract

We introduced noninvasive positive pressure ventilation (NPPV, BiPAP) in elderly patients (over 80 years old) after abdominal surgery for postoperative respiratory care, and retrospectively estimated the effectiveness of NPPV. Thirty patients were allocated to the BiPAP group, and 29 patients to the no-BiPAP group. We measured PaO_2/FiO_2 (P/F ratio) and $PaCO_2$ at preoperative day, the operative day (after attaching BiPAP), and the 1st postoperative morning (after removing BiPAP), then verified the incidence of cardiopulmonary complications, and postoperative hospital stay between both groups. In no-BiPAP group, the P/F ratio of the operative day and 1st postoperative morning was significantly lower than that of preoperative day. At the operative day and 1st postoperative morning, the P/F ratios of the BiPAP group were significantly higher than those of the no-BiPAP group, respectively (375.3±88 vs 291±64.9, 348.7±86.8 vs 279.5±61.8, $p<0.05$). There was no significant $PaCO_2$ difference between the groups. The incidence of cardiopulmonary complications of no-BiPAP group is significantly higher than that of BiPAP group ($p<0.05$), but there was no significant difference on hospital stay. These results indicated that BiPAP was effective on maintaining oxygenation and reducing cardiopulmonary complications in elderly patients after abdominal surgery.

(Key words : noninvasive positive pressure ventilation (NPPV), elderly patients, abdominal surgery)

I. Introduction

Elderly people now have more likelihood of undergoing gastrointestinal surgery because of a prolonged life span and diligent medical check-ups in Japan. For elderly patients with reduced activity and decreasing organ function, intensive care should be taken in the perioperative conditions, especially postoperative care. Among the critical points for the elderly, respiratory management is the most important issue in their decreased lung function. Postoperative pulmonary complications such as atelectasis, sputum retention, and broncho-pulmonary infec-

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tion are high risks aggravating the pulmonary function and causing postoperative death. In the prevention of respiratory complications, oxygen inhalation by mask with physiotherapy is conventional therapy.

Noninvasive Positive Pressure Ventilation (NPPV) is able to achieve positive airway pressure without intubation or tracheostomy. It is recognized as an alternative method of conventional mechanical ventilation, and becomes popular in various clinical settings such as treatment for respiratory failures[1),2)], ventilatory assist for neuromuscular diseases[3)] and ventilatory support for postoperative respiratory unstable condition[4)-10)]. We introduced NPPV for elderly patients undergoing abdominal surgery to avoid hypoxemia and prevent cardiopulmonary complications. In this study, we evaluated retrospectively the effectiveness of postoperative NPPV for patients over 80 years old on the respiratory care.

II. Patients and methods

NPPV protocol for postoperative respiratory care is outlined below. We devised the special mask which is fastened with face and head straps. It covers the nose and mouth with a hydrocolloid substance to prevent air leak from the BiPAP system (BiPAP Vison: Respironics, Inc) (BiPAP) (Figure 1). BiPAP was attached to the patient overnight through the mask. The next morning, we removed the BiPAP and applied an oxygen mask immediately to the patient, and urged the patient to recover his ADL. All patients had a nasogastric tube placed intraoperatively in advance to avoid aerophagia which was an adverse effect of BiPAP. The BiPAP parameters were as follows: The fraction of inspired oxygen (FiO_2) 0.4, inspiratory positive airway pressure (IPAP) 10 cmH2O, expiratory positive airway pressure (EPAP); positive end expiratory pressure (PEEP) 5cm H_2O, respiratory rates (RR) 8 times/minute. If a patient complained of discomfort or suffered from an adverse effect of BiPAP, we discontinued BiPAP and changed to an oxygen mask immediately.

There were 67 patients more than80-year-old who underwent gastrointestinal surgery under general anesthesia from January 2000 to September 2004 consecutively at Nasu-Minami Hospital. If the patients were smokers, we advised them to stop smoking for at least one week prior to surgery. All patients, except for emergency cases, were urged to perform respiratory

Figure 1 After surgery BiPAP mask is fitted to the patient, and connected to the BiPAP system. An nasogastric tube is inserted.

training 3 to 7 days before surgery. We excluded patients who had preoperative cardiopulmonary disease or underwent operation for more than 240 minutes, or had not been extubated after surgery. Consequently, we investigated 59 patients, and divided those patients into 2 groups, the BiPAP group (30 patients) and the no-BiPAP group who used an oxygen mask (29 patients).

We measured PaO_2/FiO_2 (P/F ratio) and $PaCO_2$ at three stages; preoperative day, the operative day (after attaching BiPAP), and the 1st postoperative morning (after removing BiPAP). We then compared P/F ratio and $PaCO_2$ between the two groups. In addition, we verified the incidence of cardiopulmonary complications using X-ray within 7 days after surgery, complications in relation to BiPAP, and postoperative hospital stay in both groups.

The data were expressed as the mean±standard deviation. Student's unpaired t-test, paired t-test, and chi-squre test for independence were used for statistical analysis of the two groups (BiPAP vs no BiPAP). $P<0.05$was considered to be statistically significant.

III. Results

No one stopped using BiPAP before the next morning. Averaged equipped time was 15±2.86 hours. There was no significant difference in the backgrounds of patients in terms of age, male/female ratio, elective/emergency operation ratio, operative time, type of operation. (Table 1).

There was no significant difference of preoperative P/F ratio and $PaCO_2$ between the two groups. On the operative day after attaching BiPAP, the P/F ratio of the BiPAP group was significantly higher than that of the no-BipPAP group (375.3±88.0 vs. 291.0±64.9 ; $p<0.05$). On 1st the operative morning after removing BiPAP, the P/F ratio of the BiPAP group was also significantly higher than that of the no-BiPAP group (348.7±86.8 vs. 279.5±61.8 ; $p<0.05$). There was no significant difference in the P/F ratio in the BiPAP group among 3 points. On the other hand, the P/F ratio of the operative day or 1st the operative morning was significantly lower than that of the preoperative day in the no-BiPAP group (Table 2) (Figure 2).

$PaCO_2$ was not significantly different between the two groups, and among the above 3 points of the two groups (Table 2).

The no-BiPAP group had one case of congestive heart failure, 2 cases of pneumonia and 2 cases of atelectasis, but the BiPAP group had only congestive heart failure. The incidence of postoperative cardiopulmonary complication was significantly lower in BiPAP group than in non-BiPAP group ($p<0.05$). All the complicated patients were cured by conservative therapy

Table 1. Backgrounds

	BiPAP	no-BiPAP	p value
Number of patients	30	29	
Age	84.4+4.1	84.9+3.9	0.86
Male/Female	13/17	14/15	0.79
Elective/Emergency	24/6	22/7	0.76
Operative time (minutes)	150.2+56.7	153.0+61.0	0.86
Operation			0.24
Gastric surgery	9	8	
Intestinal surgery	17	12	
Biliary surgery	4	9	

Table 2. Results

	BiPAP	no-BiPAP	p value
Number of patients	30	29	
P/F ratio			
(preoperative)	395.9±55.7	416.9±47.9	0.13
(operative)	375.3±88.0	291.0±64.9*	$p<0.05$
(1st postoperative)	348.7±86.8	279.5±61.8**	$p<0.05$
$PaCO_2$ (mmHg)			
(preoperative)	38.7±4.9	38.9±4.1	0.86
(operative)	38.7±4.8	40.0±4.0	0.24
(1st postoperative)	37.5±4.2	38.8±3.5	0.20
Cardiopulmonary complications			$p<0.05$
Congestive heart failure	1	1	
Pneumonia	0	2	
Atelectasis	0	2	
Complications related to BiPAP			
Compression of facial skin	1	-	
Postoperative hospital stay (day)	32.45±36.7	28.9±22.2	0.57

* : $p<0.05$vs(preoperative)
** : $p<0.05$vs(preoperative)

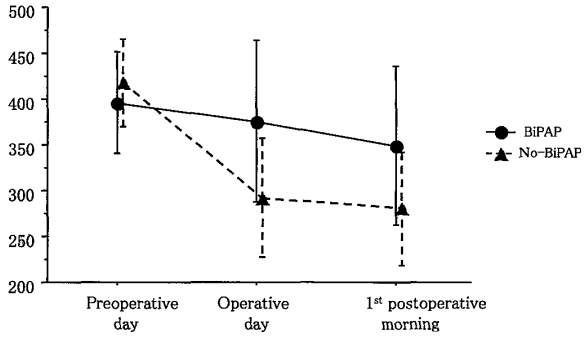

Figure 2 Change of P/F ratio at preoperative day, operative day (after attaching BiPAP), and1st postoperative morning (after removing BiPAP).

without re-intubation. One patient had facial skin compression after using BiPAP. There was no difference in the postoperative hospital stay between the two groups (Table 2).

IV. Discussion

This study showed that the BiPAP system might prevent elderly patients undergoing abdominal surgery from postoperative pulmonary complications with maintaining a high PaO_2 level.

Elderly patients especially over 80 years old, are weaker and have decreased organ functions, for example, vital capacity is only 50% of 30-year-old[11]. Decreased vital capacity and forced expiratory volume, increased closing volume, and deterioration of airway clearance and cough reflux might cause microatelectasis in the lungs and result in postoperative hypoxemia and life-threatening critical conditions[12].

The NPPV, BiPAP system can maintain dilatation of the peripheral airways patency,

improve gas exchange and promote excretion from bronchus without intubation. NPPV has been proved to be useful for acute respiratory failure[1], acute exacerbation of chronic obstructive pulmonary disease[2], and respiratory distress in the emergency department[13),14]. For postoperative respiratory care, it has been applied to obese patients undergoing gastroplasty[4-6], and to patients undergoing lung surgery[7,8] and cardiovascular surgery[9),10]. Although there are few reports focusing on the use of NPPV for elderly patients, we introduced prophylactic use of NPPV, BiPAP for elderly patients undergoing abdominal surgery to prevent postoperative hypoxemia and atelectasis.

Whether NPPV, BiPAP is successful or not depends on experienced clinicians' skill and the strict strategy. Fortunately, the failure rate was very low in this study. Hill reported the failure rate was 5-40% and he stated that a larger clinician team and expertise played important role in a higher percentage of patients succeeding on NPPV[15].

Several authors have reported that 12 to 24 hours was optimal for postoperative respiratory managements[4),5], and the limit of BiPAP is 48 hours for the treatment of respiratory failure. Our data showed that the PaO_2 of the BiPAP group remained significantly higher than the no-BiPAP group one hour after ceasing BiPAP. Our data supported Gust R and Agulio R et al. who revealed that PaO_2 was maintained even one hour after stopping BiPAP[7),9)].Whether BiPAP decreased the $PaCO_2$ level or not was controversial. There were no significant differences in the $PaCo_2$ level between with and without BiPAP in our data as Agulio R et al. reported[7].

Contraindications for NPPV were as follows: Cardiopulmonary arrest; non-respiratory organ failure; facial surgery or injury; inability to protect airway; inability to clear secretions[15]. Because of bowel distention with air due to a positive airway pressure, dehiscence of reconstructed bowel was one of the complications of NPPV[6]. We inserted a nasogastric tube overnight in all the patients and had no bowel distention or anastomotic leakage. We recommend short-time use of a nasogastric tube. We had a complication of BiPAP, facial compression in one patient. As facial buccal fat tissue is apt to shrink and be pinched in the elderly, it is sometimes difficult to fit the BiPAP mask. We considered that this complication was due to tightening the rubber band to avoid air leakage from the space between the face and mask. The mask should have been attached loosely and fitted comfortably to the face.

Hill N and Poponick et al. reported that NPPV shortend the hospital stay significantly[13),15)], however, Ebeo and Auriant I concluded that there were no differences in hospital stay between the BiPAP and the no-BiPAP[5),8)]. Our data showed no significant differences in hospital stay between the two groups. Each elderly patient varies in his postoperative course. Some elderly patients were apprehensive about their living after discharge and desired longer care in hospital. Therefore, the hospital stay may be reflected by their wish to stay long in hospital.

In conclusion, we indicated retrospectively that NPPV, BiPAP was effective on maintaining oxygenation and reducing cardiopulmonary complications in elderly patients after abdominal surgery.

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高齢者の開腹手術における非侵襲的陽圧呼吸療法（NPPV，BiPAP）

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要　約

高齢者（80歳以上）の開腹術後におけるNPPVの有効性を明らかにする目的で，帰室時から第一病日までBiPAPを施行した群（30名）と酸素マスクのみのno-BiPAP群（29名）で，酸素化能（PaO_2/FiO_2：P/F比）と換気能（$PaCO_2$），術後心肺合併症，BiPAP合併症，在院日数を遡及的に検討した。P/F比ではno-BiPAP群は術前に比して帰室後，第一病日朝が有意に低下し，BiPAP群が帰室後，第1病日朝でno-BiPAP群より有意に高かった（375.3±88 vs 291±64.9，348.7±86.8 vs 279.5±61.8，$p<0.05$）。$PaCO_2$は有意差がなかった。心肺合併症発生率ではno-BiPAP群で有意に高かった。これらの結果からNPPVは高齢者開腹手術の術後呼吸管理に有用であることが示唆された。

（キーワード：非侵襲的陽圧呼吸療法，高齢者，開腹手術）

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