Original Article

Non-invasive positive pressure ventilation for elderly patients after abdominal surgery：Results from a Japanese rural community hospital

Yasunao Ishiguro[1,2], Masanobu Hyodo[2], Toru Yoshida[1], Hidehiko Endo[1], Shin Obara[1], Chie Itoh[1], Hitoshi Fujii[1], Alan T. Lefor[2], Yoshikazu Yasuda[2]

[1]Department of Surgery, Iwate Prefectural Kamaishi Hospital, Iwate, Japan 026-8550
[2]Department of Gastrointestinal Surgery, Jichi Medical University, Tochigi, Japan 329-0498

Abstract

We prospectively analyze the effectiveness of NPPV on the elderly patient after abdominal surgery. More than 75 years old twenty patients included the study in our hospital from Oct 2010 to Mar 2011. They were randomly assigned to the NPPV group or the No-NPPV group. The Backgrounds of the both groups didn't differ significantly. A ratio of partial pressure of arterial oxygen to fraction of inspired oxygen (P/F ratio) is higher in the NPPV group ($P<0.05$) on the first postoperative day. There is no difference about the rate of the postoperative morbidity and the length of hospital stay between two groups. NPPV keeps oxygenation of the elderly abdominal surgical patients in the first postoperative day.

(Keywords：Non-invasive positive pressure ventilation (NPPV), elderly patient, abdominal surgery, community hospital)

Introduction

Non-invasive positive pressure ventilation (NPPV) is widely used to treat patients with cardiogenic pulmonary edema and chronic obstructive pulmonary disease[1)2)]. NPPV can maintain positive airway pressure without endotracheal intubation[1)2)]. In Japan, the population of the elders and the elderly surgical patients are increasing. The postoperative morbidity of the lung, especially atelectasis and pneumonia, occurs easily after abdominal surgery in elderly patients, because the abdominal incision and anesthetic effect disable the patient's respiratory function[3)4)5)]. Elderly patients have a less physical reserve and more co-morbidity, so they might suffer from the postoperative morbidities more easily after abdominal surgery. It is important to reduce the rate of the postoperative pulmonary morbidities in these patients. However, previous reports about the preventive effect of NPPV have not been extensive[6)7)8)], especially bilevel positive airway pressure. We prospectively analyzed the effectiveness of NPPV in elderly patients primarily to improve the oxygenation and a ratio of partial pressure of arterial oxygen (PaO_2) to fraction of inspired oxygen (F_IO_2) (P/F ratio) in the NPPV group on the first postoperative day, and secondarily to reduce the pulmonary morbidities.

Methods

The patients over 75 years old scheduled to undergo abdominal surgery were registered and randomly assigned to the NPPV group or the No-NPPV group from 1 October 2010 through 11 March 2011. NPPV was administered using BiPAP Vision ventilator (Respironics, Inc) after an operation. Exclusion criteria included emergency operations and the patients who could not be extubated immediately after the operation in the operating room. The patients who had severe cardio-pulmonary co-morbidity (acute myocardial infarction occurred last 6 months, uncontrolled congestive heart failure, chronic lung disease with $FEV_{1.0}$ <1L) were decided to be excluded from the study. The patients who had less severe co-morbidities (hypertension, diabetes, hyperlipidemia, atrial arrhythmia, etc.) were not excluded from this study, but the co-morbidities were recorded. Twenty patients were registered with 10 patients in each group. All patients were informed that they may be given a mask to assist respiration, and informed consent was obtained from all patients. This study was approved by the ethics review board of the Iwate Prefectural Kamaishi

Correspondence to：Yasunao Ishiguro, Department of Gastrointestinal Surgery, Jichi Medical University,Tochigi, Japan 329-0498,
E-mail：yasunao-i@jichi.ac.jp
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Hospital. The authors have no conflict of interest to declare.

After surgery, patients in the NPPV group were extubated and given the usual 4 ℓ /min oxygen mask on return to their ward, then an oronasal NPPV mask was placed. The NPPV parameters were as follows : S/T mode, F_IO_2 0.4, inspiratory positive airway pressure (IPAP) 10 cmH_2O, expiratory positive airway pressure (EPAP) 5 cmH_2O, respiratory rate (RR) 8 times/minutes. The NPPV mask was removed if the patient complained about discomfort. In that case, a 6 ℓ /min regular type mask (F_IO_2 0.4) was placed instead and the time of mask exchange was recorded. The patients in the No-NPPV group were extubated and given a usual 4 ℓ /min oxygen mask on the way back to their ward, a 6 ℓ /min oxygen mask (F_IO_2 0.4) was placed. F_IO_2 was measured around the patient's mouth with FLUKE™ VT Mobile (TAISHO BIOMED INSTRUMENTS CO,. LTD.). A nasogastric tube was placed to prevent gastric distension until the masks were removed in both groups.

Preoperatively, the arterial blood gas analysis was performed for all patients on room air. Smokers in both groups were educated about smoking cessation (4 in the NPPV group and 2 in the No-NPPV group). All patients received the respiratory muscle training in preoperative period. The site of the incision, upper or lower, was recorded.

In both groups, a blood gas sample was obtained after an operation at the point of the NPPV or 6 ℓ /min mask equipped for 60 minutes and 15 minutes after the masks were removed in the first postoperative day. Oxygen was re-administered with 2 ℓ /min nasal cannula when the arterial oxygen saturation (SaO_2) decreased 92% and below with the room air at least for 60 minutes. The chest X-ray was taken on the first, third, and seventh postoperative days to evaluate for atelectasis or other abnormal pulmonary findings. The X-rays were evaluated by four surgeons. Also an abdominal X-ray was taken to evaluate for the bowel paralysis and diagnose the ileus. The wounds and drainage tubes were checked everyday for the surgical complication (wound infection, abscess formation, anastomotic leakage, etc.).

Statistical analysis was performed using Student's t-test and the chi-square test. A P-value of <0.05 was considered significant. All statistical analysis was performed using StatView® (Version 5.0, Berkeley, CA, USA).

Results

The basic patient characteristics are shown in Table 1. There are no significant differences regarding the patients' age, male to female ratio or body mass index between the two groups. The operative time, blood loss, incision site, operated organ (biliary, gastric, colorectal) and the underlying diseases (malignant vs. benign) also had no significant differences. The prevalence of the less severe co-morbidities was not different among the groups. One patient had a history of ischemic heart disease and one patient had atrial fibrillation in the NPPV group and one patient had a history of ischemic heart disease and a history of lung resection in No-NPPV group. One patient suffered from postoperative delirium, and the NPPV mask was removed 30 minutes after placement. From the viewpoint of the intention to treat analysis, this patient was included in the NPPV group.

No significant difference was found between the NPPV group and the No-NPPV group regarding preoperative and

Table 1. Patient Demographics

Characteristic	NPPV n=10	No-NPPV n=10	P-value
Age	79.4 (75-89)	79.7 (75-85)	NS
Male/Female	4/6	5/5	NS
Body mass index (m^2/kg)	22.5 (17.5-33.8)	23.5 (17.0-30.2)	NS
Operative time (min)	148.3 (70-267)	208.2 (75-571)	NS
Blood loss (g)	162.5 (20-489)	301.5 (22-1928)	NS
Incision site: Upper/Lower	9/1	9/1	NS
Biliary/Gastric/Colorectal	3/1/6	5/3/2	NS
Benign/Malignant Diagnosis	4/6	4/6	NS
Cardiopulmonary co-morbidities with / without	2/8	2/8	NS

median (range) NS = not significant

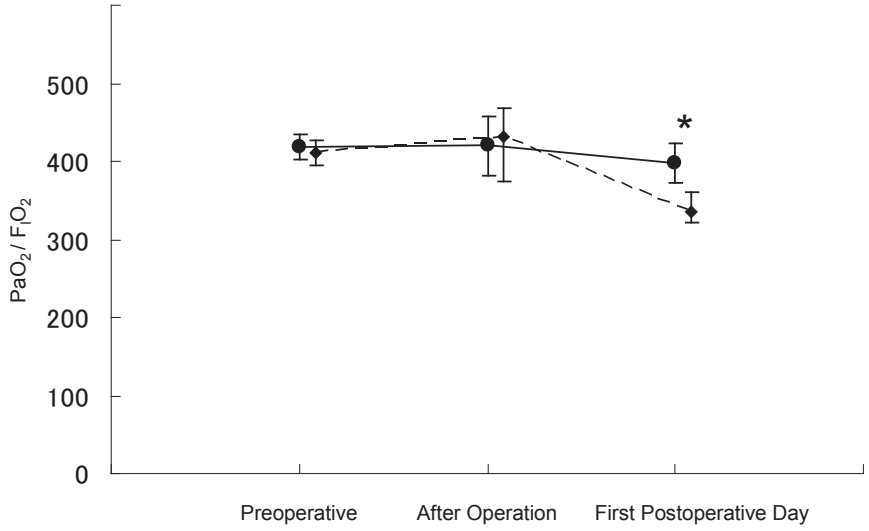

Figure 1.
P/F Ratio is shown at three time points. Value of NPPV group (closed circle) in the first postoperative day is significantly better than that of No-NPPV (square) group. Data points are means ± SD. *; P<0.05 for comparison of the NPPV group vs. No-NPPV group.

Table 2. Postoperative Morbidities and Hospital Stay

	NPPV n=10	No-NPPV n=10	P-value
Pulmonary morbidities	4	2	NS
Atelectasis	3	1	
Pneumonia	1	0	
Pleural effusion	0	1	
Oxygen re-administration	2	4	NS
Other morbidities	5	5	NS
Wound infection	2	1	
Abscess	1	1	
Leakage	1	0	
Ileus	0	1	
Delirium	1	2	
Hospital stay (days)	35.0 (8-159)	21.6 (8-46)	NS

NS = not significant

postoperative P/F ratio on the day of the operation. On the other hand, P/F ratio in the NPPV group was statistically higher than the No-NPPV group on the first postoperative day.

The postoperative pulmonary morbidity, other morbidities and hospital stay are shown in Table 2. Atelectasis on X-ray was seen in three patients in the NPPV group and one in the No-NPPV group. Only one case of pneumonia developed in the NPPV group and that patient also had anastomotic leakage after a low anterior resection for rectal cancer. In the No-NPPV group, a small amount of pleural effusion requiring no intervention was seen in one patient. No significant differences were seen regarding pulmonary morbidity in the two groups. There were 2 and 4 patients in the NPPV and No-NPPV groups requiring re-administration of oxygen respectively, but the difference was not significant. No difference was seen regarding other morbidities, as well. The total hospital stay was similar in the both group, despite the NPPV group include the patient with the anastomotic leak.

Discussion

In internal medicine, NPPV has been one of the modalities used to treat congestive heart failure, chronic

respiratory failure etc.[1)2)]. NPPV has also been used to treat postoperative acute respiratory failure in some reports[6)9)] including patients undergoing liver transplantation[10)]. There have been no prospective studies about the preventive use of NPPV in elderly patients undergoing open abdominal surgery. We expected that NPPV would reduce the incidence of atelectasis and improve blood gas exchange on the patients with impaired respiratory function due to pain at the incision site and/or general anesthesia. A reduction in pulmonary morbidity and length of hospital stay were anticipated.

There were no significant differences regarding patient characteristics in the NPPV groups and No-NPPV groups. The operative time and blood loss of both groups were not different, and that means the influence of the surgical stress was removed from our study. So we think that the effect of NPPV on the postoperative oxygenation was precisely evaluated under the same surgical stress level.

Because the faster recovery of the ambulatory may also help to reduce the postoperative morbidity, the mask and oxygen were removed in the morning of the first postoperative day in this study. It is clear that the adaptation of the mask will reduce the patient's activity especially in the daytime, so the mask should be removed as early as possible, unless there is the respiratory condition that must be treated with NPPV.

On the morning of the first postoperative day, the data from the NPPV group showed significantly better oxygenation than the No-NPPV group. In the NPPV group, the peripheral alveoli might remain expanded after the overnight positive airway pressure, so the oxygenation would be maintained without the mask and oxygen. Even though, the difference of the number of patients who were re-administrated oxygen in both groups was not significant.

Similar to previous reports in thoracic surgery[11)12)13)], the pulmonary morbidity was not different in the two groups of our study limited to the elder patients with abdominal surgery. Although the oxygenation was better in the NPPV group, atelectasis occurred similarly in two groups. The NPPV may have little effect to prevent atelectasis.

One patient with pneumonia in the NPPV group suffered from the anastomotic leakage after low anterior resection for rectal cancer. The condition of the patient was deteriorating due to peritonitis, and that patient was further complicated by pneumonia. It is unlikely that the NPPV device played any role in the development of the anastomotic leak of the rectum, particularly since a nasogastric tube was in place to drain air from the upper-gastrointestinal tract.

The length of hospital stay was not different significantly in the two groups, but a trend toward longer stay in the NPPV group, including a case of rectal anastomotic leakage, was seen. Excluding that patient from analysis in the NPPV group, decreased the difference in the length of stay between the two groups. However, our patient's length of stay was longer than previous study[7)]. Our hospital is in a rural area, where older people are not discharged from the hospital because of a shortage of outpatient services and over 75 years old patients took up 45% of all patients undergoing laparotomy in the study period. It may be incompatible to include the length of stay in a situation with many biases in the evaluation of the effect of NPPV on elderly patients undergoing laparotomy.

At last, a preventive effect of NPPV in elderly patients undergoing abdominal surgery[6)7)8)] to reduce the rate of the postoperative pulmonary morbidity and the length of hospital stay was not demonstrated in this small prospective study. However these results are preliminary and demonstrate a possible benefit.

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地域中核病院における高齢者開腹手術後の非侵襲的陽圧換気法（NPPV）の検討

石黒　保直[1, 2]，俵藤　正信[2]，吉田　　徹[1]，遠藤　秀彦[1]，小原　　眞[1]，伊藤　千絵[1]，藤井　仁志[1]，
Alan T. Lefor[2]，安田　是和[2]

[1]岩手県立釜石病院　外科　岩手県釜石市甲子町第10地割483番地6
[2]自治医科大学　消化器一般外科　栃木県下野市薬師寺3311-1

要　　約

高齢者人口比率の高い地域の中核病院では，近年増加傾向の予備力の低下した高齢者の開腹手術をいかに安全に施行するかが重要である。非侵襲的陽圧換気（NPPV）は挿管せずに陽圧の呼吸補助を行うことができ，術直後にNPPVを使用することで肺合併症を減少させる可能性がある。NPPVが高齢者の開腹手術後の経過に与える影響をprospectiveに検討した。2010年10月１日から2011年３月11日までの間に，岩手県立釜石病院外科で開腹手術を予定された75歳以上の高齢患者20名を無作為にNPPV群とNo-NPPV群に振り分けた。両群の患者背景に差を認めず，NPPV群の第１病日朝のP/F ratioが有意に高く維持された（P<0.05）。術後合併症発生率，在院日数は差を認めなかった。NPPVが75歳以上の高齢者の全身麻酔下開腹手術術後翌日以後の酸素化の維持に有効である可能性がある。
（キーワード：非侵襲的陽圧呼吸療法（NPPV），高齢者，開腹手術，地域中核病院）

連絡先：石黒保直，自治医科大学　消化器一般外科，〒320-0498 栃木県下野市薬師寺3311-1，E-mail：yasunao-i@jichi.ac.jp
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