ABSTRACT

Background: In the conventional surgical treatment of aneurysms, the respiratory physiotherapy is one of the cornerstones of patient rehabilitation. The endovascular technique, with less invasiveness, has significantly changed the rehabilitative approach to the operated subject.

Objective of the study: to evaluate and compare the effectiveness of the pre and post-operative rehabilitation treatment associated with the conventional OPEN surgery compared to the EVAR procedure and their incidence in preventing postoperative respiratory complications.

Design: Longitudinal case control study to compare patients who have open surgery with patients who do not have the laparotomy, as in ENDO technique, to look how frequently the postoperative pneumonia and the risk factor was present in each group to determine the relationship between the risk factor, the type of operation and the pneumonia incidence.

Setting Data were collected from patients admitted consecutively at the Tor Vergata Hospital with diagnosis of an abdominal aortic aneurysm. Risk factors, type of intervention, pneumonia incidence in postoperative period was evaluated at 30 days.

Population: Three hundred and twenty patient were enrolled.

Materials and methods: From 2005 to 2016, 320 patients suffering from an abdominal aortic aneurysm were treated consecutively. One hundred eighty one patients were treated using the open technique (group A) and 139 using the EVAR technique (group B). All patients in OPEN group were submitted to respiratory rehabilitation protocol. Risk factors, type of intervention, anesthesia and results of treatment with complications, observed mortality, mean hospital stay were studied. Pre and postoperative respiratory rehabilitation treatment protocol was performed in all of the patients. The data were analyzed with descriptive statistics and inferential statistics using SPSS 18.0 for Windows.

Results: From 2005-2010, the postoperative stay (days) was significant shorter for EVAR compared to open (6.47 vs. 10.48; P 0.001). From 2011-2016, the postoperative stay (days) was significant shorter EVAR compared open (4.07 vs. 11.41; P 0.001). The patients treated from 2011 to 2016 for both OPEN and EVAR groups presented an average age 3 years lower compared to the patients treated in the period from 2005-2011 (75.5 to 72.8 for EVAR and from 71,2 to 68,2). The patients treated from 2011 to 2016 for EVAR group presented an average reduction in post-operative hospitalization of 2.4 days (-37.09%) compared to 2005-2011 period. There was a significant higher incidence of pneumonia in the open group (P=0.001). The reduction of the incidence of pneumonia in group A and B during the two different periods from 2005 to 2010 and from 2011 to 2016 was observed. There wasn’t a significant difference in the incidence of pneumonia in patients treated from 2005 to 2010.
INTRODUCTION

OPEN treatment of aneurysms of the abdominal infrarenal aorta has good immediate and late results [1-4]. Pre and postoperative rehabilitation treatment has a decisive role in the prevention of respiratory complications because abdominal surgery causes an important alteration of respiratory physiology. The preoperative phase is necessary to train the patient for ventilation exercises that he will have to perform autonomously in the postoperative period. The main culprits of perioperative and postoperative respiratory disorders are laparotomy, surgical incision and anesthesia [5-12].

The use of anesthetic drugs during surgery cause the depression of the respiratory centers, the onset of bronchial spasms, a decrease in bronchial activity and a reactive hyper secretion. The surgical incision, instead, has very important effects on the ventilatory function; therefore, it depends on the location, the route and the length of the incision. The surgical act involves the reduction of the lung volumes, above all of the vital capacity and, to a lesser extent, of the residual lung capacity. Furthermore, it induces modifications of the thoracoabdominal movements: involving the abdominal muscles, the incision modifies the expiratory kinetics of the diaphragm and alters the synergy of the transverse diaphragm couple determining a basal hypoventilation, in addition to the pain related to the deep inspiration [13]. The introduction of the EVAR procedure, with an access route that does not compromise the respiratory dynamics in the postoperative period, reduces postoperative morbidity and hospitalization length [14]. The aim of this work is to evaluate the predictive factors of respiratory complications associated with the traditional OPEN and EVAR method and the influence of rehabilitation protocol in the prevention and treatment of postoperative complications.

MATERIALS AND METHODS

From 2005 to 2016, 320 patients suffering from an abdominal aortic aneurysm were treated consecutively. One hundred eighty one patients were treated using the open technique (group A) and 139 using the EVAR technique (group B). All patients in OPEN group were submitted to respiratory rehabilitation protocol. A further subdivision of groups A and B was then made based on the period during which the intervention was performed: respectively between 2005 and 2010; and between 2011 and 2016. Cardiovascular risk factors were evaluated: smoking, COPD, diabetes mellitus, chronic renal failure, arterial hypertension, dyslipidemia, ischemic heart disease, chronic obstructive artery and immediate results in the two groups. All patients treated in group A underwent preoperative and postoperative training by means of sessions lasting 30 minutes, according to the physiotherapy protocol adopted at our Teaching Hospital. Treatment protocol of perioperative-operative physiotherapy, Role of respiratory rehabilitation and rehabilitation protocol. Inspiratory muscle training during the preoperative training phase and the application of an adequate postoperative rehabilitation protocol play an important role in reducing the incidence of postoperative respiratory complications in patients undergoing OPEN treatment. Among the goals of physiotherapy treatment it is important to pay particular attention to counteracting the effects caused by surgery on respiratory function, through breathing exercises and lung re-expansion aimed at facilitating mucociliary clearance and preventing the formation of atelectasis, considered as one of the subclinical signs more predisposing to the onset of pneumonia, the main object of our study.

The following is the rehabilitation protocol after abdominal surgery for AAA. Treatment should start early, immediately after surgery. The sessions will be brief and frequent. The physiotherapist has the task of changing the patient’s position and adopting, on the first day, an early mobilization limiting, as far as possible, only the supine decubitus. The next day, the patient will be able to adopt a sitting position. On the 3rd and 5th days, the patient will be able to perform all the exercises several times a day. A self-treatment program is set up:

- To favor the restoration of a balanced and symmetrical cost-diaphragmatic kinetics (prudent solicitation of upper and lower costal expansions in supine or sitting decubitus position).
- To avoid stiffness or reduction of muscle strength (work mainly on the scalpula fixators: latissimus dorsi muscle, granulated tooth, rhomboid muscle and trapezius, active-assisted kinesitherapy of the cervico/dorso/lumbar spine).
- Education for family members (when deemed necessary).

1st Day-During the session the oximetry is monitored maintaining saturation above 90-92%, eventually using or increasing the oxygen therapy and controlling post-surgical pain that could compromise the compliance of the treatment. The following key point are essential: Thoracic breathing (TEE technique), Use of spirometric incentives, Cough education. After the surgeon’s consent, the patient can adopt an upright position after wearing a containing abdominal band, necessary to protect and contain the abdominal expansion.

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2nd and 3rd Day—exercises with TEE and BC technique. In the presence of secretions, assisted cough techniques are performed. Passive and active exercises for the shoulder girdle, for the AAAS (upper limbs) and AAII (lower limbs), for the head and neck.

4th and 5th Day—Contraction of the abdominal muscles. Exercises are performed in a sitting position of muscular reinforcement for the lower limbs and, subsequently, re-education to the march.

From 6th Day - proceed as in the fifth, making the patient responsible, who will have to perform all the exercises several times a day. Global physical re-education exercises and adaptation to effort are started. Ultimately the validity of this protocol contributes significantly to the success of the intervention. In fact, it is necessary to consider that, even if there is less use of traditional surgery, it is imperative to pay adequate attention to physiotherapy.
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in patients to be treated with OPEN, since the role of prevention of postoperative complications is undisputed.

STATISTICAL ANALYSIS AND DATA COLLECTION

The clinical records of the patients affected by aortic abdominal aneurysm and treated using open or EVAR procedures at the University Teaching Hospital were collected and analyzed. The research project aims to explore and demonstrate the relationships between these types of intervention and postoperative complications, particularly respiratory ones, to verify possible correlations. In order to declare the statistical evidence and significance, the expected value of the p-value must be equal to alpha ≤ 0.05 (α = 0.05). The demographic variables, risk factors, comorbidities and immediate results in the two groups were studied. Where possible, the respiratory parameters FEV-1 and FVC and the preoperative ventilatory deficit of treated patients were considered. Three ad hoc tables have been created to relate the type of intervention (EVAR, OPEN), and the positivity or otherwise to the pneumonia factor. From the data entered we were able to extrapolate the odd ratio, variance, gau distribution parameters and finally the P-value, a value that in a hypothesis test indicates the probability of obtaining an equal result or "more extreme "of the one observed, assuming the null hypothesis to be true. It is also called the observed significance level.

RESULTS

The Tables 1 and 2 showed the risk factors of the EVAR and OPEN group, during the two analyzed period. In red, we have highlighted the statistically significant data.

Tables 3 and 4 reveal data regarding the age of the patients, the diameter of the aneurysm and the duration of postoperative hospitalization during the two analyzed period. From 2005-2010, the postoperative stay (days) was significant shorter for EVAR compared to open (6.47 vs. 11.41; P 0.001). From 2011-2016, the postoperative stay (days) was significant shorter EVAR compared open (4.07 vs. 11.41; P 0.001). The patients treated from 2011 to 2016 for both OPEN and EVAR groups presented an average age 3 years lower compared to the patients treated in the period from 2005-2011 (75.5 to 72.8 for EVAR and from 71.2 to 68.2).

The patients treated from 2011 to 2016 for EVAR group presented an average reduction in post-operative hospitalization of 2.4 days (-37.09%) compared to 2005-2011 period.

Table 3: Demographic and laboratory data. Period 2005/2010: EVAR e OPEN treatment.

| Patients '05-'10 | EVAR | OPEN | P-value |
|-----------------|------|------|---------|
| Age (years)     | 75.5 | 71.27| 0.001   |
| Diam (mm)       | 55.1 | 59.9 | 0.003   |
| C-reactive protein | 6.18 | 12.79| 0.005   |
| ESR pre-op      | 22   | 23.72| 0.80    |
| Postoperative hospitalization (day) | 6.47 | 10.48| 0.001   |

Table 4: Demographic and laboratory data. Period 2011/2016: EVAR e OPEN treatment.

| Patients '11-'16 | EVAR | OPEN | P-value |
|-----------------|------|------|---------|
| Age (Years)     | 72.8 | 68.2 | 0.03    |
| DTM (mm)        | 53.725 | 61.68 | 0.21   |
| C-reactive protein | 6.2  | 22.37 | 0.02   |
| ESR pre-op      | 37.7 | 33.4 | 0.38    |
| Postoperative hospitalization (day) | 4.07 | 11.41| 0.001   |

Table 5: Pneumonia incidence: Period 2005/2016. EVAR e OPEN treatment comparison.

| Pneumonia | EVAR | OPEN | TOTALE | % |
|-----------|------|------|--------|---|
| Yes       | 2    | 2    | 4      | 100|
| NO        | 137  | 98.56| 156.8  | 87.85 | 295 | 91.86|

Overall patients 139 180 319 0.001

Table 6: Pneumonia incidence: Period 2005/2010. EVAR e OPEN treatment comparison.

| Pneumonia | EVAR | OPEN | TOTALE | % |
|-----------|------|------|--------|---|
| Yes       | 2    | 2.08 | 9      | 63.4 | 11 | 4.66 |
| NO        | 94   | 97.62| 142    | 93.66 | 236 | 95.34|

Overall patients 96 151 151 0.1
In Tables 6 and 7 are described the incidence of pneumonia in group A and B during the two different periods from 2005 to 2010 (Table 6) and from 2011 to 2016 (Table 7). There wasn’t a significant difference in the incidence of pneumonia in patients treated from 2005 to 2010 (P-value=0.1), (tab VI). In patients treated from 2011 to 2016 there was a significant increasing the incidence of pneumonia in open group (P=0.001) (tab.VII). The Table 8 show significant difference in pneumonia incidence between the two groups during 2005 and 2016 periods.

### DISCUSSION

From the literature data and from our experience it emerges how the lower rate of respiratory complications are correlated with the EVAR technique [15,16]. The goodness of physiotherapy in training the patients before surgery and in rehabilitating the miss evident. From our data analysis it is clear that there is a need for less hospitalization for the patients operated by EVAR. Our results, confirmed by comparative studies between the OPEN and EVAR methods, demonstrate how the endovascular method is associated with reduced postoperative complications such as mortality within 30 days, and comorbidity, compared to the OPEN surgery repair method involving laparotomy [17]. The complications correlate to the open method can commonly include cardiac, renal, hematologic, and genitourinary function [3]. The number of days in hospital is on average higher for open treatment (4.07 EVAR-11.41 Open. P-value 0.001). Infectious complications, such as atelectasis, infections, or pneumonia. The data obtained, especially from tab. 5, give us an indication of how an effective pre-operative training protocol, an early post-operative respiratory rehabilitation improve significantly the outcome in the OPEN group.

EVAR repair techniques together with the latest and most reliable endoprosthesis, contribute to decreasing the incidence of postoperative respiratory complications, especially pneumonia. Endovascular treatment of AAA should be considered as a procedure with medium-high heart risk ranging from 3% to 7% [15]. If pre-procedural cardiac disease is identified, appropriate therapy should be considered prior to the EVAR election [16,17]. It is known that preexisting renal failure is associated with poor outcome after EVAR and that renal protection strategies should be used to avoid kidney damage, also during the follow up [18-20].

Our results concerning the postoperative length stay showed in Tables 3 and 4 are enhanced according to the Literature [14,21].

### CONCLUSIONS

Rehabilitation physiotherapy plays a fundamental role in the prevention of postoperative complications of patients undergoing OPEN treatment. Despite of the excellent results obtained in patients undergoing OPEN treatment, the lower rate of complications in EVAR group showed better results of endovascular treatment. The good outcome can be ascribed to the lower exposure of complication risk factors, such as the absence of laparotomy, the lower incidence of gold tracheal intubation (iot) and early post-operative mobilization.

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**Contribution of paper**

- Postoperative physiotherapy plays an essential role in rehabilitation after open abdominal surgery and reduces postoperative complications.
- The introduction of endovascular methods reduces the incidence of postoperative respiratory complications compared to open treatment in abdominal aortic aneurysm surgery.
- The applied postoperative treatment protocol has a favorable impact on both open and endo patients suffering from an aortic aneurysm.

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