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Original Research Article

Rib resection versus rib division in two-stage oesophagectomies: a retrospective cohort study

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ABSTRACT

Background: Rib resection (removal of a portion of one rib) and rib division are different approaches used to gain exposure and access to the thoracic cavity in the two-stage oesophagectomy. The analgesic requirement, respiratory complications and physiotherapy and rehabilitation requirements of rib resection and rib division in two-stage oesophagectomy procedures for oesophageal carcinoma were compared.
Methods: Patients who underwent two-stage oesophagectomy between 2017 and 2022 were retrospectively identified. The patients were analysed in a rib resection group (n=14) and a rib division group (n=14) with regards to patient demographics, engagement with the institution's acute pain service, analgesic requirement, incidence of pneumonia, physiotherapy and rehabilitation requirements.
Results: The overall amount of opioid analgesia used was greater in the rib division group compared to the rib resection group (674.6 versus 528.0 mg, p=0.3799). There were no significant differences in the incidence of pneumonia between the two groups (n=4 versus 1, p=0.3259). There was a trend towards longer ventilation times (0.643 versus 0.357 days, p=0.3333), increased physiotherapy (9.93 versus 9.71 days, p=0.4700), rehabilitation requirements (n=0 versus 2, p=0.1422) within the rib division compared to the rib resection group.
Conclusions: The differences in outcomes between the rib resection and rib division groups are not statistically significant and have been shown to be non-inferior in this dataset. The choice of approach should be based on individual patient factors and the surgeon's preference.

Keywords: Oesophagectomy, Rib resection, Rib division, Oesophageal carcinoma, Two-stage oesophagectomy, Analgesic requirement

INTRODUCTION

Oesophageal carcinoma ranks as the eighth most common cancer worldwide with 600,000 new cases in 2020. The age-standardised incidence rate is 6.3 per 100,000.[1] In Australia, oesophageal carcinoma was diagnosed in 1,724 people and accounted for 1,394 deaths in 2022.[2]

Surgery is the mainstay of curative therapy for non-metastatic oesophageal carcinoma in medically fit patients.[3] However, contemporary series report significant morbidity rates of 26-66.7% and significant perioperative mortality of 5.8%. Of note, the incidence of mortality with pneumonia was 20%.[4,5]

Recent meta-analyses have shown that the trans-thoracic approach, as described by Ivor Lewis and McKeown, is more effective than the transhiatal approach in terms of oncological outcomes for oesophageal carcinomas in the distal part of the oesophagus and gastro-oesophageal junction.[6] Since the original description of the two-stage

oesophagectomy by Ivor Lewis, many innovations have enabled less invasive and morbid transthoracic oesophageal surgery.[7]

Rib resection, the removal of a portion of one rib, and rib division are different approaches used to gain exposure and access the thoracic cavity in a trans-thoracic portion of an open or laparoscopic assisted two-stage oesophagectomy. Rib resection is performed by identifying the neck of the rib, removing attachments with a Doyen rib raspatory along a 4 cm segment, and dividing the rib twice with rib shears and removing a 4 cm segment of bone between the two cuts. Rib division is performed by identifying the neck of the rib, removing attachments with a Doyen rib raspatory along a 2cm segment and dividing the bone once with rib shears.

There is a paucity of evidence to suggest any superiority between rib resection and rib division in the immediate postoperative period. Rib resection in thoracotomies have long been thought to prevent apposition of the ends and hence possibly lessen pain. It also enables shorter operating times by increasing space and easier and safer dissection. However, some proponents of rib division consider resection to be unnecessary and can in and of itself cause pain.[8]

The surgeons within our group are equally divided with respect to these approach concepts. This allowed us to retrospectively investigate the relative utility of rib resection and rib division in two-stage oesophagectomy procedures for oesophageal carcinoma.

METHODS

A prospective database including patients with oesophageal carcinoma is maintained by the clinicians of the Department of Upper Gastrointestinal Surgery of the Gold Coast University Hospital (GCUH), Gold Coast, Australia. Permission to collect and use the information was approved by the Gold Coast University Hospital (GCUH) Human Research and Ethics Committee (Code: LNR HREC/2023/QGC/101263). Clinicians within the unit completed these records.

All patients who had a two-stage oesophagectomy procedure for squamous cell carcinoma or adenocarcinoma of the oesophagus in our institution during the 5 year period between 2017 and 2022 were included in our study. Exclusion criteria included patients who had a procedure in 2023 due to the lack of follow up and those who did not undergo an open chest procedure or had another type of oesophagectomy were also excluded. All patients meeting the criteria were included and sampling was not required.

Included patients were separated into a rib resection arm and a rib division arm depending on the surgeon. Patient records were accessed by the researchers in March 2023 with respect to demographic data, length of hospital stay in days, engagement with the institution's acute pain service in days, daily analgesic requirement, respiratory complication (incidence of pneumonia), physiotherapy requirement in days and rehabilitation requirements.

Daily analgesic requirements were expressed as an oral Morphine Equivalent Daily Dose (oMEDD) as per the Australian and New Zealand College of Anaesthetists[9] from medication charts and records of patient controlled analgesia (PCA). The modality of the PCA, complications of the PCA as well as other adjuncts e.g., neuraxial blocks, ketamine infusions and regional blocks, were recorded as well.

Respiratory complication was recorded as the incidence of pneumonia and this was defined as the radiological presence of consolidation as reported by a radiologist, consistent clinical features e.g., shortness of breath and presence of fever, as well as commencement of antibiotics for this.

Statistical analysis

Data were analysed with the R Suite (Version 4.2.2, R Foundation for Statistical Computing, Vienna, Austria) with the Tidyverse Package installed (Version 2.0.0).[10] Continuous variables were expressed as mean with standard deviations and were compared using a Student's T-test. Categorical variables were compared using a Fisher squared test. For all calculations, $p<0.05$ was considered significant.

RESULTS

A total of 28 patients were included in this series with 14 patients in each of the rib resection and rib division arms. Patient demographics are summarised in Table 1. The rib resection arm had marginally more males than the rib division (13 versus 11) and were marginally older (63.2 versus 61.6). However, fewer resection patients received neoadjuvant therapy when compared to rib division patients (n=9 versus 12). More patients in the rib resection arm underwent an open approach to the abdominal stage of the Ivor Lewis oesopagectomy compared to the rib division arm (n=11 versus 1). Hence, fewer patients in the rib resection arm had a laparoscopic approach to the abdominal stage compared to the rib division arm (n=3 versus 13).

In our institution, all the patients in the study had reviews from the acute pain service (APS) to determine analgesia requirement. All but one patient received patient PCA. Three patients in the rib resection group received a spinal block and all the patients in the study received a local anaesthetic infusion device (pain buster). Table 2 summarises the types of PCAs used and the opioid use per day and Figure 1 compares the opioid use per day in a graphical format.

Table 1: Patient demographics who received rib resection and rib division approaches to two-stage oesophagectomy procedures for oesophageal carcinomas.

	Rib resection	Rib division
Number	14	14
Gender		
Male	13	11
Female	1	3
Age, mean±SD	63.2±9.43	61.6±9.33
Neoadjuvant therapy	9	12
Abdominal approach		
Open	11	1
Laparoscopic	3	13

Table 2: Types of PCA, neuraxial adjuncts and opioid use per day expressed as an oMEDD in the immediate postoperative period.

Types	Rib resection (n=14)	Rib division (n=14)	P value
PCA			
None	0	1	
Morphine	1	1	
Fentanyl	6	5	
Oxycodone	7	7	
PCA complications	0	3	
Neuraxial			
Pain buster	14	14	
Spinal block	3	0	
Opioid use			
Post operative day	**Mean±SD mg/day**		
1	85.21±94.88	119.8±127.2	0.4229
2	129.3±108.1	155.2±150.5	0.6056
3	130.4±104.5	188.9±172.9	0.2907
4	109.7±121.2	116.3±108.8	0.8793
5	50.25±71.30	71.02±85.38	0.4911
6	23.14±48.65	11.27±26.30	0.4314
7	0	11.86±33.45	0.2076
8	0	0	
9	0	1.929±7.216	
Total opioid use, mean mg	528.0	676.4	0.3799

Table 3: Respiratory complications in rib resection versus rib division approaches.

Complications	Rib resection (n=14)	Rib division (n=14)	P value
Pneumonia	1	4	0.3259^

^ Fisher squared test was used due to categorical variables.

Table 4: Days required for hospital stay, ventilation, APS engagement and physiotherapy. Two patients in the rib division required rehabilitation.

Days	Rib resection (n=14)	Rib division (n=14)	P value
Hospital stay in days, mean±SD	13.0±7.87	12.8±7.72	0.9426
Ventilated days, mean±SD	0.357±1.08	0.643±2.13	0.3333
APS days, mean±SD	5.0±0.96	4.9±1.82	0.8979
Physiotherapy days, mean±SD	9.71±6.98	9.93±8.30	0.4700
Rehabilitation requirement, n	0	2	0.4815^

^ Fisher squared test was used due to categorical variables

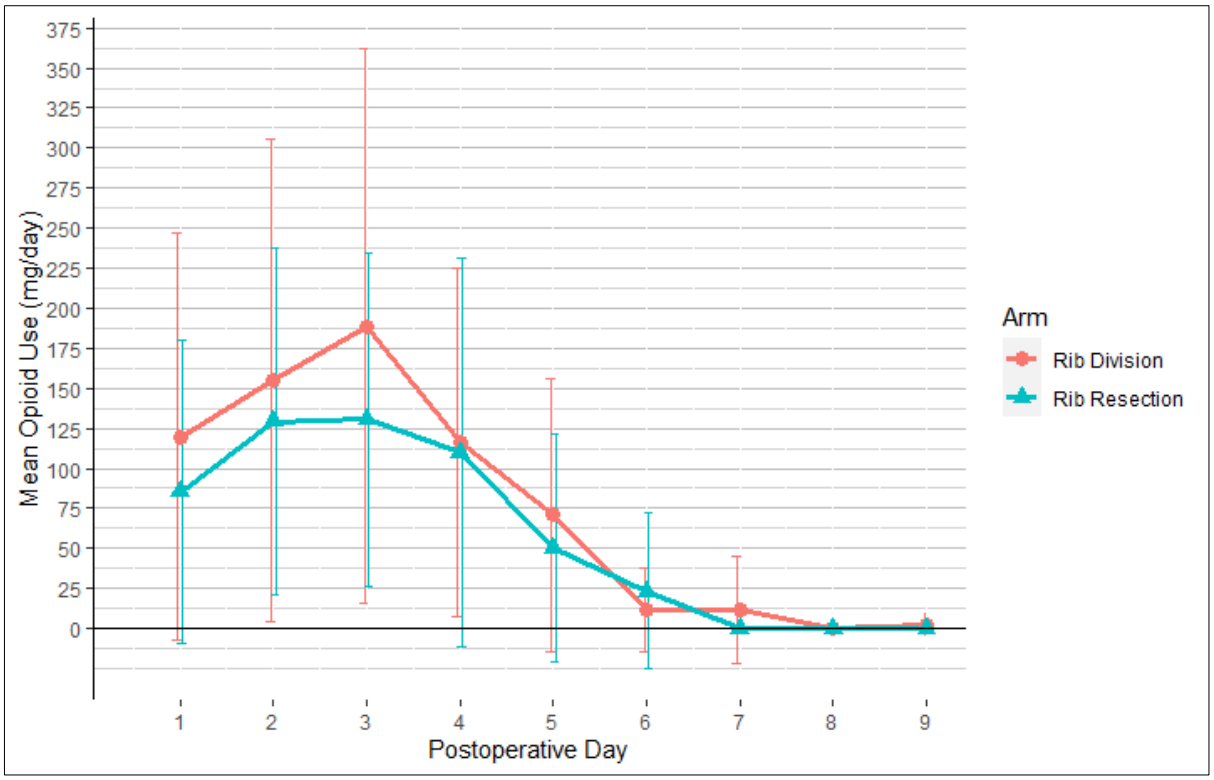

Figure 1: Opioid use per day expressed as an oMEDD in the immediate postoperative period in rib division versus rib resection in two stage oesophagectomies.

In the first 9 postoperative days, the total oMEDD increases daily until the opioid use reaches a maximum by postoperative day 3 (mean of 130.4mg/day in the rib resection versus 188.9 mg/day in the rib division arms). This decreases significantly by postoperative day 5 at 50.25 mg/day in the rib resection arm versus 71.02mg/day. Patients did not require opioids by postoperative day 7 in the rib resection versus day 8 in the rib division arm. However, none of the means were found to be statistically significant.

The mean total opioid use during the in-hospital admission was less in the rib resection arm at 528.0mg versus 676.4mg in the rib division arm but this was not found to be statistically significant either (p=0.3799).

Table 3 summarises the respiratory complications. There was a slightly higher number of patients in the rib division compared to the rib resection arm (4 versus 1) with pneumonias but this was not statistically significant (p=0.3259).

Finally, there was no difference in length of hospital stays between the groups. There was no difference in engagement in the APS in days. There was a trend towards longer ventilation times, increased physiotherapy days in the rib division group but this was not found to be statistically significant. There were two patients who required inpatient rehabilitation. This is summarised in Table 4.

DISCUSSION

This appears to be the first study to compare the rib resection and rib division cohorts' immediate postoperative periods. Previous studies show only that rib resection is superior to rib spreading in terms of chronic postoperative pain, defined as pain after 2 months, in thoracotomies.[11] No other studies appear to directly compare rib resection to rib division in oesophagectomies.

Our study suggests little difference in the immediate postoperative period between the rib resection and rib division approaches in the thoracic part of the two-stage oesophagectomy procedure for oesophageal carcinoma in terms of inpatient postoperative analgesic requirement, respiratory complications, length of hospital stay, length of ventilated days, physiotherapy, engagement in the APS and rehabilitation requirement. Hence either can be recommended depending on patient and surgeon's preferences and expertise.

Our data supports proponents of the rib resection approach who believe their approach lessens pain due to the lack of apposition of the ends of the rib. In every postoperative day in the immediate postoperative period, opioid use is less in the rib resection compared to the rib division arm. Mean opioid use reduces to zero a day earlier and there is a smaller mean total opioid use compared to the rib division arm. However, we could not demonstrate any statistical significance. Furthermore, this

did not have any difference clinically in hospital stay nor engagement in the APS or physiotherapy.

The findings in our study are comparable to other studies. Opioid analgesia requirement in the first 24 hours (Table 2) is comparable to other studies with mean morphine requirement which have been reported from 10-125 mg.[12] Respiratory complications in this cohort of 17.9% were similar to other reports which range from 14.1 to 38%.[4,13,14] The length of stay is similar to other reports of length of stay with a mean length of stay reported in other studies as 12 to 19.7 days.[4,15] Length of ventilated days in our study was less than the mean of the 91.8 hours in a study by Avendano et al.[13] No previous studies were found to report length of engagement with physiotherapy, engagement with APS nor rehabilitation requirement.

The study has some limitations that should be acknowledged. Firstly, the small sample size of 14 patients in each group may limit the generalizability of the findings. The retrospective design using past medical records hinders the ability to establish clear cause-and-effect relationships. Finally, the study does not take into account the approach to the abdominal stage of the oesophagectomies and the location of the local anaesthetic infusion device (Pain Buster). Despite these limitations, the study serves as a valuable starting point for future research with a larger population size, validated pain scores and prospective approach to draw more robust conclusions

CONCLUSION

The differences in inpatient postoperative analgesic requirement, respiratory complications, length of hospital stay, length of ventilated days, physiotherapy, engagement in the APS and rehabilitation requirement between the rib resection and rib division groups were not statistically significant. The choice of approach should be based on individual patient factors and the surgeon's preference.

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