Assessment of intra-operative haemodynamic changes associated with transhiatal and transthoracic oesophagectomy

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Abstract

Objective: Previous comparisons of the different surgical techniques for oesophagectomy have concentrated on mortality, morbidity and survival. There is limited data regarding the intra-operative physiological ramifications of the transhiatal (TH) versus the transthoracic (TT) approach to oesophageal resection. We carried out an in-depth analysis of the intra-operative haemodynamic changes and assessed the potential implications on perioperative outcomes in a matched cohort of patients undergoing TH and TT oesophagectomy. Methods: A retrospective case review study of TT and TH oesophageal resection at a high-volume tertiary referral centre for oesophageal diseases. General demographics and outcomes of the patients were accumulated prospectively in an Institutional Review Board (IRB) approved database. Intra-operative haemodynamic measurements were obtained from anaesthetic records. A total of 40 patients (20 TT + 20 TH) were retrospectively identified after matching them for age, co-morbidities, tumour stage and American Society of Anesthesiologists (ASA) status. Main outcome measures included perioperative outcomes, operative time, blood loss, intensive care unit (ICU) and hospital length of stay, incidence and types of dysrhythmias, incidence of intra-operative hypotension and vasopressor usage, as well as perioperative morbidity and 90-day mortality. Results: Indications for resection included oesophageal cancer (27 patients), high-grade dysplasia (six patients), laryngopharyngeal oesophageal cancer (three patients), achalasia (two patients) and scleroderma (1 patient). Nine patents with oesophageal cancer had pT3 tumours (TH1, TT8). The mortality was zero in both groups. The total duration of hospitalisation and ICU care was similar in both groups. The mean estimated blood loss was 213 ml (range 100—400 ml) for the TH group and 216 ml (range 80—500 ml) for the TT group. The median operating times for both approaches were similar (398 min TH vs 382 min TT). Intra-operative dysrhythmias were noted in 11 TH and 15 TT patients. Both groups maintained at least 80% of the pre-operative systemic blood pressure (SBP) intra-operatively (TT 89% vs TH 85%) and required vasopressors in comparable quantities. The comparative statistical analysis of intra-operative incidences of hypotensive episodes below 100, 90 and 80 mm Hg showed no significant differences in both groups. However, the TH group experienced a greater frequency of acute hypotension (acute SBP decreases by ≥10 mm Hg per 5-min reading) intra-operatively (TH 25% vs TT 16% of operative time, p = 0.02. Phenylephrine infusions were required for longer periods in the TH group (TH 10 mm Hg per 5-min reading) intra-operatively (TH 25% vs TT 16% of operative time, p = 0.02. Phenylephrine infusions were required for longer periods in the TH group (TH 52.7% vs TT 33.6% of operation time), p = 0.01. Conclusion: This study demonstrates that intra-operative haemodynamic changes and perioperative outcomes are similar in both TT and TH approaches for oesophagectomy in a well-matched cohort of patients. Patients undergoing the TH approach demonstrated a higher frequency of intra-operative haemodynamic lability. The approaches to oesophageal resection should be based on matching the operation to the patient’s pre-existing conditions and tumour characteristics rather than perceived differences in haemodynamic impact.

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1. Introduction

Oesophagectomy can be safely performed using different approaches including transhiatal (TH), transthoracic (TT) and minimally invasive approaches. There are multiple studies comparing the different surgical approaches for oesophagectomy in terms of postoperative complications, morbidity and survival. Although survival does not seem to differ significantly depending on surgical approach [1], it is suggested that there are differences related to the perioperative physiological impact [2]. However, controversy remains in this regard over the superiority of TT, TH or minimally invasive oesophagectomy [3, 4]. A complete understanding of the various ramifications of the different approaches for oesophagectomy allows the surgery to be better matched to individual patient characteristics such as tumour size, location, previous surgeries and co-morbidities [5—7]. However, perioperative outcomes are variable and the differences in intra-operative physiologic factors have not been thoroughly assessed [8].
Specifically, there is limited data comparing the impact on intra-operative haemodynamic changes caused by different approaches for oesophagectomy. We hypothesise that intra-operative haemodynamic changes and the impact on perioperative outcomes are similar in both TT and TH approaches for oesophagectomy in a well-matched cohort of patients.

2. Methods

A retrospective, case review study of TH oesophageal resection and TT oesophageal resection during a 10-year period at a high-volume tertiary referral centre for oesophageal diseases. Demographics and outcomes of the patients were obtained from a prospectively collected Institutional Review Board (IRB)-approved database. Intra-operative haemodynamics was reviewed from perioperative anaesthetic records (anaesthetic charts). A total of 40 patients, of which 20 patients had TH and 20 patients had TT oesophagectomy were retrospectively identified and matched for age, co-morbidities, tumour stage and American Society of Anesthesiologists (ASA) status during the 10-year period between 1995 and 2004. During this period, 261 oesophageal resections were done in our unit. A total of 151 patients had left thoraco-abdominal operations and two had retrosternal operations. As many as 84 patients had undergone TT oesophagectomy and 24 patients had undergone TH oesophagectomy. We have compared the Ivor—Lewis and TH approaches because they are the most common approaches both within the United States and internationally. Twenty patients in the TH group met inclusion criteria by having sufficient data to interpret and being comparable to the TT group in their physiological presentation and pathological conditions. The oesophagectomy database and the anaesthetic records were used to obtain pathological stage, number of lymph nodes in resected specimen, operative duration, blood loss, urine output, intravenous fluid administration, intra-operative and perioperative dysrhythmias (heart rate \(>100\) beats/min and \(\leq 60\) beats/min were recorded as tachycardia and bradycardia, respectively), intra-operative hypotension (>10 mm Hg of systolic blood pressure change in 5 min intra-operatively), intra-operative use of antiarrhythmic and vasoactive medications, immediate postoperative complications and mortality. Comparative statistical analysis was done using the Fisher’s exact test and the Mann–Whitney U test. Means were compared with 95% confidence interval for the clinically relevant intra-operative haemodynamic parameter differences in both groups.

3. Results

3.1. Forty patients underwent oesophagectomy for the following indications

Oesophageal cancer 27 patients (TT 56% + TH 44%) Tis \((n = 3)\) TT1, TH2; T1 \((n = 10)\) TT3, TH7; T2 \((n = 4)\) TT2, TH2; T3 \((n = 8)\) TT7, TH1 and T4 \((n = 2)\) TT2, TH0, high-grade dysplasia \((n = 6)\) TT3, TH3; laryngopharyngoesophageal cancer (three patients TH); thyroid cancer (one patient TH); achalasia (two patients TT) and scleroderma (one patient TH).

The mean age of the study population was 64.9 years (range, 43—79 years). There were 23 males and 17 females and the mean ASA status was 2.6 in both groups of patients. Cardiac co-morbidities were identified in 60% of patients in both the TT and TH groups. Pulmonary co-morbidity (chronic obstructive pulmonary disease (COPD)) was documented in 15% of both groups. Both groups received patient-controlled epidural analgesia postoperatively, supervised by the anaesthesia pain service. Intra-operative variables were taken from the IRB-approved prospective database and the anaesthetic records (see Table 1).

Statistical comparisons of the hospital length of stay showed both groups had similar mean length of stay: 11.7 days for the TH group and 12 days for the TT group. The mean intensive care unit (ICU) stay for the TH group was 2.2 days versus 1.8 days for the TT group (Table 2).

Median operating times for both approaches were relatively similar with 398 min for TH and 382 min for TT group. Intra-operative episodes of dysrhythmia were detected in 11 of the TH group versus 15 for the TT group. Incidences of sinus tachycardia were seven in TT group compared with two in TH group, whereas the incidence of bradycardia was similar in both groups. Intra-operative atrial fibrillation with haemodynamic compromise occurred in one patient in the transthoracic oesophagectomy group.

There were no significant differences in the intra-operative fluid requirements. The mean estimated blood loss for both groups was similar, 213 ml (range 100–400 ml) for the TH group versus 216 ml (range 80–500 ml) for the TT group.

Intra-operative epidural management included the use of intermittent bolus lidocaine (50—100 mg) in four patients in the TH group; one patient in the TH group received a lidocaine (3 mg min\(^{-1}\)) epidural infusion. Bolus lidocaine was used in only one patient in the TT group.

<table>
<thead>
<tr>
<th>Outcome</th>
<th>TH (range) ((n = 20))</th>
<th>TT (range) ((n = 20))</th>
</tr>
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<tbody>
<tr>
<td>Hospital mean LOS (days)</td>
<td>11.7 (7—22)</td>
<td>12 (7—16)</td>
</tr>
<tr>
<td>ICU mean LOS (days)</td>
<td>2.2 (1—9)</td>
<td>1.8 (1—5)</td>
</tr>
</tbody>
</table>
Mean duration of phenylephrine infusion (min) 217 (66.1) 143 (60.6)

Mean number of boluses per patient with vasopressor 7.1 (2.3) 7.0 (2.1)

Mean duration of phenylephrine infusion as % of total operation time 52.7% (0.14) 33.6% (0.15)

Number of patients required intra-operative vasopressor 19 20

More than 10 mm Hg of change in 5 min intra-operatively was considered significant and the recordings were compared statistically, which showed no significant difference in both groups intra-operatively. Both groups maintained at least 80% of the pre-operative systolic blood pressure intra-operatively (TT 89% vs TH 85%). The comparative statistical analysis with 95% confidence interval (CI), the intra-operative incidences of hypotensive episodes below 100, 90 and 80 mm Hg showed no significant differences in both groups. However, the TH group showed increased blood pressure lability (hypotensive trends by 10 mm Hg or more per 5-min reading) intra-operatively (TH 25% vs TT 16% of operative time), \( p = 0.02 \). Phenylephrine and ephedrine were the vasopressors most commonly used. The comparative analysis of intra-operative haemodynamic changes (Table 3) showed both groups needed vasopressors usage intra-operatively in equal numbers, although TH patients required vasopressors for a longer period and for a greater percentage of their intra-operative time. Phenylephrine infusions were required for longer periods in TH group (TH 52.7% vs TT 33.6% of operation time), \( p = 0.01 \).

Perioperative complications in both groups were comparable, with the exception of higher incidences of pneumonia in the TH group (Table 4).

4. Discussion

The literature documents that the TH and TT approaches can be performed safely with acceptable level of morbidity and operative mortality, especially at high-volume centres. The morbidity and mortality and survival rates associated with oesophagectomy have improved significantly over the past three decades [9–11]. In spite of perioperative outcomes clearly demonstrating similar results, there remain ongoing comparisons between various approaches for oesophagectomy, which occasionally advocate for the superiority of one technique over the other. One example has been the concern for major pulmonary complications in the TT approach, with its potential for affecting morbidity, mortality and costs [8,12–15]. These concerns have influenced some surgeons to select less invasive approaches for oesophagectomy. Others have projected the TT approach as a superior cancer operation associated with higher lymph node harvest [16,17]. Hulscher et al. randomised 220 patients between TT and TH approach for oesophagectomy with extended lymphadenectomy. Although they did not show survival differences at a median of 4.7 years, they did find that survival, and disease-free interval curves were similar for first 2 years but diverged subsequently favouring the TT approach [18]. Smith et al. reviewed the differences associated with specific specialties. They indicated that the majority of oesophagectomies for carcinoma performed by thoracic surgeons use the Ivor—Lewis approach; on the other hand, general surgeons favour the transhiatal technique. This study shows that, although the approach was influenced by the surgeons training, it did not impact the outcomes [19].

Large-volume multicentre comparative retrospective studies [20,21] or prospective randomised trials [18,22] have concluded that the overall morbidity and mortality in those undergoing TH or TT oesophagectomy are similar and the incidence of mediastinitis, wound infection, pulmonary, gastrointestinal, cardiovascular, systemic, procedure-related or overall complications, length of hospital stay or quality of life [23] between these groups show no significant difference. In addition, the involvement of intensive care specialists in the oesophagectomy care pathway helped to reduced postoperative complications, length of stay and cost [24]. The choice of operative approach in our institution is based on the individual characteristics of each patient and the disease process. Primary goals include accomplishing an appropriate cancer operation and minimising the overall physiological impact. We have previously shown that routine use of regional anaesthesia techniques and minimising the intra-operative fluid and blood transfusion requirements is associated with better outcomes [25]. In addition, frank and continuous perioperative communication between the surgeon, anaesthesiologist and surgical team
yields coordinated management of intra-operative haemodynamic perturbations in this high-risk surgical population.

The current study demonstrates that intra-operative haemodynamic changes and perioperative outcomes are similar in both TH and TT approaches for oesophagectomy in a well-matched cohort of patients. We tend to use intraoperative vasopressors more liberally to minimise the intraoperative use of crystalloids. We also noted that the TH group required a longer duration of vasopressor support intraoperatively due to relatively increased intraoperative haemodynamic liability and a trend suggesting a higher number of intra-operative dysrhythmias. We did not note that the TH group had a well-matched cohort of patients. We tend to use intra-operative vasopressors more liberally to minimise the intra-operative use of crystalloids. We also noted that, in contrast to historic concerns, the incidence of pulmonary complications in general, but particularly pneumonia, was not higher in patients having TT operations in our series. We believe that the ongoing technological advances in the field of non-invasive perioperative monitoring will provide more opportunity to thoroughly evaluate the physiological stress caused by various surgical approaches including the minimally invasive techniques in a large randomised multicentre study. We do not believe that any single surgical procedure has significant advantages in all patients but overall outcomes can be optimised by individualising the surgical approach based on specific physiologic and tumour characteristics of patients.

References