Penetrating Esophageal Injuries: Multicenter Study of the American Association for the Surgery of Trauma

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Objective: **The purpose of this study was to define the period of time after which delays in management incurred by investigations cause increased morbidity and mortality. The outcome study is intended to correlate time with death from esophageal causes, overall complications, esophageal related complications, and surgical intensive care unit length of stay.**

Methods: **This was a retrospective multicenter study involving 34 trauma centers in the United States, under the auspices of the American Association for the Surgery of Trauma Multi-institutional Trials Committee over a span of 10.5 years. Patients surviving to reach the operating room (OR) were divided into two groups: those that underwent diagnostic studies to identify their injuries (preoperative evaluation group) and those that went immediately to the OR (no preoperative evaluation group). Statistical methods included Fisher's exact test, Student's *t* test, and logistic regression analysis.**

Results: **The study involved 405 patients: 355 male patients (86.5%) and 50 female patients (13.5%). The mean Revised Trauma Score was 6.3, the mean Injury Severity Score was 28, and the mean time interval to the OR was 6.5 hours. There were associated injuries in 356 patients (88%), and an overall complication rate of 53.5%. Overall mortality was 78 of 405 (19%). Three hundred forty-six patients survived to reach the OR: 171 in the preoperative evaluation group and 175 in the no preoperative evaluation group. No statistically significant differences were noted in the two groups in the following parameters: number of patients, age, Injury Severity Score, admission blood pressure, anatomic location of injury (cervical or thoracic), surgical management (primary repair, resection and anastomosis, resection and diversion, flaps), number of associated injuries, and mortality. Average length of time to the OR was 13 hours in the preoperative evaluation group versus 1 hour in the no preoperative evaluation group ($p < 0.001$). Overall complications occurred in 134 in the preoperative evaluation group versus 87 in the no preoperative evaluation group ($p < 0.001$), and 74 (41%) esophageal related complications occurred in the preoperative evaluation group versus 32 (19%) in the no preoperative evaluation group ($p = 0.003$). Mean surgical intensive care unit length of stay was 11 days in the preoperative evaluation group versus 7 days in the no preoperative evaluation group ($p = 0.012$). Logistic regression analysis identified as independent risk factors for the development of esophageal related complications included time delays in preoperative evaluation (odds ratio, 3.13), American Association for the Surgery of Trauma Organ Injury Scale grade >2 (odds ratio, 2.62), and resection and diversion (odds ratio, 4.47).**

Conclusion: **Esophageal injuries carry a high morbidity and mortality. Increased esophageal related morbidity occurs with the diagnostic workup and its inherent delay in operative repair of these injuries. For centers practicing selective management of penetrating neck injuries and transmediastinal gunshot wounds, rapid diagnosis and definitive repair should be made a high priority.**

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Penetrating esophageal injuries represent an unusual entity even in busy urban trauma centers.[1–6] It is estimated that, at most, these centers admit an average of five patients yearly.[3] Several series average two to nine patients treated per year.[2–6] The outcome of penetrating esophageal injuries is dependent on multiple factors. Delay in implementing diagnostic investigations to establish their presence and the difficulty in identifying these injuries, especially when other associated, potentially life-threatening injuries are present. These are factors that increase the risk for complications, even death.[7]

Although delay in the time required to reach definitive surgical intervention in esophageal injuries is cited as the most important factor responsible for the elevated rates of morbidity and mortality,[4–5,7–10] time to treatment has not been widely evaluated as a contributor to outcome. In 1985, Glatterer et al.[11] reported that primary closure more than 16 hours after injury carried major risks for disruption, but the

basis for that conclusion was not well documented. Similarly, Asensio et al.[7] could not support a definitive conclusion correlating delay in treatment with morbidity and mortality.

A multi-institutional study was conducted to attempt to define the time after which delays in management incurred by diagnostic investigation cause increases in morbidity and mortality, identify risk factors in the development of esophageal related complications, and correlate mortality with the American Association for the Surgery of Trauma Organ Injury Scale (AAST-OIS) for esophagus.[12]

MATERIALS AND METHODS

The Multi-institutional Trials Committee of the American Association for the Surgery of Trauma (AAST) conducted a retrospective study of the current evaluation and management of esophageal injury over a 10.5-year period (June 17, 1988, through December 26, 1998). Participating institutions were recruited from the general membership of the AAST. This study was approved at the annual meeting of the AAST in September 1997.

A protocol delineating inclusion and exclusion criteria along with a data collection sheet to conduct institutional review was developed by the Multi-institutional Trial Committee and sent to those institutions that agreed to participate. Institutional review board permission was obtained to conduct this study by all participating institutions. Data collection sheets were returned to the principal investigator for entry into a computer database. This study was designed as purely descriptive.

The main inclusion criterion was the confirmed presence of a penetrating esophageal injury, from a gunshot wound (GSW), stab wound, shotgun wound, or other causes. Cervical, thoracic, and intra-abdominal esophageal injuries were included in patients of all ages. All study patients were required to have measurable vital signs at the time of admission. Patients were excluded if they had preexisting esophageal disease, or the evidence of preinjury immunosuppression and/or immunocompromise (i.e., steroids or acquired immunodeficiency syndrome).

Data collected included demographics, admission blood pressure (BP) of <90 versus >90 mm Hg, Revised Trauma Score (RTS), Glasgow Coma Scale (GCS) score, Injury Severity Score (ISS), mechanism of injury, presenting symptoms and signs, and emergency department (ED) procedures. Anatomic location of injury, time interval elapsed from ED admission to definitive surgical care, presence and type of investigations, and their results were also determined. The surgical approaches and types of surgical repairs performed (primary repair, resection and anastomosis, resection and diversion or drainage) were also recorded, and morbidity and mortality for these patients were tabulated. The characteristics of survivors and nonsurvivors were analyzed.

Surviving patients were stratified into two groups: patients with preoperative evaluation (preoperative evaluation group) and those patients not subjected to any investigative procedures preoperatively and transported directly to the operating room (no preoperative evaluation group). These two groups were compared by the following parameters: number of patients in each group, age, admission BP, RTS, ISS, time interval elapsed from admission to OR, mechanism of injury, anatomic location of injury, surgical management, number of associated injuries, mortality, and overall complications, which were divided into nonesophageal and esophageal related complications. Length of stay (LOS) in the surgical intensive care unit (SICU-LOS) and hospital (Hosp-LOS) were also determined.

Univariate and multivariate analyses were performed. The χ^2 test was used to test the significance of association between each of the categorical variables describing patient characteristics and esophageal related complications. Where small cell size did not warrant the use of χ^2, Fisher's exact test was used. The difference in the means of the continuous variables between the patients with and without esophageal complications was tested using Student's t test. Statistical significance was set at the $p < 0.05$ level for the univariate analysis.

Independent variables having at least a moderate level of significance ($p < 0.2$) with esophageal related complications,

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which also did not have a zero frequency count in the cross-tabulation with esophageal related complications, and did not have more than 5% of the data missing, were entered into a stepwise logistic regression for the purpose of investigating risk factors for esophageal related complications. Statistical analysis of data were performed using the SAS system for PC Windows Release 6.12 (SAS Institute, Inc., Cary, NC) and was performed by the statistician authors of this study (L.C. and E.R.).

RESULTS

Over the span of this 10.5-year study, there were 405 patients that sustained esophageal injury enrolled from the 34 participating institutions. There were 355 (88%) male and 50 (12%) female patients, with a mean age of 29 (range, 2–87 years). Ninety-nine (24%) were admitted with systolic blood pressures of less than 90. Most patients had no symptoms or signs of esophageal injury. Dysphagia was present in 29 (7%) and subcutaneous emphysema was found in 78 (19%).

The mean RTS was 6.3 (range, 1.46–7.84), the mean ISS was 28 (range, 4–75), and the mean Glasgow Coma Scale score was 12 (range, 3–15) for the entire group, indicating a severely injured patient population. The predominant mechanism of injury was GSWs in 306 (75.5%), stab wounds in 75 (18.5%), shotgun wounds in 13 (3.3%), and other mechanisms in 11 (2.7%). There were a total of 433 esophageal injuries incurred in the 405 patients of the study population, with some patients incurring multiple injuries.

Cervical esophageal injuries were most common (229 [56.5%]), and thoracic and abdominal esophageal injuries occurred in 121 (30%) and 69 (17%), respectively. There were 14 combined injuries, as follows: 8 (2%) incurred combined thoracic and abdominal esophageal injuries, 5 (1.2%) were cervicothoracic, and 1 (0.3%) was a combined cervical and abdominal esophageal injury. Emergency department studies included chest radiographs in 312 (77%); neck films in 163 (40%); and kidneys, ureters, bladder films in 53 (13%). Chest tubes were inserted in 179 (44%).

The overall mortality rate was high, at 78 (19%). Forty-one patients underwent ED thoracotomy, and only one survived. Twenty-four (6%) patients died in the ED from various causes, thus allowing 381 (94%) patients to reach the OR alive. Thirty-five (8.6%) patients of the 381 patients died in the OR and were excluded from further analysis. Thus, there was a total of 59 patients that died early from causes other than their esophageal injury, yielding a 14.6% early mortality rate (Table 1).

Three hundred forty-six patients survived their ED admission and surgical intervention and were stratified into two groups: a group that underwent preoperative evaluation before their admission to the OR (the preoperative evaluation group), consisting of 171 patients; and a group admitted directly to the OR, consisting of 175 patients (the no preoperative evaluation group). These two groups form the basis for the comparative analysis in this study and are described below. Time from admission to operative treatment was 6.5 hours for the entire group.

Table 1 Comparison between Survivors and Nonsurvivors (n = 405)

Variable	Survivors	Nonsurvivors
No. of patients	327	78
Mean age (y)	28.7	29.2
Mean RTS	6.99	3.26
Mean ISS	23	34
Mean admission systolic BP	121	57
<90 mm Hg	50	49
>90 mm Hg	277	29
Mean time from admission to OR	7.0 h	5.5 h
Mechanism of injury		
GSW	243	64
SW	63	12
SGW	11	2
Other	11	0
Anatomic location of injured esophagus		
Cervical	201	28
Thoracic	78	43
Abdominal	61	8
No. of patients with complications	123	10
Esophageal related complications		
Wound infection	26	1
Abscess	13	0
Suture line dehiscence	3	1
Esophageal fistula	16	1
Tracheoesophageal fistula	5	0
Mediastinitis	14	1
Empyema	25	0

SW, stab wound; SGW, shotgun wound.

Data were available in 301 patients who underwent 476 explorations, of which cervical exploration was most frequently performed (n = 231), followed by thoracotomy (n = 88), laparotomy (n = 84), and sternotomy (n = 17). There were 56 combined approaches involving explorations of two or more body cavities, including six patients that had their necks, chests, and abdomens explored. The surgical approach was not described in 45 patients. The mean estimated blood loss was 1,378 mL (range, 10–44,000 mL). Patients had their esophageal injuries graded using the AAST-OIS. Data were available in 383 (95%) of all cases and was correlated with mortality (Table 2).

Primary repair was used in 285 (82%), 13 (4%) underwent resection and diversion, 10 (3%) underwent resection and anastomosis, and 38 (11%) were treated by drainage

Table 2 AAST OIS for Esophagus (n = 383)

Injury Grade	No. of Patients	Nonsurvivors	Mortality
I	71	6	8.4%
II	219	30	13.7%
III	77	21	27.3%
IV	10	3	30.0%
V	6	4	66.6%
Not described	22		

Table 3 Comparison of Preoperative Evaluation versus No Preoperative Evaluation Groups (n = 346)

Variable	Preoperative Evaluation Group (n = 171)	SE	No Preoperative Evaluation Group (n = 175)	SE	Statistical Significance
Mean age	29	±1	29	±1	NS
Mean admission systolic BP	124	±3	117	±3	NS
Mean pulse	97	±2	96	±2	NS
Mean respiratory rate	20	±1	20	±1	NS
Mean RTS	7.30	±0.1	6.66	±0.2	$p = 0.002$
Mean ISS	22	±1	25	±1	NS
Time interval from admission to OR	13 h	±2	1 h	±0.1	$p < 0.001$

Variable	Number	%	Number	%	Statistical Significance
Mechanisms of injury					
GSW	134	78%	122	70%	
SW	26	15%	42	24%	
SGW	7	4%	4	2%	
Other	4	2%	7	4%	
Anatomic location of injury					
Cervical	114	67%	99	57%	NS
Thoracic	45	26%	39	22%	NS
Abdominal	18	10%	45	26%	$p < 0.001$
Mean number of associated injuries per patient	2		2		NS

SE, standard error; SW, stab wound; SGW, shotgun wound.

alone. Drainage was used as an adjunct procedure in 215 (62%) of the 346 patients, with a mean duration of drainage of 7.7 days (range, 1–60 days). Muscle flaps were used to buttress repairs in 54 (16%) patients, and other surgical techniques were used in 14 (4%).

There were 19 (5.4%) late deaths from either associated injuries or complications. Exsanguination was the most frequent cause of death and occurred in 61(78%) of the 78 nonsurvivors. One hundred thirty-three patients (38%) experienced a total of 217 complications, for a mean number of 1.66 complications per patient. Of these complications, 111 (51%) were nonesophageal related and 106 (49%) were deemed to be esophageal related.

The preoperative evaluation group underwent a total of 303 investigative procedures, for a mean number of 1.7 procedures per patient. Esophagoscopy was performed in 124 (73%) patients (85 rigid and 39 flexible). Contrast studies were used in 105, and 74 patients underwent computed tomographic scan of either the neck, chest, abdomen, or a combination.

These two groups were comparable in terms of numbers, mechanism of injury, and physiologic parameters. AAST-OIS injury grades and mean number of associated injuries were also equivalent. The RTS was lower in the groups that proceeded directly to the OR ($p = 0.002$). There were more abdominal injuries in the group that proceeded directly to the OR ($p < 0.001$). The mean time elapsed from admission to the OR was 13 hours for the preoperative evaluation group and 1 hour for the no preoperative evaluation group ($p < 0.001$) (Table 3).

These two groups were comparable with respect to the surgical approaches used to access their injuries. No statistical significance was noted between those undergoing neck exploration, right or left thoracotomy, or sternotomy (NS). There were, however, a larger number of exploratory laparotomies performed in the no preoperative evaluation group—50 versus 25 in the preoperative evaluation group ($p = 0.002$), which correlated well with the larger number of abdominal esophageal injuries in the no preoperative evaluation group (Table 3). The no preoperative evaluation group experienced a significantly larger mean estimated blood loss, 1,696 mL versus 505 mL ($p < 0.001$).

The surgical management of these patients revealed no significant differences between patients undergoing primary repair versus other more complicated surgical procedures such as resection and anastomosis, resection and diversion, or repair plus drainage. No difference was noted in the number of muscle flaps used as adjunct surgical measures. Data were available in 59 patients in the preoperative evaluation group and in 74 patients in the no preoperative evaluation group describing mean length of time for drainage. This period of time was the only statistically significant difference ($p = 0.01$) between the two groups. Data were available in 338 (98%) of the 346 patients describing their AAST-OIS grade for their esophageal injuries with no statistical significance noted (NS).

A significant number of patients experienced complications in these two patient groups. There were 77 (45%) patients that incurred a total of 134 complications in the preoperative evaluation group versus 56 (32%) that experienced a total of 87 complications in the no preoperative evaluation group ($p < 0.001$). These complications were then separated into nonesophageal and esophageal related. When stratified into each of the two groups, there were 60 versus 55

Table 4 Esophageal Related Complications: Preoperative Evaluation versus No Preoperative Evaluation Groups (n = 106)

Complication	Totals		Preoperative Evaluation Group (n = 171)		No Preoperative Evaluation Group (n = 175)		Statistical Significance
	Number	%	Number	%	Number	%	
Wound infection	27	8	16	9	11	6	NS
Abscess	13	4	10	6	3	2	$p = 0.043$
Suture line dehiscence	4	1.2	1	0.6	3	2	NS
Esophageal fistula	17	5	10	6	7	4	NS
Tracheoesophageal fistula	5	1.4	4	2.3	1	0.6	NS
Mediastinitis	15	4	13	8	2	1	$p = 0.003$
Empyema	25	7	20	12	5	3	$p = \leq 0.001$
Total number of complications	106		74		32		$p = 0.003$
Average number of complications per patient	0.43 ± 0.07				0.18 ± 0.04		$p < 0.001$

nonesophageal related complications in the preoperative evaluation group versus the nonpreoperative evaluation group, respectively; this was not significant (NS).

However, in the esophageal related category, there were marked differences between the groups. There were 74 (41%) patients that experienced esophageal related complications in the preoperative evaluation group versus 32 (19%) patients in the no preoperative evaluation group ($p = 0.003$). Most of the complications were infectious in nature and included abscess ($p = 0.043$), mediastinitis ($p = 0.003$), and empyema ($p < 0.001$) (Table 4). No statistical significance was noted regarding the incidence of suture line dehiscence, esophageal leak, or tracheoesophageal fistula, as the overall incidence of these complications was low.

When comparing both SICU-LOS and Hosp-LOS, there were statistically significant differences between the groups. The mean SICU-LOS for the preoperative evaluation group was 11 versus 7 days for the no preoperative evaluation group ($p = 0.012$). Similarly, the mean Hosp-LOS for the preoperative evaluation group was much longer, 22 versus 11 days for the no preoperative evaluation group ($p = 0.007$). Regarding mortality, there were 7 nonsurvivors in the preoperative evaluation group versus 12 in the no preoperative evaluation group (NS).

Stepwise logistic regression analysis identified the following independent risk factors in the development of esophageal related complications: time delays incurred in preoperative evaluation ($p = 0.0024$; odds ratio, 3.13), any esophageal injury AAST-OIS grade >2 ($p = 0.0013$; odds ratio, 2.62), and patients undergoing resection and diversion ($p = 0.0131$; odds ratio, 4.47). The total variance explained by the six variables is 21%, with a concordance of 68% (Table 5).

DISCUSSION

Many series in the literature[1,8–10,13,14] that report experiences in the management of esophageal perforations lump together many etiologies with penetrating trauma, hindering thoughtful analysis of these injuries as a separate entity. For the past 50 years, improved outcomes have been tied to early recognition and definitive surgical management,[15–27] and delays have been associated with higher morbidity and mortality.[9,23–28]

Glatterer et al.[11] in 1985 first addressed time as a contributory factor for the development of complications in penetrating injuries, defining a safety interval of 16 hours. The basis of this conclusion is unclear. Asensio et al.[7] correlated time to diagnosis with esophageal related complications and outcome, showing a trend that prolonged interval to repair increased the number of esophageal related complications. A note of caution was raised for trauma centers using selective management of penetrating cervical and transmediastinal injuries, urging a more expedient approach to early diagnosis during their observation period to better differentiate patients to be managed nonoperatively.

Table 5 Risk Factors of Esophageal Related Complications: Stepwise Logistic Regression

Risk Factors	Parameter Estimate	Maximum Rescaled R^2	Odds Ratio	95% CI	*p* Value
Intercept	–4.3422				
Left thoracotomy	1.2581	0.047	3.52	1.26–9.78	0.0004
Preoperative study	1.1412	0.089	3.13	1.72–5.89	0.0024
AAST-OIS >2	0.9620	0.130	2.62	1.33–5.12	0.0013
Neck radiograph not done	0.8216	0.160	2.27	1.25–4.27	0.0093
Resection and diversion	1.4984	0.183	4.47	1.19–17.60	0.0131
Stay in ICU	1.5104	0.207	4.53	1.28–28.89	0.0308

Routine use of selective management for penetrating cervical injuries in most trauma centers,[29] the concept that not all transcervical neck injuries mandate exploration,[30] and that hemodynamically stable thoracic inlet and transmediastinal neck injuries may be investigated[31] safely have decreased the number of explorations, with a concomitant increase in the number of investigations necessary to exclude esophageal injuries.

This large, retrospective, multi-institutional study has defined the characteristics of patients with penetrating esophageal injuries as a severely injured patient population. The majority of these injuries can be dealt with by primary repair (82%); more complex procedures are infrequently needed (3–4%). The use of muscle flaps to buttress repairs was used in 16%. Of significance is the prolonged mean interval of 6.5 hours from admission to surgical intervention. The two groups analyzed were comparable by all parameters assessed (p = NS). The only difference between these two groups was a larger number of abdominal esophageal injuries incurred in the no preoperative evaluation group, 45 versus 18. This was statistically significant ($p < 0.001$).

The surgical management of these two groups of patients was also analyzed. Most patients underwent primary repair, with 135 of 171 (79%) in the preoperative evaluation group versus 141 of 175 (81%) in the no preoperative evaluation group (p = NS). Similarly, more complex surgical procedures were required infrequently for both groups (p = NS). No difference was noted regarding the adjunct procedures such as drainage and flaps (p = NS). However, there was a significant difference in the mean duration of drainage between the two groups, with patients in the preoperative evaluation group (n = 59) having a larger period of drainage, 10 $\pm$ 11, versus 6 $\pm$ 3 in the no preoperative evaluation group (n = 74) ($p = 0.01$).

The AAST-OIS for esophagus[12] was used to grade injuries in these two patient groups. Data were available in 166 (97%) of 171 patients in the preoperative evaluation and 172 (98%) of 175 patients in the no preoperative evaluation group. When stratified to injury grade, there was no statistical significance noted for each of the injury grades (p = NS). The main difference between these two groups was the time interval elapsed from admission to reaching the OR: 13 hours for the preoperative evaluation versus 1 hour for the no preoperative evaluation group. This was highly significant ($p < 0.001$).

To correlate delay in time with outcomes, we analyzed deaths from esophageal causes, postoperative complications including both nonesophageal and esophageal related, SICU-LOS, and Hosp-LOS with one question in mind: Did this increase in time to diagnose or exclude an esophageal injury produce worse outcomes in the preoperative evaluation group?

Late mortality, defined as patients dying after 24 hours from esophageal injuries, was evaluated. There were 19 late deaths. There were 7 nonsurvivors in the preoperative evaluation group versus 12 in the no preoperative evaluation group (p = NS). Therefore, it appears that late mortality was not affected by time delays.

Morbidity defined as nonesophageal and esophageal related complications was also part of our outcome analysis. A significant number of patients experienced complications in these two patient groups, with 77 (45%) patients developing 134 complications in the preoperative evaluation group versus 56 (32%) patients developing 87 complications in the no preoperative evaluation group ($p < 0.001$). When stratified into nonesophageal and esophageal related complications, there was no difference between the two groups in the nonesophageal related category (p = NS), but a significant difference was noted in the number of patients incurring esophageal related complications, 74 (41%) versus 32 (19%) in the preoperative evaluation group versus the no preoperative evaluation group, respectively ($p < 0.001$).

In closely scrutinizing the types of esophageal related complications between these two groups, the differences are accounted for by the larger number of infectious complications such as abscess ($p = 0.043$), mediastinitis ($p = 0.003$) and, most importantly, empyema ($p < 0.001$). No difference was noted in the number of complications that may be technique oriented in nature, such as suture line dehiscence or esophageal fistulas or leaks (p = NS), perhaps because their overall numbers are low.

Other important outcome parameters that may be related to the larger number of esophageal related complications include SICU-LOS and Hosp-LOS. Both were longer for the preoperative evaluation group. This group incurred longer SICU-LOS (11 days, $p = 0.012$) and Hosp-LOS (22 days, $p = 0.007$) than the no preoperative evaluation group.

Logistic regression analysis identified time delays incurred during preoperative evaluation ($p = 0.0013$; odds ratio, 3.13; 95% confidence interval [CI], 1.72–5.89) as an independent risk factor in the development of esophageal related complications. Other independent risk factors included any esophageal injury AAST-OIS grade >2 ($p = 0.0131$; odds ratio, 4.47; 95% CI, 1.33–5.12) and complicated surgical procedure such as resection and diversion ($p = 0.0131$; odds ratio, 4.47; 95% CI, 1.19–17.60). This triad of variables reliably predicted outcome.

Data were available in 383 (95%) of all patients submitted to the study describing their injury grade according to the AAST-OIS injury scale for the esophagus.[12] Injury grade correlated well with mortality, lending validity to this scale as a predictor of outcome.

On the basis of these findings, we conclude that increased esophageal related morbidity occurs with the diagnostic workup and its inherent delay in the operative repair of these injuries. The mean interval of time to establish the presence of an esophageal injury in the preoperative evaluation group was 13 hours. The optimal safety period remains to be defined, but clearly it should be much less than this. For centers practicing selective management of penetrating neck

injuries and transmediastinal GSWs, rapid diagnosis of penetrating esophageal injuries and definitive repair should be made a high priority.

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DISCUSSION

Dr. J. David Richardson (Louisville, Kentucky): The Program Committee asked me to discuss this article, and it is certainly an honor to do so.

I think this represents yet another important study to emanate from the Multi-institutional Study Committee. Although not a trial per se, it does represent a large collection of patients treated over a fairly short period of time, and in that regard I believe its conclusions are valid and defensible.

The limitations of the study certainly need to be mentioned, and I'm sure all are aware of this. This is not a prospective study, and certainly not one that is randomized. It would be very difficult to ever accumulate randomized patients even in these centers, but that is a limitation nonetheless.

The patients are not stratified by severity of injury, and it is difficult to sort out why one treatment was given over the other. It is difficult to determine the judgment that individual surgeons used in their decision to either investigate preoperatively or go ahead and operate.

Now, having mentioned these shortcomings, I think the positive aspects of the article are certainly important. Patients who underwent preoperative evaluation had a mean delay of 13 hours versus 1 hour, and this group certainly had a statistically significant increase in infectious complications, particularly abscess and mediastinitis.

Please note that the authors do not recommend that immediate operation be performed on every patient. The authors conclude that whatever method is chosen to evaluate patients, whether it be with preoperative study or fairly immediate operation, we need to be more expeditious about it. I think that one could argue that 13 hours isn't terribly expeditious!

We do have to remember that when you start with a positive outcome, that is, with the patients that are known to be injured, you don't really have any information on all those other hundreds of patients who weren't injured and presumably treated at those institutions. Clearly, before making any kind of treatment algorithm, you have to factor in those uninjured patients.

I really have only one question. Were you able to determine in this retrospective review whether or not these patients had a preoperative evaluation because their injuries were inappropriately diagnosed and the surgical team did not really recognize that they were seriously injured?

Or was in fact the opposite true, that a certain number of patients had other injuries that prevented the surgical team from evaluating the esophagus, and therefore the 13 hours was just a product of treating a serious injury? If the latter were the case, then it would not be surprising that they would have more complications.

If you could decipher any of that, I think I'd be interested in the information. I thank you so much.

Dr. John R. Hall (Kingsport, Tenessee): My question to you is, for those of us who look at nonoperative management of zone 2 injuries, did you look at location of the wound, specifically high cervical, and see whether there was any difference in that specific group at the time of operation?

Dr. Sidney F. Miller (Dayton, Ohio): I would also like to congratulate you on an excellent article and an opportunity to do a lot of data mining on an infrequent injury, as you alluded to.

I have two questions. First, it would seem to me that those directed to ORs probably went to the operating room for some reason other than their esophageal injury. I'm wondering if you might be able to give us some information on the reason for those.

Second, which I think is probably really more important, is that in the group of patients who had esophageal injuries who weren't in the direct to OR group, were you able to dissect out a group of patients, to really prove your premise, that were diagnosed rapidly and operated on, let's say, within 12 or 24 hours versus a group of patients that were delayed, and were there differences in outcomes between those two groups?

Dr. Juan A. Asensio (closing): I would like to thank Dr. Richardson for his insightful discussion and Drs. Hall and Miller for their questions.

Dr. Richardson, we also looked at other data points regarding these esophageal injuries, and one of them was whether the admitting trauma surgeon had any suspicion whatsoever of the presence of an esophageal injury. What we found was that in about 53% of the cases, they had some suspicion, and in about 47% of the cases they had no suspicion.

The 13-hour time period for the workup is classical of institutions that actually see many different patients and, for the most part, obviously incur these delays. So we cannot dissect out from the data which patients actually went to the OR immediately and for what particular reasons.

I think this also answers Dr. Hall's question. We looked at the different anatomic location of injury, cervical, thoracic and, of course, abdominal, but we could not dissect out those with high cervical esophageal injuries.

Dr. Miller, regarding your comments, they are very well taken. We don't know exactly for what reason many of these patients went to the OR. Of course, I strongly agree with you that for the most part these were probably injuries other than the esophageal injuries.

With regards to a 12- to 24-hour delay period, the longest patient in the database went to the OR in approximately 36 hours, and again we could not dissect that out from the data.

What this study essentially says is that obviously we need to define a safety period. What that safety period is, again, could not be defined. I would like it to be less than 8 hours, but we have no data to support this. In our institutions, as this study obviously originated from many of the inner-city urban trauma centers—there are significant delays because of lack of resources.

Perhaps what we could do in the future is attempt to define a true safety period and do this prospectively.

I would like to thank the Association for the privilege of allowing me to conduct this multicenter study, which is only the third it has approved in its history. I would like to thank Dr. Richardson for his comments and, of course, congratulate him on his presidency.