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Emergency Action Planning in Kansas High Schools

Riley Hedberg, B.S., William Messamore, M.D., Ph.D., Tanner Poppe, B.S., Armin Tarakemeh, B.A., Jordan Baker, B.A., Rick Burkholder, M.S., ATC, Luis Salazar, M.D., Bryan G. Vopat, M.D., Jean-Philippe Darche, M.D.

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ABSTRACT

Introduction. Current evidence showed a variable rate of emergency action plan (EAP) implementation and a low rate of compliance to EAP guidelines in United States secondary schools. Compliance to EAP recommendations in Kansas high schools is not known. The purpose of this study was to identify the emergency preparedness of high school athletics in the state of Kansas and identify prevailing characteristics of schools that correlate with decreased compliance of an EAP.

Methods. Athletic directors for high schools in the state of Kansas were asked to participate in a web-based questionnaire that was emailed to each athletic director. The questionnaire identified demographics of the study population, EAP implementation rates, compliance to national EAP guidelines, access to certified medical personnel, and training received by athletics personnel. Descriptive statistics were then compiled and reported.

Results. The response rate for the survey was 96% (341/355). A total of 94.1% (320/340) of schools have an EAP, 81.4% (276/339) of schools have an automated external defibrillator (AED) at all athletic venues, and 51.8% (176/340) of schools had an athletic trainer (AT) on staff. Urban schools were significantly more likely than rural schools to have an AT on staff (OR = 11.10, 95% CI = [6.42, 19.18], p < 0.0001), have an EAP (OR = 3.69, 95% CI = [1.05, 13.02], p = 0.0303), require additional training for coaches (OR = 2.69, 95% CI = [1.42, 5.08], p = 0.0017), and have an AED on-site for some events (OR = 2.18, 95% CI = [1.24, 3.81], p = 0.0057).

Conclusions. Most Kansas high schools have an EAP in place and have at least one AED. Emergency planning should be improved through venue specific EAPs, access to early defibrillation, and additional training. Rural and lower division schools had less AT staffing and consequently were impacted more significantly than urban and higher division schools by these factors. These factors should be taken into account in future improvement strategies.

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INTRODUCTION

In 2019, nearly 8 million adolescents participated in school-related sporting activities according to the 2018-19 High School Athletics Participation Survey conducted by the National Federation of State High School Associations. From 2011 to 2014, the U.S. Centers for Disease Control and Prevention reported nearly 5.6 million injuries related to sport or recreation among persons aged 5-24. Although the majority of injuries were not life threatening, there were a significant amount of catastrophic and fatal injuries.

During the 2017-2018 academic year, 99 catastrophic injuries occurred in U.S. high school and college athletics. Catastrophic injuries were defined as fatalities, permanent disability injuries, serious injuries (fractured neck or serious head injury) even though the athlete had a full recovery, temporary or transient paralysis, heat stroke due to exercise, sudden cardiac arrest or severe cardiac disruption, and they occurred in high school and college athletes. Of these, 85 events occurred during or due to sport-related activities, and 66 of 85 sport-related catastrophic injuries were at the high school level.

Implementing an EAP is an essential part of ensuring an efficient response to any catastrophic event in high school athletics. An EAP is a written guideline of emergency planning designed to help individuals respond to a catastrophic injury within sports. The National Athletic Trainers’ Association (NATA) has published guidelines on emergency preparedness in organized athletics through their position statements. NATA’s guidelines identify the components of emergency response preparation, which includes formulating and implementation of an EAP, proper education and training for personnel, acquisition and maintenance of emergency equipment and supplies, and appropriate use of personnel. In addition, the Sideline Preparedness Collaboration (comprised of six major professional organizations: American Academy of Family Physicians, American Academy of Orthopaedic Surgeons, American College of Sports Medicine, American Medical Society for Sports Medicine, American Orthopaedic Society for Sports Medicine, American Osteopathic Academy of Sports Medicine), American Academy of Pediatrics, and American Heart Association all endorse the formation and implementation of emergency plans in schools.

EAP adoption has been studied in many other states and cities, but, to our knowledge, no literature has studied EAP adoption in Kansas. The purpose of this study was to identify the emergency preparedness of high school athletics in the state of Kansas and identify prevailing characteristics of schools that correlate with decreased compliance of an EAP.

METHODS

A web-based questionnaire (see Appendix) was developed to perform a cross-sectional analysis of the emergency preparedness of Kansas high schools. The questionnaire included 16 questions focused on demographics of the study population, EAP adoption, compliance to national EAP guidelines, access to certified medical personnel, and training received by athletics personnel.

The questionnaire was delivered by email to athletic directors for each high school in March, April, and May 2020. All recipients were contacted through the Kansas State High School Athletic Association (KSHSAA) in December 2020 asking all non-responders to complete
the questionnaire. Questionnaire distribution and data organization was done using REDCap® (Research Electronic Data Capture) software.

For statistical analysis, responses were stratified by high school division, or between rural and urban status. For the analysis of responses by division, Cochran-Armitage tests for trend were used to test for increasing or decreasing trends in the proportions of school district with respect to their division. For the analysis of responses stratified between rural and urban, a chi-square test was used to analyze dichotomous responses. Continuous responses were analyzed by t-tests. A p value of < 0.05 was considered statistically significant.

RESULTS

Of the 355 recipients, 341 (96%) returned the survey in some capacity. KSHSAA assigns schools to each division by the size of their student population in grades 9-12. The assignment is updated in September of each year. The largest 36 schools are classified as 6A, the next 36 are 5A, the next 36 are 4A, the next 64 are 3A, the next 64 are 2A, and the remaining schools are classified as 1A. From this, it could be determined that 59% (196/341) of schools had a student population greater than or equal to 1,000 students, and 41% (136/341) had a student population less than 1,000 students. In 50.1% (170/339) of schools, athletic trainers (AT) were the primary medical providers during school athletic events (Figure 1), and 51.8% (340/355) of schools had an AT on staff. Figure 1 represents the proportion of schools in Kansas that were the primary medical provider for athletic events. The proportion of schools using each medical provider as their primary provider for athletic events is shown in Figure 1. AED access and EAP adoption rates are shown in Table 1.

Urban/Rural. Urban schools were significantly more likely than rural schools to have an AT on staff (OR = 11.10, 95% CI = [6.42, 19.18], p < 0.0001), have an EAP (OR = 3.69, 95% CI = [1.05, 13.02], p = 0.0303), require additional training for coaches (OR = 2.69, 95% CI = [1.42, 5.08], p = 0.0017), and have an AED on-site for some events (OR = 2.18, 95% CI = [1.24, 3.81], p = 0.0057; Table 2). Urban schools were significantly less likely than rural schools to have an ambulance at football games (OR = 0.119, 95% CI = [0.063, 0.227], p < 0.0001). Among schools that have an EAP, there was no significant difference between urban and rural schools with regards to having a site specific EAP (OR = 1.51, 95% CI = [0.812, 2.81], p = 0.1914) or reviewing the EAP with opponents prior to events (OR = 0.954, 95% CI = [0.602, 1.51], p = 0.8422). Among schools that did not have an ambulance at their football games, urban schools were significantly closer to an ambulance than rural schools (6.36 vs. 11.58 minutes; Δ = 5.21, 95% CI = [0.641, 9.78], p = 0.0284). Among schools that had an AT on staff, urban schools had ATs that worked significantly more hours (28.60 vs. 9.43 hours; Δ = 19.17, 95% CI = [15.51, 22.85], p < 0.0001).

Athletic Trainers. Schools that had an AT on staff were more likely to have an EAP (OR = 3.38, 95% CI = [1.89, 9.60], p = 0.0160), have an AED on site for some events (OR = 1.85, 95% CI = [1.05, 3.27], p = 0.0326), require additional training for coaches (OR = 3.55, CI = [1.75, 7.24], p = 0.0003), and, if they had an EAP, have site-specific EAPs (OR = 2.23, CI = [1.23, 4.05], p = 0.0076; Table 3).

Division. For having an AT on staff, a higher division was associated with a higher proportion of schools with an AT on staff (p < 0.0001). Lower divisions were associated significantly with higher proportions of having an ambulance at football games (p < 0.0001). Additionally, higher divisions were associated significantly with greater proportions of having an EAP (p = 0.0005), requiring additional training for coaches (p = 0.0049), and having an AED on-site for some events (p = 0.0229). Among schools that had an EAP, there was no significant trend in the proportions of having a site-specific EAP (p = 0.1142) or reviewing the EAP with opponents prior to an event (p = 0.6429).

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Table 1. Automated external defibrillator (AED) access and emergency action plan (EAP) adoption.

<table>
<thead>
<tr>
<th>AED access within 4 minutes</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>AED available for all athletic venues</td>
<td>276 (81.4%)</td>
</tr>
<tr>
<td>AED available for some venues</td>
<td>63 (18.6%)</td>
</tr>
<tr>
<td>AED not available</td>
<td>0 (0%)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Presence of EAP</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>EAP adopted</td>
<td>320 (94.1%)</td>
</tr>
<tr>
<td>No EAP</td>
<td>20 (5.9%)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>EAP is venue specific</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>259 (82.5%)</td>
</tr>
<tr>
<td>No</td>
<td>55 (17.5%)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>EAP is reviewed with the opposing team before an event</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>201 (59.5%)</td>
</tr>
<tr>
<td>No</td>
<td>137 (40.5%)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Open to assistance in creating or improving EAP</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>228 (67.7%)</td>
</tr>
<tr>
<td>No</td>
<td>109 (32.3%)</td>
</tr>
</tbody>
</table>

Figure 1. Providers of medical care during high school athletic events (n = 339).
EAP IN KANSAS HIGH SCHOOLS

Note: EAP = emergency action plan; AED = automated external defibrillator.

**DISCUSSION**

Rural and lower division schools are less likely to have EAP implementation, AED access, and additional athletics staff training, which are three vital components of emergency preparedness in athletics. Schools with an AT on staff were more likely to have site-specific EAPs, access to AEDs, and require additional training for coaches. Both access to an AT and access to an AED have shown a positive correlation with other markers of emergency preparedness. Poor access to ATs in rural Kansas schools likely plays a role in other aspects of emergency preparation. This is important because it emphasizes the fact that many schools rely on athletic directors and other staff to implement health and safety policies without the help of an AT. Additional training may allow schools with and without an AT on staff to more efficiently implement the standard of care as outlined by the NATA’s recommended health and safety guidelines.

All schools reported having access to at least one AED on campus, but only 81.4% (276/339) have an AED available within four minutes of all athletic venues. It is well known that early defibrillation and early activation of an emergency response are crucial for cardiac arrest survival, thus improving AED access in Kansas schools should be of utmost importance. Pike et al. identified education and cost as barriers to health and safety policy implementation for state high school athletic associations. This was relevant for rural and lower division schools who were less likely to have an AT on staff, as shown by our survey results. Rural schools could have limited funding and AT availability compared to urban areas, further compounding the difficulty in successful implementation of state health and safety policies. In addition, more than 25% of schools utilize coaches, school administrators, and other staff for medical coverage. These individuals would benefit from training beyond cardiopulmonary resuscitation and AED, like concussion management, heat illness, and emergency action planning. Trained healthcare providers are vital to high school athletics. The majority (67.7%) of Kansas schools were open to assistance in creating or improving their current EAP. This showed that future improvement strategies will be received positively and are likely to be successful.

**Limitations.** This study was limited by potential bias since only 96% (341/355) of responses were received and some of the schools may have been underrepresented because some responses may be duplicates if the same school submitted the survey more than once. Survey responses were received anonymously through REDCap, therefore we were unable to determine if there were any duplicate entries. Finally, a lack of AT staffing may be the result of lower funding, which could impact how many schools have EAPs.

**CONCLUSIONS**

The results of this study showed that the majority of Kansas high schools have an EAP in place and have at least one AED. While these are important factors, there is improvement to be made through venue-specific EAPs, access to early defibrillation, and additional training. While having an AT on staff seemed to improve the emergency preparedness of schools, it can be challenging due to financial cost. Funding and other barriers to emergency preparedness in school-based athletics should be discussed with relevant stakeholders like athletic directors, state legislative officials, and ATs to determine a viable improvement strategy. Education regarding the importance of EAPs, AEDs, and ATs should be discussed with relevant stakeholders like athletic directors, state legislative officials, and ATs to determine a viable improvement strategy. Education regarding the importance of EAPs, AEDs, and ATs could be an important improvement strategy, especially in schools with low compliance to current recommendations. Rural and lower division schools were impacted more significantly than urban and higher division schools and this should be taken into account in future improvement strategies.
REFERENCES


Keywords: sports medicine, athletic injuries, youth sports, team sports
# APPENDIX

## Questionnaire

<table>
<thead>
<tr>
<th>Question</th>
<th>Available Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>1  What division of high school do you participate in?</td>
<td>1A, 2A, 3A, 4A, 5A, 6A</td>
</tr>
<tr>
<td>2  Where are you located in the state of Kansas?</td>
<td>Northwest, Southwest, North Central, South Central, Northeast, Southeast</td>
</tr>
<tr>
<td>3  Would you consider your school rural? (fewer than 1,000 population)</td>
<td>Yes, No</td>
</tr>
<tr>
<td>4  Which of the following provide care for athletic injuries or illnesses during school athletic events?</td>
<td>Athletic trainer (ATC), Coach, School administrator, School nurse, Emergency medical technician or paramedic, Physician (MD or DO), Chiropractor (DC), Physical therapist (PT), Other, None of the above</td>
</tr>
<tr>
<td>5  Do you have an athletic trainer on staff?</td>
<td>Yes, No</td>
</tr>
<tr>
<td>6  If so how many hours per week?</td>
<td>Open numerical value</td>
</tr>
<tr>
<td>7  Do you have an ambulance at your football games?</td>
<td>Yes, No</td>
</tr>
<tr>
<td>8  If not how far away is the nearest ambulance (minutes)?</td>
<td>Open numerical value</td>
</tr>
<tr>
<td>9  Does your school require coaches to obtain CPR and AED training?</td>
<td>Yes, No</td>
</tr>
<tr>
<td>10 Does your school require coaches to undergo additional training on athlete healthcare beyond what is required by KSHSAA? Currently KSHSAA requires all coaches to be trained in CPR and AED use.</td>
<td>Yes, No</td>
</tr>
<tr>
<td>11 If your school requires additional training, please specify:</td>
<td>Open</td>
</tr>
<tr>
<td>12 Does your school have an automated external defibrillator (AED) that is available and can be used within 4 minutes of any athletic venue?</td>
<td>Yes, for all athletic venues; No; Yes, but only for some athletic venues</td>
</tr>
<tr>
<td>13 Does your school have an emergency action plan for medical emergencies during athletic events?</td>
<td>Yes, No</td>
</tr>
<tr>
<td>14 If your school does have an emergency action plan, is the emergency action plan specific to all athletic venues? (e.g. specific for football field, basketball court, weight room, etc.)</td>
<td>Yes, No</td>
</tr>
<tr>
<td>15 Do you review the EAP with the opposing team before an event?</td>
<td>Yes, No</td>
</tr>
<tr>
<td>16 Would you be open to assistance to help create or improve your EAP?</td>
<td>Yes, No</td>
</tr>
</tbody>
</table>
Comparing Outcomes of Robotic-Assisted versus Conventional Laparoscopic Hiatal Hernia Repair

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Department of Surgery

ABSTRACT

Introduction. Robotic-assisted laparoscopic surgery for anti-reflux and hiatal hernia surgery is becoming increasingly prevalent. The purpose of this study was to compare hospital length of stay and outcomes of robotic-assisted versus conventional laparoscopic hiatal hernia repair.

Methods. A retrospective review was conducted of 58 patients who underwent robotic-assisted laparoscopic (n = 16, 27.6%) or conventional laparoscopic (n = 42, 72.4%) hiatal hernia repair.

Results. Patient characteristics and comorbidities were similar between groups. The robotic-assisted group had a significantly higher use of fundoplication (81.3% vs. 38.1%; p = 0.007). Complications observed between the robotic-assisted and conventional laparoscopic groups were pneumothorax (6.3% vs. 11.9%; p = 1.000), infection (0% vs. 4.8%; p = 1.000), perforation (0% vs. 2.4%; p = 1.000), bleeding (6.3% vs. 2.4%; p = 0.479), ICU admission (31.3% vs. 11.9%; p = 0.119), and mechanical ventilation (18.8% vs. 2.4%; p = 0.60). There were no reported complications of dysphagia, deep vein thrombosis/pulmonary embolus, myocardial infarction, or death in either group. Hospital length of stay was similar for robotic versus conventional patients (3.0 vs. 2.5 days; p = 0.301).

Conclusions. Robotic-assisted versus conventional laparoscopic hiatal hernia were compared, which demonstrated similar post-operative complication rates and hospital length of stay. The results showed robotic-assisted or conventional laparoscopic hiatal hernia repair can be performed with similar outcomes.

INTRODUCTION

Patients with medically refractory gastroesophageal reflux disease (GERD) or hiatal hernia may undergo surgical repair to treat their symptoms. Anti-reflux surgery has a satisfactory outcome in 85–90% of patients with these conditions. Prior to minimally invasive techniques, a traditional open approach was used for hiatal hernia repair. This approach eventually was replaced by conventional laparoscopic repair, with reduced rates of perioperative morbidity and shorter hospital stays. However, there were some pitfalls to conventional laparoscopic surgery, including unstable video-camera, limited motion of straight laparoscopic instruments, and 2-D imaging. More recently, robotic-assisted laparoscopic surgery has become increasingly prevalent.

Robotic surgery overcomes many of the pitfalls of conventional laparoscopic surgery, including steady state, 3-D cameras, improved dexterity of robotic instruments, and superior ergonomics for the surgeon. After a thorough search of the surgical literature, there were very few studies that directly compared the outcomes of robotic-assisted versus conventional laparoscopic hiatal hernia repair. Soliman et al. performed a retrospective review of data collected from The Society of Thoracic Surgery database comparing outcomes of conventional laparoscopic versus robotic surgery for hiatal hernia repairs, whereas Tolboom et al. used a single institute cohort to compare laparoscopic versus robotic redo hiatal hernia repairs. Those studies demonstrated statistically significant decreases in hospital length of stay (LOS) from 1.8 to 1.3 days and from 4 to 3 days. Solomon et al. also found a statistically significant decrease in post-operative events (i.e., intensive care unit [ICU] admission, pneumonia, respiratory failure, deep vein thrombosis [DVT], urinary tract infection [UTI], surgical site infection, and need for ventilatory support), from 29 to 9 with robotic-assisted hiatal hernia repair. However, in a retrospective population-based analysis by Ward et al., robotic-assisted hiatal hernia repair had a significantly increased risk of complications, such as respiratory failure and esophageal perforation (2.4% vs. 1.6%; p = 0.003 and 0.6% vs. 0.3%; p = 0.01, respectively). This study also demonstrated a longer hospital LOS for the robotic-assisted group, although this was not statistically significant. The purpose of this study was to add to the existing literature of outcomes of robotic-assisted versus conventional laparoscopic hiatal hernia repair.

METHODS

This study was approved for implementation by the Ascension Via Christi Hospitals Wichita, Inc Institutional Review Board. A three year retrospective review was conducted of all patients, ≥ 18 years of age, who underwent robotic-assisted or conventional laparoscopic hiatal hernia repair at a single tertiary-care hospital. The medical records utilized covered the time period from January 1, 2014 through December 31, 2016. All patients were followed for three years, with the follow-up period ending December 31, 2019.

Data collected included patient demographics (age, sex, height, weight, body mass index [BMI], American Society of Anesthesiologist [ASA] physical status class, and the presence of co-morbidities [GERD, hypertension, diabetes, coronary artery disease, and chronic obstructive pulmonary disease [COPD]). Medical records also were reviewed for procedure performed (conventional laparoscopic versus robotic-assisted laparoscopic), use of fundoplication and type, use of mesh, conversion to open procedure, post-operative complications (i.e., pneumothorax, infection, bleeding, perforation, dysphagia, DVT/pulmonary embolus [PE], myocardial infarction [MI], and other), ICU admission and LOS, need for mechanical ventilation and ventilator days, hospital LOS, 30-day readmission rate, mortality, and discharge to hospice.

The primary outcome variables were hospital LOS and post-operative complications between the two groups. In addition, patient age, BMI, ASA class, as well as specific co-morbidities that may have affected the primary outcomes were evaluated.

Data Analysis. A total of 58 cases met inclusion criteria. Data were summarized and presented as frequency and counts for categorical data, mean ± standard deviation for parametric continuous data, or median and interquartile range for nonparametric continuous data.
Pearson’s Chi-Square was used to compare all categorical variables, though Fisher’s Exact Test was used when the cell count was less than 5. The t-test and Mann-Whitney U test were used to compare continuous parametric and nonparametric data, respectively. Analyses were considered significant when the p value was ≤ 0.05. All analyses were conducted using IBM SPSS release 19.0 (IBM Corp., Armonk, NY).

RESULTS

Patient Demographics and Comorbidities. A total of 58 patients were included in the final analyses after exclusions were applied. Patient demographics (age, sex, height, weight, BMI) and ASA class were similar between study groups (Table 1). The average patient age was 63.9 years and average BMI was 30.9. Female sex was most common (70.7%). ASA class 2/3 was most common (91.4%). Patient comorbidities also were similar between the two groups with GERD being the most common comorbidity observed (82.8%). Hypertension was observed more commonly in patients undergoing conventional laparoscopic repair (71.4% vs. 43.8%; p = 0.050).

Procedure Comparisons. Conventional laparoscopic hiatal hernia repair was performed more commonly than robotic-assisted repair (72.4% vs. 27.6%; Table 2). Fundoplication was used twice as often in the robotic-assisted group than in the conventional group (81.3% vs. 38.1%; p = 0.007). In those patients that underwent a fundoplication, the Nissen was the most common type of fundoplication performed in both the robotic-assisted (84.6%) and conventional laparoscopic groups (68.8%). Use of mesh was not different between the robotic-assisted and conventional laparoscopic groups (37.5% vs. 28.6%; p = 0.511) nor was conversion to open procedure (0% vs. 16.7%; p = 0.173).

Post-operative Complications. No patients in either group had a reported complication of dysphagia, DVT/PE or MI (Table 3). The robotic-assisted group had no reported complications of infection or perforation, and only one reported complication of pneumothorax (6.3%) and bleeding (6.3%). The conventional laparoscopic group had five reported cases of pneumothorax (11.9%), two reports of infection (4.8%), one for bleeding, and one for perforation (2.4% each). Other complications included acute hypoxia that required new home oxygen, acute kidney injury, atrial fibrillation, supraventricular tachycardia, urinary retention, ileus, immediate hiatal hernia recurrence, and retained surgical foreign body. There were no differences between the two groups for these complications.

Hospital Outcomes. There were no statistically significant differences between study groups for ICU admission or LOS, mechanical ventilator requirements, hospital LOS, 30-day readmission, mortality, or discharge disposition (Table 3). There was a trend for the conventional laparoscopic group to have a longer median ICU LOS (five vs. two days; p = 0.095). However, the robotic-assisted group tended to have more patients require mechanical ventilation (18.8% vs. 2.4%; p = 0.060). There were no mortalities in either group.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Composite</th>
<th>Study Group</th>
<th>p Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of observations</td>
<td>58 (100%)</td>
<td>42 (72.4%)</td>
<td>16 (27.6%)</td>
</tr>
<tr>
<td>Age (years)</td>
<td>63.9 ± 14.2</td>
<td>64.9 ± 13.1</td>
<td>61.4 ± 16.9</td>
</tr>
<tr>
<td>Female sex</td>
<td>41 (70.7%)</td>
<td>28 (66.7%)</td>
<td>13 (81.3%)</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>166.3 ± 9.9</td>
<td>166.1 ± 10.5</td>
<td>166.7 ± 8.4</td>
</tr>
<tr>
<td>Weight (Kg)</td>
<td>85.2 ± 19.2</td>
<td>83.4 ± 18.4</td>
<td>899 ± 209</td>
</tr>
<tr>
<td>Body mass index</td>
<td>30.9 ± 5.5</td>
<td>30.3 ± 5.4</td>
<td>32.3 ± 5.5</td>
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<tr>
<td>ASA class</td>
<td>0.929</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>4 (6.9%)</td>
<td>3 (7.1%)</td>
<td>1 (6.3%)</td>
</tr>
<tr>
<td>2</td>
<td>33 (56.9%)</td>
<td>24 (57.1%)</td>
<td>9 (56.3%)</td>
</tr>
<tr>
<td>3</td>
<td>20 (34.5%)</td>
<td>14 (33.3%)</td>
<td>6 (37.5%)</td>
</tr>
<tr>
<td>4</td>
<td>1 (1.7%)</td>
<td>1 (2.4%)</td>
<td>0 (0.0%)</td>
</tr>
<tr>
<td>Comorbidities</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GERD</td>
<td>48 (82.8%)</td>
<td>35 (83.3%)</td>
<td>13 (81.3%)</td>
</tr>
<tr>
<td>Hypertension</td>
<td>37 (63.8%)</td>
<td>30 (71.4%)</td>
<td>7 (43.8%)</td>
</tr>
<tr>
<td>Diabetes</td>
<td>8 (13.6%)</td>
<td>8 (19.0%)</td>
<td>0 (0.0%)</td>
</tr>
<tr>
<td>Coronary artery disease</td>
<td>4 (6.9%)</td>
<td>2 (4.8%)</td>
<td>2 (12.5%)</td>
</tr>
<tr>
<td>COPD</td>
<td>1 (1.7%)</td>
<td>1 (2.4%)</td>
<td>0 (0.0%)</td>
</tr>
</tbody>
</table>

*Presented as number (%) or mean ± standard deviation.

ASA = American Association of Anesthesiologists, GERD = gastroesophageal reflux disease, COPD = chronic obstructive pulmonary disease.

Table 2. Comparison of operative procedures of patients undergoing hiatal hernia repair by a conventional laparoscopic or robot-assisted laparoscopic approach.*

*Presented as number (%).

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Composite</th>
<th>Study Group</th>
<th>p Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of observations</td>
<td>58 (100%)</td>
<td>42 (72.4%)</td>
<td>16 (27.6%)</td>
</tr>
<tr>
<td>Use of fundoplication</td>
<td>29 (50.0%)</td>
<td>16 (38.1%)</td>
<td>13 (81.3%)</td>
</tr>
<tr>
<td>Nissen fundoplication</td>
<td>Yes</td>
<td>22 (75.9%)</td>
<td>11 (68.8%)</td>
</tr>
<tr>
<td>No</td>
<td>7 (24.1%)</td>
<td>5 (31.3%)</td>
<td>2 (15.4%)</td>
</tr>
<tr>
<td>Use of mesh</td>
<td>18 (31.0%)</td>
<td>12 (28.6%)</td>
<td>6 (37.5%)</td>
</tr>
<tr>
<td>Conversion to open</td>
<td>7 (12.1%)</td>
<td>7 (16.7%)</td>
<td>0 (0.0%)</td>
</tr>
</tbody>
</table>
Table 3. Comparison of complications and hospital outcomes of patients undergoing hiatal hernia repair by a conventional laparoscopic or robot-assisted laparoscopic approach.*

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Composite</th>
<th>Conventional Laparoscopic</th>
<th>Robotic Assisted Laparoscopic</th>
<th>p Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of observations</td>
<td>58 (100%)</td>
<td>42 (72.4%)</td>
<td>16 (27.6%)</td>
<td>---</td>
</tr>
<tr>
<td>Patients with 1 or more complications</td>
<td>20 (34.5%)</td>
<td>15 (35.7%)</td>
<td>5 (31.3%)</td>
<td>0.749</td>
</tr>
<tr>
<td>Pneumothorax</td>
<td>6 (10.3%)</td>
<td>5 (11.9%)</td>
<td>1 (6.3%)</td>
<td>1.000</td>
</tr>
<tr>
<td>Infection</td>
<td>2 (3.4%)</td>
<td>2 (4.8%)</td>
<td>0 (0.0%)</td>
<td>1.000</td>
</tr>
<tr>
<td>Bleeding</td>
<td>2 (3.4%)</td>
<td>1 (2.4%)</td>
<td>1 (6.3%)</td>
<td>0.479</td>
</tr>
<tr>
<td>Perforation</td>
<td>1 (1.7%)</td>
<td>1 (2.4%)</td>
<td>0 (0.0%)</td>
<td>1.000</td>
</tr>
<tr>
<td>Dysphagia</td>
<td>0 (0.0%)</td>
<td>0 (0.0%)</td>
<td>0 (0.0%)</td>
<td>---</td>
</tr>
<tr>
<td>DVT/PE</td>
<td>0 (0.0%)</td>
<td>0 (0.0%)</td>
<td>0 (0.0%)</td>
<td>---</td>
</tr>
<tr>
<td>Myocardial infarction</td>
<td>0 (0.0%)</td>
<td>0 (0.0%)</td>
<td>0 (0.0%)</td>
<td>---</td>
</tr>
<tr>
<td>Other complications</td>
<td>16 (27.6%)</td>
<td>11 (26.2%)</td>
<td>5 (31.3%)</td>
<td>0.700</td>
</tr>
<tr>
<td>ICU admission</td>
<td>10 (17.2%)</td>
<td>5 (11.9%)</td>
<td>5 (31.3%)</td>
<td>0.119</td>
</tr>
<tr>
<td>ICU days</td>
<td>3.5 (1.75-5.5)</td>
<td>5.0 (2.5-8.5)</td>
<td>2.0 (1.2)</td>
<td>0.095</td>
</tr>
<tr>
<td>Mechanical ventilation</td>
<td>4 (6.9%)</td>
<td>1 (2.4%)</td>
<td>3 (18.8%)</td>
<td>0.060</td>
</tr>
<tr>
<td>Ventilator days</td>
<td>2.5 (1.0-4.0)</td>
<td>4.0</td>
<td>1.0</td>
<td>0.423</td>
</tr>
<tr>
<td>Hospital LOS</td>
<td>3.2 (2-4)</td>
<td>2.5 (1-4)</td>
<td>3 (2.5-7.5)</td>
<td>0.301</td>
</tr>
<tr>
<td>30-day readmission</td>
<td>7 (12.1%)</td>
<td>6 (14.3%)</td>
<td>1 (6.3%)</td>
<td>0.660</td>
</tr>
<tr>
<td>Mortality</td>
<td>0 (0.0%)</td>
<td>0 (0.0%)</td>
<td>0 (0.0%)</td>
<td>---</td>
</tr>
<tr>
<td>Discharged to hospice</td>
<td>1.7% (1)</td>
<td>1 (2.4%)</td>
<td>0 (0.0%)</td>
<td>1.000</td>
</tr>
</tbody>
</table>

*Presented as number (%) or median (IQR).
DVT = deep vein thrombosis, PE = pulmonary embolus, ICU = intensive care unit, LOS = length of stay.

**DISCUSSION**

GERD and hiatal hernias are a common complaint among many patients, and anti-reflux surgery has been reported to have a satisfactory outcome in 85-96% of patients with these conditions. While a conventional laparoscopic approach is more common, robotic surgery is becoming common place in many general surgeons’ practices. There were several studies that have compared robotic-assisted and conventional laparoscopic hiatal hernia repairs, with three studies demonstrating decreased hospital LOS and a decrease in the number of post-operative events, whereas one study demonstrated increased hospital LOS and the number of post-operative complications in the robotic-assisted group. This study aimed to add to the existing literature on comparing the outcomes of robotic-assisted and conventional laparoscopic hiatal hernia repair.

**Hospital Length of Stay.** The median hospital LOS for conventional laparoscopic hiatal hernia repair was 2.5 days and for robotic-assisted was 3.0 days (p = 0.301). Our data suggested that there was no statistically significant difference or trend in hospital LOS between the two groups. The study by Soliman et al. showed a statistically significant reduction in hospital LOS when comparing conventional laparoscopic and robotic-assisted hiatal hernia repair (1.8 vs. 1.3 days; p = 0.003). Their study had a larger sample size (laparoscopic, n = 151; robotic-assisted, n = 142) compared to the study presented in this paper. The increased power of their study likely explained the statistically significant results. The single-center study by Vasudevan et al. demonstrated a mean hospital LOS of 2.8 days (n = 29) for robotic-assisted hiatal hernia repair. Our study demonstrated similar median LOS of 3.0 days for the robotic-assisted group. The study by Tolboom et al. demonstrated a significant reduction in hospital LOS for robotic-assisted redo hiatal hernia repair compared to laparoscopic redo hiatal hernia repair (three vs. four days; p = 0.042). Also, the retrospective observational cohort study performed by O’Connor et al. showed a statistically significant decrease in hospital LOS favoring the robotic-assisted approach (3.3 vs. 2.3 days; p = 0.003). Ward et al. demonstrated a longer hospital LOS in the robotic-assisted group, although this was not statistically significant.

While our study did not specifically divide first-time and redo hiatal hernia repairs, the results showed similar robotic-assisted hospital LOS of three days as the Vasudevan et al. and Tolboom et al. studies. Overall, the literature on robotic-assisted compared to conventional laparoscopic hiatal hernia repair was limited, with most studies showing statistically significant decreases in hospital LOS, favoring robotic-assisted over laparoscopic hiatal hernia repair. Our study did not demonstrate a statistically significant difference in hospital LOS between the two groups, however, the median hospital LOS for our robotic-assisted group was three days, which is very similar to other studies in the literature.

**Complications.** Post-operative complications were the other main outcome of interest in this study. Pneumothorax was the most common complication observed in our study. In our study, five patients in the conventional laparoscopic group and one patient in the robotic group had a pneumothorax (11.9% and 6.3%, respectively). Tolboom et al. had two patients (4.4%) in the robotic group who had a pleural defect during surgery, one of which required a chest tube, while the conventional laparoscopic group had no patients with a pleural defect.

Our study had one patient (2.4%) in the conventional laparoscopic group with a perforation while the robotic group had no patients with a perforation. Tolboom et al. had three patients (6.7%) in the robotic group and four patients (13.3%) in the conventional laparoscopic group having either an esophageal or gastric perforation; these were noted to be repaired and managed laparoscopically. Ward et al. demonstrated a statistically significant difference in the number of esophageal perforations, favoring the conventional laparoscopic group over robotic-assisted (457 [0.8%] vs. 64 [0.6%]; p = 0.01).

Our rates of bleeding as a complication compared favorably to that reported in the literature with one patient in both the conventional laparoscopic and robotic groups (2.4% and 6.3%, respectively; p = 0.479). Soliman et al. had three patients (2.0%) in the laparoscopic...
group and two patients (1.4%) in the robotic group that had a need for post-operative transfusion of packed red blood cells. Tolboom et al. found two patients (4.4%) in the robotic group that had bleeding as a minor complication that was able to be controlled during surgery; they had no patients in the laparoscopic group with a bleeding complication. As with our study, Ward et al. demonstrated no difference in rates of post-operative bleeding between the two groups (2.5% conventional laparoscopic vs. 2.8% robotic-assisted; p = 0.39).

Two patients (4.8%) in the laparoscopic group and no patients in the robotic group had an infection as a complication in our study. In Soliman et al., five patients (3.3%) in the laparoscopic group and two patients (1.4%) in the robotic group had an infection, either a urinary tract infection, surgical site infection, or other infection requiring intravenous antibiotics, as a post-operative complication. Ward et al. showed a trend for the robotic-assisted group to have a higher rate of post-operative infections (1.5% vs. 1.1%; p = 0.08).

In our study, no patients in either the laparoscopic or robotic-assisted groups had dysphagia as a post-operative complication. In the literature, the rate of dysphagia as a complication was also low. Vasudevan et al. found 1 patient out of 28 redo robotic-assisted hiatal hernia repairs (3.6%) had post-operative dysphagia. Tolboom et al. found 2 patients out of 30 (6.7%) in the conventional laparoscopic group and 5 patients out of 45 (11.1%) in the robotic-assisted group had dysphagia as a post-operative complication.

Intensive Care Unit Utilization. This study demonstrated a trend for conventional laparoscopic hiatal hernia repair to have a higher number of ICU days (5 vs. 2 days; p = 0.095); although the proportion of ICU admissions trended to be higher for the robotic-assisted group (31.3% vs. 11.9%; p = 0.119). In contrast, Soliman et al. showed a trend for laparoscopic hiatal hernia repair patients to have higher initial ICU admissions compared to robotic-assisted repair patients (7/151 vs. 2/142 = 4.6% vs. 1.4%; p = 0.17). However, both our findings and that of Soliman et al. were nonsignificant trends. Ward et al. demonstrated a statistically significant difference in the number of post-operative respiratory failure events, favoring the conventional laparoscopic group (1.6% vs. 2.4%; p = 0.003). However, this study did not define what the post-operative complication of respiratory failure included (e.g., home oxygen, ICU admission, mechanical ventilation).

Mortality. Similar to the studies by Tolboom et al. and Soliman et al., there were no deaths in hiatal hernia repair patients in either the laparoscopic or robotic groups. Vasudevan et al. had one reported death in the immediate post-operative period out of 28 patients undergoing robotic-assisted hiatal hernia repair. The retrospective study by Ward et al. demonstrated a trend for the robotic-assisted group to have a higher rate of mortality (0.4% vs. 0.3%; p = 0.08). Overall, the complication rates for both conventional laparoscopic and robotic-assisted hiatal hernia repair in the literature are very low, which was similar to the findings in our study.

Limitations. There were several limitations to this study. This study was performed at a single tertiary-care, Midwestern hospital over a three year time period, from January 2014 to December 2016, with a limited sample size. While robotic surgery was becoming more popular during this time, the application of robotic surgery has increased drastically since this time. Increasing the time frame for data collection to include more recent years would increase the sample size and power of this study. Also, adding additional institutions to the study would increase sample size and power. Another limitation encountered during data collection was that the single institution reviewed in this study had switched electronic medical records during the year 2014. This caused some of the patient data in the early parts of 2014 to be lost/missing during the conversion, and these patients had to be excluded from the study as details surrounding the operations and post-operative courses were unable to be located.

Another limitation of this study was that it did not differentiate elective, urgent, or emergent hiatal hernia repairs. During data collection, there was a trend for more of the urgent/emergent procedures to undergo open repair from the start of the operation, which excluded these from this study. There also seemed to be a trend that laparoscopic hiatal hernia repair was more common in urgent repairs for gastric volvulus, which likely contributed to the trend for the conventional laparoscopic group to have a higher number of ICU days (5.4 vs. 2.4 days; p = 0.095). Limiting the data collection to elective hiatal hernia repairs for GERD (done on day of admission and excluding repairs done for gastric volvulus) likely would make the two groups more equal and standardized.

CONCLUSIONS

Robotic-assisted versus conventional laparoscopic hiatal hernia repairs were compared, which demonstrated comparable post-operative complication rates and hospital LOS. The results showed robotic-assisted or conventional laparoscopic hiatal hernia repair can be performed safely with similar outcomes. Further study is needed to illicit any statistically significant differences between the two groups.

REFERENCES


Keywords: gastroesophageal reflux disease, hiatal hernia, robotic surgical procedures, laparoscopic surgical procedures, postoperative complications
Debridement Versus Simple Scrubbing of External Fixator Pin Sites

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Department of Orthopedic Surgery

ABSTRACT

INTRODUCTION

Methods. This single center retrospective cohort study was performed at a university level I trauma center. All cases in which a single surgeon removed an external fixator and followed this with definitive open reduction and internal fixation (ORIF) in the same operative setting between October 2007 and October 2018 were reviewed. A total of 313 patients were temporized in 334 external fixators prior to ORIF and were included in the study.

Results. Eighteen of the 179 Irrigation and Debridement cohort (10.0%) and 8 of the 155 Simple Scrubbing cohort (5.2%) had infections that required a return to the operating room. No statistical difference (p = 0.10) or meaningful effect size (Cohen’s d = 0.18) were found between irrigation and debridement and simple scrubbing of external fixator pin sites.

Conclusions. Given no significant differences were found in deep infection rates between debridement of pin sites versus simply scrubbing, it is reasonable to ask whether the time and resources required for debriding external fixator pin sites is worthwhile.


METHODS

This was a retrospective chart review of all patients who underwent external fixator removal by an individual fellowship-trained traumatologist at an academic level I trauma center. Definitive fracture fixation was performed with plates, screws, intramedullary nails, or a combination thereof. When these implants intercrossed with external fixator pin sites, infection was observed in all cases unless debridement of the pin sites occurred prior to internal fixation. Furthermore, neither study made mention of whether the pin sites were debrided at the time of definitive internal fixation versus prior removal. Furthermore, neither study demonstrated a method to prevent clinically significant deep infection when internal fixation is placed in an external fixator undergoing internal fixation, other than only overlapping pin sites with the fracture implants.²

Finally, in an animal model of infected external fixator pin sites in which intramedullary nailing was performed after pin sites were inoculated with staphylococcus, infection was observed in all cases unless debridement of the pin sites occurred prior to internal fixation.² Although this was an animal study, it demonstrated a very clear link between infected external fixator pin sites with overlap of fracture implants by the development of subsequent deep infection, with the same bacteria used to inoculate the pin site. In addition, this study also demonstrated a method to prevent clinically significant deep infection when internal fixation is placed in the face of a pin site infection. In this study, pin sites were debrided mechanically and irrigated prior to performing the surgical procedure in addition to the administration of antibiotics. This regimen was found to prevent the development of clinically significant infection following the placement of internal fixation.

Currently, some surgeons will debride external fixator pin sites mechanically when removal of the external fixator is followed by internal fixation of the fracture in the same operative setting. The rationale for performing this mechanical debridement of the external fixator pin sites is to decrease the risk of post-operative infection. However, to our knowledge, this procedure has never been substantiated in a clinical study. In this study, it was hypothesized that sharply debriding (DB) external fixator pin sites compared to simply scrubbing (SS) external fixator pin sites prior to performing definitive internal fixation will result in no significant difference in surgical site infection.
combination of devices. After approval from the associated University Institutional Review Board, all surgical cases for which the CPT® billing code for the removal of external fixation system under anesthesia was billed for were reviewed to ensure they met the inclusion criteria. A manual chart review was performed to collect patient information including age, sex, body mass index (BMI), fracture status, duration in external fixator device, management of external fixator pin sites, and presence of a deep infection requiring return to the operating room for surgical debridement. The HERON data query tool was utilized to cross reference patient medical records of included study participants to collect patient status with regards to diabetes mellitus diagnosis and current smoking status.8

The period for this study spanned 11 years, including all cases from October 2007 to October 2018. This period was chosen as it would include all cases performed by one surgeon at this center after he completed his orthopedic trauma fellowship training. The October 2018 stop date was chosen as it allowed for appropriate patient follow-up prior to data collection and analysis. The following pin site care regimen was utilized in the respective time frame to determine whether debridement or scrubbing affected infection:

- Pin site debridement was the mainstay of practice from October 2007 to January 2013.
- From February 2013 to December 2014, there was a similar number of cases of both debridement and simple scrubbing.
- From January 2015 to October 2018, when the study was concluded scrubbing had become the treatment of choice.

Inclusion criteria included all patients over the age 12 where an external fixator was removed immediately prior to definitive internal fixation of a fracture in the same operative setting. Patients with the following fractures were included in this study: radius, ulna, humerus, pelvis, femur, tibia, fibula. For a patient to be included in this study, the infection required a return to the operating room for treatment.

Exclusion criteria included known bone or deep tissue infection prior to external fixator placement, age under 12 years old, those not receiving definitive internal fixation at the time of external fixator removal, the treatment of non-unions and mal-unions, and inadequate follow-up. Reasons for not receiving definitive internal fixation at time of external fixator removal included risk to patient, patient refusal of definitive surgery, a fracture that had healed satisfactorily in the external fixator, amputation, death, and external fixator use in the treatment of vascular, soft tissue, and other ligamentous injury not requiring reconstruction of a fracture. All patients that were included in the study were followed for at least 12 months after the removal of their external fixator and performance of definitive internal fixation.

**Surgical Technique.** For both sharp debridement and simple scrubbing of external fixator pin sites protocols were developed as described below.

The removal of the external fixator was performed the same for each technique. The patient’s limb was marked prior to entering the operating room. Once in the operating room, anesthesia was induced and patients were administered perioperative antibiotics within 30 minutes of incision. The external fixator was removed by cutting the pins with a bolt cutter or deconstructing the external fixator with wrenches. The external fixator pins within the bone were removed with a t-handle chuck. From this point, the external fixator pin sites were managed in one of two ways: sharp debridement or scrubbing.

**Sharp Debridement.** The patient’s limb was scrubbed with chlorhexidine and rinsed with sterile normal saline. Next, a sterile curette was used to sharply debride the pin tracts. The skin, subcutaneous tissue, muscle, and bone were debrided until only healthy bleeding tissue remained. The tracts were irrigated using a 60 cc syringe of sterile normal saline with an 18 gauge angiocatheter attached to the end that was inserted into the depth of the external fixator pin sites. After at least 1 L of normal saline had been placed through the external fixator pin sites, the limb was prepped and draped in sterile fashion for definitive internal fixation.

**Scrubbing.** The limb and skin over the pin sites were scrubbed with a chlorhexidine scrub-brush and rinsed with sterile saline. Then, the limb was prepped and draped in sterile fashion, followed by open reduction and internal fixation of the fracture.

**Statistical Analysis.** All statistical analyses were calculated and/or confirmed by a consulting statistician. Patient demographics between the two pin site management techniques were described with means and standard deviation. Student t-tests were used to compare contiguous variables including age, BMI, and duration in an external fixator. Categorical variables including patient sex, smoking status, diabetes mellitus, and whether a fracture was open or closed were compared with a chi-square test. Sex, age, open versus closed nature of fracture, BMI, smoking status, diabetes mellitus, and duration of time in external fixation were considered as possible confounders between the techniques. To isolate the impact of pin site management on the outcome of interest, which was deep post-operative surgical site infections that required surgical debridement, the previously stated demographics were compared using a chi-squared test to determine if there was a statistically significant difference between the interventions, and a Cohen’s d effect size was calculated to determine if the magnitude of the difference was meaningful for analysis purposes. A statistical difference was a p value < 0.05. The Cohen’s d effect size was interpreted using the traditional stratification of Small 0.2, Medium 0.5, and Large 0.8.

**RESULTS**

There were 472 external fixators removed from 444 patients during the date range of our chart review. A total of 335 external fixators on 316 patients met the inclusion criteria of our review and are presented in the results. Polytrauma patients with more than one injury requiring external fixation were included in this study. Furthermore, all infections recorded in this study were deep tissue infections. To account for them accurately, all external fixation devices were considered independent cases, as they were managed as separate injuries. Sharp debridement of pin sites to the bone was performed for 179 external fixators on 171 patients. Scrubbing of the surgical site with chlorhexidine was performed for 156 external fixators on 145 patients. Table 1 compares general demographics of the populations, including some comorbid...
conditions between the two groups that are known to increase the risk of infection.9

Table 1. Demographics of all included patients.

<table>
<thead>
<tr>
<th>Variable</th>
<th>DB (n = 179)</th>
<th>SS (n = 155)</th>
<th>p Value</th>
<th>Cohen's d</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, Years, Mean</td>
<td>45.2 (16-87, 14.3)</td>
<td>45.0 (14-84, 16.0)</td>
<td>0.93</td>
<td>0.18</td>
</tr>
<tr>
<td>BMI, kg/m², Mean</td>
<td>30.2 (19-55, 7.5)</td>
<td>29.9 (16.7-66.7, 8.9)</td>
<td>0.71</td>
<td>0.01</td>
</tr>
<tr>
<td>Diabetes Mellitus, %</td>
<td>16.2%</td>
<td>14.2%</td>
<td>0.61</td>
<td>0.18</td>
</tr>
<tr>
<td>Duration in external fixator, days, Mean (Range, SD)</td>
<td>17.6 (1-74, 11.5)</td>
<td>18.8 (1-64, 11.9)</td>
<td>0.34</td>
<td>0.01</td>
</tr>
<tr>
<td>Open fracture, %</td>
<td>32.4%</td>
<td>25.8%</td>
<td>0.19</td>
<td>0.18</td>
</tr>
<tr>
<td>Sex, Female, %</td>
<td>38.5%</td>
<td>38.1%</td>
<td>0.93</td>
<td>0.01</td>
</tr>
<tr>
<td>Smoking history, %</td>
<td>55.9%</td>
<td>45.8%</td>
<td>0.22</td>
<td>0.18</td>
</tr>
</tbody>
</table>

When comparing the demographics of the two groups of patients, no statistical differences were detected in the age of participants, sex of participant, BMI, open versus closed, or duration in external fixator. This lack of statistical difference supported the assumption that the two groups were composed of comparable populations and eliminated some sources of confounding. Table 2 displays the frequency of deep infections that required return to the operating room. Table 3 shows infection information.

Table 3. Infection information.

<table>
<thead>
<tr>
<th>Variable</th>
<th>DB (n = 18)</th>
<th>SS (n = 8)</th>
<th>p Value</th>
<th>Cohen's d</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex at birth, Males/Females</td>
<td>11/9</td>
<td>6/2</td>
<td>0.10</td>
<td>0.18</td>
</tr>
<tr>
<td>Age of patients in years, Mean (SD)</td>
<td>42.4 (14.1)</td>
<td>47.1 (13.4)</td>
<td>0.71</td>
<td>0.18</td>
</tr>
<tr>
<td>Duration of external fixator prior to infection in days, Mean (SD)</td>
<td>21.1 (16.8)</td>
<td>21.5 (11.8)</td>
<td>0.93</td>
<td>0.18</td>
</tr>
<tr>
<td>Status of fracture, Open/Closed</td>
<td>7/11</td>
<td>3/5</td>
<td>0.10</td>
<td>0.18</td>
</tr>
<tr>
<td>Body Mass Index in kg/m², Mean (SD)</td>
<td>30.3 (79)</td>
<td>27.7 (2.5)</td>
<td>0.10</td>
<td>0.18</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Variable</th>
<th>DB (n = 18)</th>
<th>SS (n = 8)</th>
<th>p Value</th>
<th>Cohen's d</th>
</tr>
</thead>
<tbody>
<tr>
<td>Methicillin Sensitive Staphylococcus Aureus (MSSA), n (%)</td>
<td>1 (5.6%)</td>
<td>1 (12.5%)</td>
<td>0.10</td>
<td>0.18</td>
</tr>
<tr>
<td>Methicillin Resistant Staphylococcus Aureus (MRSA), n (%)</td>
<td>0</td>
<td>2 (25%)</td>
<td>0.10</td>
<td>0.18</td>
</tr>
<tr>
<td>Coagulate Negative Staphylococcus species, n (%)</td>
<td>7 (38.8%)</td>
<td>2 (25%)</td>
<td>0.10</td>
<td>0.18</td>
</tr>
<tr>
<td>Multiple bacteria grow on culture, n (%)</td>
<td>5 (27.8%)</td>
<td>1 (12.5%)</td>
<td>0.10</td>
<td>0.18</td>
</tr>
<tr>
<td>No growth appreciated on culture, n (%)</td>
<td>5 (27.8%)</td>
<td>2 (25%)</td>
<td>0.10</td>
<td>0.18</td>
</tr>
</tbody>
</table>

Abbreviations: DB, Irrigation and Debridement; SS, Simple Scrubbing; SD, Standard Deviation

**DISCUSSION**

In this retrospective cohort study, cases performed by an individual, fellowship trained, orthopedic traumatologist over more than a decade were reviewed. After data analysis, no significant difference in the rate of deep surgical site infection requiring return to the operating room was found between the two groups.

Research surrounding the management of external fixators and the care of patients temporized in an external fixator for the purpose of eventually performing internal fixation was incomplete. Ideal pin site dressings, pin care, management of pin crusts, types of pins implanted, and location of pins in relation to likely locations where definitive internal fixation will be placed have been studied.\(^7\) 8-11 The information yielded was beneficial to the decision making process in managing patients with external fixators.

To our knowledge, there are no studies in humans examining the best method to prepare external fixator pin sites when internal fixation is performed in the same operative setting as removal of the external fixator. This conclusion was reached after a thorough review of the literature.

As mentioned, an animal study by Clasper et al.\(^7\) demonstrated a decreased rate of infection when debridement was performed on infected external fixator pin sites prior to intramedullary nailing. In this study, *Staphylococcus aureus* was used to infect the external fixator pin sites two weeks prior to intramedullary nailing of a tibia in an ovine model. This resulted in widespread infection in the control group, while the treatment group with debrided pin sites and administered antibiotics, for the most part, healed without clinical infection. It was difficult to
conclude from this study how much debridement of the external fixator pin sites contributed to the lack of clinical infection because local and systemic antibiotics also were administered to the treatment group but not in the control group.

In this current study, we attempted to determine if the debridement technique used to decrease surgical site infection in the Clasper et al. model could be repeated in humans. Debridement of external fixator pin sites prior to definitive internal fixation is practiced by a number of orthopedic surgeons, with some of the rationale for doing so based upon extrapolations from the ovine model. Indeed, when the surgeon (AH) inquired in his trauma fellowship why external fixator pin sites were debrided prior to placement of internal fixation, he was referred to the Clasper study. There were some major differences between the Clasper et al. model and our study. However, it was reasonable to conduct this study, because the manner in which external fixator pin sites were debrided, prior to internal fixation, in our study, was the manner in which the Clasper study has been translated into clinical practice by a number of surgeons.

In this study, the null hypothesis that there would be no difference in deep infection rates between patients that had debrided pin sites versus simple scrubbing was upheld. However, because this was a retrospective study that evaluated a limited number of parameters, there are a number of factors which could have resulted in a type 2 statistical error, which needs to be discussed.

The lack of statistically significant infection rates between the two groups may be explained by the relatively small sample size of this study. Therefore, caution must be applied when interpreting these study results. In addition, the patients were all treated by an independent surgeon spanning the course of his career from immediately after graduating trauma fellowship to 11 years into his career. Surgeon experience has been demonstrated to effect a number of parameters in orthopedic surgery. It was possible the effect of gained experience by this surgeon could have resulted in a decrease in surgical site infection rate over time. This possible decrease in infection rate due to experience could have negated any small increased risk of infection that may have been present with simply scrubbing the external fixator pin sites, as this was the method of pin site preparation during the surgeons most experienced years of this study.

In light of this, a more appropriate conclusion to this study would be that simple scrubbing of external fixator pin sites, prior to performing definitive internal fixation, performed by an experienced traumatologist (i.e., greater than six years of experience) demonstrated no difference in deep post-operative infection rates when compared to patients treated by sharp debridement of their external fixator pin sites, prior to definitive internal fixation, performed by a less experienced traumatologist (i.e., less than six years). One might conclude from this study that if the difference of post-operative deep infection between simple scrubbing versus debridement was so small that it can be overcome by experience, it would be better to invest time and resources in training that more quickly brings junior surgeons up to an experienced level.

Other issues that could have affected the outcome of this study that were not analyzed included the socioeconomic status of the patient, education level, race, workers compensation status, discharge home versus to a rehabilitation or skilled nursing facility, presence of active psychiatric issues, and whether the initial external fixator was placed by the surgeon performing definitive internal fixation.

CONCLUSIONS

Based on these results, irrigation and debridement of external fixator pin sites prior to definitive internal fixation in the same operative setting did not result in a decreased rate of deep surgical site infection requiring re-operation compared to simply scrubbing with a chlorhexidine scrub brush. Surgeons should decide based upon this information, if it is worth the extra time, expense, and effort to perform debridement of external fixator pin sites prior to definitive internal fixation.

REFERENCES


Keywords: bone fracture, external fixation device, surgical site infection, orthopedics
Variations in Postpartum Opioid Prescribing Practices among Obstetrician-Gynecologists

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2Office of Research
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4Department of Obstetrics and Gynecology
5Newton Medical Center, Newton, KS

ABSTRACT

Introduction. There have been many efforts to combat the United States opioid crisis that has been occurring for the past two decades, specifically with postpartum patients that often were prescribed opioids. Prior studies described how accounting for usage of inpatient opioids on the day prior to discharge had an impact on how much discharge opioids were prescribed on the day of discharge. These studies provided a guideline to use the inpatient opioid amount from the day before discharge to determine discharge opioid quantity and minimize how much was being prescribed. In July 2018, the American College of Obstetricians and Gynecologists (ACOG) published Committee Opinion 742, guidelines for obstetricians-gynecologists about postpartum pain management. Prescription pain medications (including opioids, if necessary) require a shared decision-making approach between the physician and patient to determine the medication type and quantity. This study aimed to determine if there were differences in prescribing practices based on the specific post-operative day that opioid prescriptions were written, and if there were differences in the prescribing practices for cesarean deliveries following the publication of ACOG Committee Opinion 742.

Methods. This retrospective chart review included patients who had a live cesarean birth at one rural Midwest facility anytime between July 1, 2017 and February 28, 2021. This study excluded those with chorioamnionitis and those discharged after more than four days. Opioid amounts were converted to oral morphine milligram equivalents (MME) for comparison, and total MME was calculated for each prescription. Patients were stratified into two groups based on the day that their discharge opioid medication prescriptions were written (i.e., a day prior to discharge or the day of discharge). Patients were also stratified based on date of delivery, before or after the publication of ACOG Committee Opinion 742.

Results. Of 411 cesarean patients, 93.9% (n = 386) had opioids prescribed at discharge, 86% (n = 330) of whom received a prescription written on the day of discharge. There was no difference in the quantity of MMEs, doses per day, or dosage from discharge prescriptions between those written on the day of discharge and those written on a prior day. Patients whose deliveries occurred after the publication of ACOG Committee Opinion 742 (63.9%, n = 263) received discharge prescriptions with fewer average MMEs (159.53 ± 61.64) than those whose deliveries occurred before the publication (36.9%, n = 148; 187.35 ± 53.42; \( \chi^2 \) (1, N = 411) = 17.71; p < 0.001), and they were prescribed fewer doses per day.

Conclusions. After cesarean sections, the specific post-operative day did not seem to impact the prescribing trends as there were no differences in MMEs, doses per day, or dosage between prescriptions that were written on the day of discharge and before the day of discharge. Patients whose deliveries occurred after the publication of ACOG Committee Opinion 742 received discharge prescriptions with fewer MMEs, fewer doses per day, and the same dosage than those whose deliveries occurred before the publication, reflecting the overall national trend of decreasing prescription opioids over these years.

INTRODUCTION

From 1999 to 2019, there was a four-fold increase in the number of drug overdose deaths in the U.S., with prescription opioid overdose accounting for 247,000 deaths.1 The quantity of opioids prescribed per patient (determined through morphine milligram equivalents (MMEs)) was approximately three times higher in 2015 than the MMEs prescribed in 1999.2 The overall rate of opioid prescriptions peaked at 81.3 prescriptions per 100 patients in 2012, stabilized at 70.6 prescriptions per 100 patients from 2015 through 2017, and has decreased more since then, at 43.3 prescription per 100 patients in 2020.3

Although postpartum cesarean and vaginal delivery patients often were prescribed opioids, patients with cesarean deliveries more commonly were prescribed discharge opioid prescriptions.4 However, there was a lack of standardization regarding the quantity of opioids prescribed for cesarean or vaginal deliveries,4,6 the quantities did not always correlate with postpartum patient’s measures of pain,4 and patients often were prescribed more opioids than what was consumed.5,6

Prior studies have described the quantity of discharge opioid prescriptions written on the day of discharge and evaluated if accounting for the usage of inpatient opioids on the day prior to discharge had an impact on how much was prescribed.7,8 Hill and colleagues suggested that home post-discharge opioid use was best predicted by usage of inpatient opioids the day before discharge, and suggested a guideline to use the inpatient opioid amount from the day before discharge to determine discharge opioid quantity and minimize how much is being prescribed.7 Schwab and colleagues implemented a protocol that eliminated patient-controlled analgesia on the days prior to discharge and found that patients continued to be prescribed excess opioids at discharge compared to inpatient opioid use the day prior to discharge.8 However, it was unknown if the day that the discharge prescriptions were written, which can be on the day of discharge or an earlier postoperative day, led to a difference in prescribing practices for discharge opioid medications after cesarean deliveries.

In an effort to combat the opioid crisis, the American College of Obstetricians and Gynecologists (ACOG) published a Committee Opinion in July 2018 with guidelines for obstetricians-gynecologists about postpartum pain management.9 While there is varying information on what
might reduce overprescribing opioids, ACOG Committee Opinion 742 described that prescription pain medications (including opioids, if necessary) required a shared decision-making approach between the physician and patient to determine which type of medication and the appropriate quantity to prescribe.9

Therefore, this study sought to determine if patients with caesarean deliveries received different prescribing practices based on the day that discharge opioid medications were written, relative to the day of discharge. This study also sought to determine if patients with caesarean deliveries that occurred before the publication of ACOG Committee Opinion 742 experienced a change in opioid prescriptions compared to those whose deliveries occurred after the publication. Specifically, this study sought to determine if the publication contributed to a change in the type and quantity of MMEs.

**METHODS**

**Participants.** Eligible patients had a live birth via cesarean anytime between July 1, 2017 and February 28, 2021 and received care in a specific rural community hospital. Patients were identified through the medical records at Newton Medical Center in Newton, KS through DRG codes (783, 784, 786, 787, 785, or 788) for all types of caesarean deliveries. Patients eligible for this study delivered newborns at Newton Medical Center with APGAR (Appearance, Pulse, Grimace, Activity, and Respiration) scores that were greater than zero at one minute. Patients were excluded from this study if they were diagnosed with chorioamnionitis or discharged post-operatively after more than four days.

**Instrument.** The primary outcome for this study was the discharge prescription’s morphine milligram equivalents (MMEs). The independent variables included the date of the written postpartum opioid prescription (day of discharge or prior to day of discharge) and date of delivery (if it occurred before or after the publication of ACOG Committee Opinion 742). Possible confounding variables included previous narcotic use, type of cesarean, and type of anesthesia.10

The data abstracted from each patient’s medical records included demographics (e.g., name, race, ethnicity, date of birth), maternal history (e.g., smoking status, diabetes, past opioid use), delivery information (e.g., first or repeat cesarean, anesthesia type, date, time), and infant information (e.g., gestational age, APGAR score). Discharge information (e.g., date, time) and opioid medication information (e.g., prescription type, dose, date prescription written) also were abstracted from patient charts.

Opioids were converted to oral MMEs to compare the different types of opioids.11 The total MME of each prescription was calculated by using an opioid conversion factor, based on the strength of each opioid, and multiplying it by the dose and the number of tablets in the prescription. For example, oxycodone is a stronger opioid than hydrocodone, so it had a 1.5 conversion factor when converting to MME, whereas hydromorphone had a conversion factor of 1.

**Procedures.** This project was approved by the Institutional Review Boards at the University of Kansas Medical Center and Newton Medical Center. Patient charts that met study criteria were abstracted into a Research Electronic Data Capture (REDCap®) database hosted at the University of Kansas School of Medicine.12

Patients were stratified into two groups based on if physicians wrote their discharge opioid medication on the day of discharge or if it was written on a day prior to discharge. Patients also were stratified into two additional groups based on their date of delivery, with reference to the publication of ACOG Committee Opinion 742. Patients who had their caesarean delivery from July 1, 2017 through July 1, 2018 were categorized as having delivered “before the ACOG publication”, and patients who had their caesarean delivery from July 2, 2018 through February 28, 2021 were categorized as having delivered “after the ACOG publication”.

**Statistical Analysis.** Data were analyzed using SAS version 9.4 (SAS Int. Inc., Cary, NC). Means and standard deviations (or medians and interquartile ranges) were reported for continuous variables; counts and percentages were reported for categorical variables. Likelihood ratio chi-square and Fisher’s exact tests were for 2*2 and r*c contingency tables to test the association and agreement for the categorical and nominal variables. Based on the distribution of the quantity of opioid medication, a robust regression approach was used to test the relationship between the quantity of MME prescribed and if it was prescribed on the day of discharge or prior to the day of discharge, as well as if it was before or after the publication of ACOG Committee Opinion 742. For modeling the relationship between number of pills and the predictor variable, negative binomial regression model was utilized. Goodness of fit criteria such as Akaike and Bayesian Information criteria were used to identify the approach that better fits for the model between outcome and predictor variables. All statistical tests at \( p \leq 0.05 \) were considered significant.

**RESULTS**

In total, 411 patient charts were reviewed for this study, and all met inclusion and exclusion criteria. The ages of the patients ranged from 15 to 43 years, with a mean patient age of 28 years (SD = 5.0). Most of the population was White (95.1%, \( n = 391; \) Table 1). Sixty-nine percent (\( n = 286/411 \)) of patients had a history of past pregnancies prior to the current cesarean delivery. For approximately half of the patients (52.8%, \( n = 217/411 \)), this was a repeat cesarean delivery. Nearly two-thirds of the patients had a history of past opioid use (64.2%, \( n = 264/411 \)). Most patients (63.5%, \( n = 269/411 \)) had a spinal block anesthesia, 67.3% of whom (\( n = 181/269 \)) had Duramorph® (morphine sulfate injection) as part of their anesthesia plan. The average body mass index for patients was 35.21 and the average gestational age was 38.66 weeks. There were no significant differences in demographic or clinical characteristics before or after the publication of ACOG Committee Opinion 742.
<table>
<thead>
<tr>
<th></th>
<th>All Patients</th>
<th>Before ACOG Publication</th>
<th>After ACOG Publication</th>
<th>p Value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total</strong></td>
<td>411 (100.0%)</td>
<td>148 (36.0%)</td>
<td>263 (64.0%)</td>
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<tr>
<td><strong>Ethnicity</strong></td>
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<td>0.562</td>
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<tr>
<td>Hispanic or Latino</td>
<td>43 (10.5%)</td>
<td>16 (10.8%)</td>
<td>27 (10.3%)</td>
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</tr>
<tr>
<td>Not Hispanic or Latino</td>
<td>358 (87.1%)</td>
<td>130 (87.9%)</td>
<td>228 (86.7%)</td>
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</tr>
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<td>Unknown/not reported</td>
<td>10 (2.4%)</td>
<td>2 (1.4%)</td>
<td>8 (3.0%)</td>
<td></td>
</tr>
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<td><strong>Race</strong></td>
<td></td>
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</tr>
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<td>Asian American</td>
<td>3 (0.7%)</td>
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<td>1 (0.4%)</td>
<td></td>
</tr>
<tr>
<td>Native Hawaiian or Other Pacific Islander</td>
<td>1 (0.2%)</td>
<td>1 (0.7%)</td>
<td>0 (0.0%)</td>
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<tr>
<td>Black or African American</td>
<td>10 (2.4%)</td>
<td>4 (2.7%)</td>
<td>6 (2.3%)</td>
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<tr>
<td>White or Caucasian</td>
<td>391 (95.1%)</td>
<td>139 (93.9%)</td>
<td>252 (95.8%)</td>
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<td>Unknown/not reported</td>
<td>6 (1.5%)</td>
<td>2 (1.4%)</td>
<td>4 (1.5%)</td>
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<td><strong>Smoking status</strong></td>
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<td></td>
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<td>Never smoker</td>
<td>275 (66.9%)</td>
<td>95 (64.2%)</td>
<td>180 (68.4%)</td>
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<td>Current smoker</td>
<td>83 (20.2%)</td>
<td>29 (19.6%)</td>
<td>54 (20.5%)</td>
<td></td>
</tr>
<tr>
<td>Former smoker</td>
<td>52 (12.7%)</td>
<td>24 (16.2%)</td>
<td>28 (10.6%)</td>
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<td>Unknown/not recorded</td>
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<td>0 (0.0%)</td>
<td>1 (0.4%)</td>
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<td><strong>Diabetes status</strong></td>
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<td></td>
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<td>Type 1 diabetes</td>
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<td>4 (2.7%)</td>
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<td>Type 2 diabetes</td>
<td>3 (0.7%)</td>
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<td>1 (0.4%)</td>
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<tr>
<td>Gestational diabetes</td>
<td>39 (9.5%)</td>
<td>13 (8.8%)</td>
<td>26 (9.9%)</td>
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</tr>
<tr>
<td>No diabetes diagnosis</td>
<td>363 (88.3%)</td>
<td>129 (87.2%)</td>
<td>234 (89.0%)</td>
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<td><strong>Hypertension</strong></td>
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<td>No</td>
<td>382 (92.9%)</td>
<td>139 (93.9%)</td>
<td>243 (92.4%)</td>
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<tr>
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<td>29 (7.1%)</td>
<td>9 (6.1%)</td>
<td>20 (7.6%)</td>
<td></td>
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<td><strong>Chronic pain</strong></td>
<td></td>
<td></td>
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<td>No</td>
<td>401 (97.6%)</td>
<td>144 (97.3%)</td>
<td>257 (97.7%)</td>
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<td>Yes</td>
<td>10 (2.4%)</td>
<td>4 (2.7%)</td>
<td>6 (2.3%)</td>
<td></td>
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<tr>
<td><strong>Past opioid use</strong></td>
<td></td>
<td></td>
<td></td>
<td>&lt; 0.001</td>
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<td>No</td>
<td>147 (35.8%)</td>
<td>72 (48.7%)</td>
<td>75 (28.5%)</td>
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<tr>
<td>Yes</td>
<td>264 (64.2%)</td>
<td>76 (51.4%)</td>
<td>188 (71.5%)</td>
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<td><strong>Alcohol consumption during pregnancy</strong></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>No</td>
<td>347 (84.4%)</td>
<td>121 (81.8%)</td>
<td>226 (85.9%)</td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>43 (10.5%)</td>
<td>19 (12.8%)</td>
<td>24 (9.1%)</td>
<td></td>
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<td>Unknown</td>
<td>21 (5.1%)</td>
<td>8 (5.4%)</td>
<td>13 (4.9%)</td>
<td></td>
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<tr>
<td><strong>History of past pregnancy</strong></td>
<td></td>
<td></td>
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<td>0.373</td>
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<tr>
<td>No</td>
<td>125 (30.4%)</td>
<td>49 (33.1%)</td>
<td>76 (28.9%)</td>
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<tr>
<td>Yes</td>
<td>286 (69.6%)</td>
<td>99 (66.9%)</td>
<td>187 (71.1%)</td>
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<td><strong>First or repeat cesarean</strong></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>First</td>
<td>194 (47.2%)</td>
<td>73 (49.3%)</td>
<td>121 (46.0%)</td>
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<tr>
<td>Repeat</td>
<td>217 (52.8%)</td>
<td>75 (50.7%)</td>
<td>142 (54.0%)</td>
<td></td>
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<td><strong>Anesthesia type</strong></td>
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<td></td>
<td></td>
<td>0.293</td>
</tr>
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<td>Epidural</td>
<td>142 (34.6%)</td>
<td>56 (37.9%)</td>
<td>86 (32.7%)</td>
<td></td>
</tr>
<tr>
<td>Spinal</td>
<td>269 (65.5%)</td>
<td>92 (62.2%)</td>
<td>177 (67.3%)</td>
<td></td>
</tr>
</tbody>
</table>
Of the 411 patients included in this study, 93.9% (n = 386) had opioids prescribed to them at discharge, 85.5% of whom (n = 330) received a prescription that was written on the day of discharge (Table 2). The other 14.5% (n = 56) received a prescription that was written one or two days prior to discharge. The most common prescription type was hydrocodone (70.5%, n = 272), and the most common prescription dosage was 5 mg (94.6%, n = 360; Table 2). Most patients (82.1%, n = 317) received a prescription with instructions to take a dose up to six times per day (every four hours). The total MME ranged from 25 to 450, with a mean of 169.9 MME (SD = 60.15).

Differences in Outcomes in Reference to Publication of ACOG Committee Opinion 742. Patients whose caesarean deliveries occurred after the publication of the ACOG document (62.4%, n = 241) received prescriptions at discharge with fewer quantities of MMEs than for those who delivered before the publication (37.6%, n = 145; \( \chi^2(1, N = 411) = 17.71; p < 0.001; \) Figure 1). The average quantity of MME for the deliveries that occurred prior to the publication was 187.35 ± 53.42 MME, whereas the average quantity of MME for the deliveries that occurred after the publication was 159.53 ± 61.64 MME. However,
there was no difference in the type of opioid prescribed before compared to after the publication of ACOG Committee Opinion 742.

Figure 1. Differences in MME based on date of delivery: Before or After ACOG guidelines.

On average, patients whose deliveries occurred after ACOG Committee Opinion 742 was published received prescriptions at discharge with fewer doses per day than patients whose deliveries occurred before the publication ($\chi^2(1, N = 411) = 46.60; p < 0.001$). Nearly all (99.3%, $n = 144$) caesarean delivery patients who delivered before the publication received a prescription for opioid medication to be administered up to six times a day, whereas 71.8% of their post-publication counterparts ($n = 173$) received the same number of doses per day.

There was no difference in prescription dosage. The dosage was 5 mg for 94.5% of patients ($n = 137$) who delivered before the ACOG Committee Opinion 742 was published and 94.6% of patients ($n = 228$) who delivered after the publication. However, fewer discharge opioid prescriptions were written on the day of discharge (82.8%, $n = 120$) before the publication of ACOG Committee Opinion 742 than after the publication (87.1%, $n = 210$; $\chi^2(2, N = 386) = 5.65; p < 0.05$).

Outcomes of Patients with History of Opioid Use. Two incidental findings were found in this study in relation to patients with past opioid use. A significant difference was found in the proportion of patients who had a history of opioid use between those who delivered before (51.4%, $n = 76$) and after the publication of ACOG Committee Opinion 742 (71.8%, $n = 188$). Additionally, patients who previously used opioids (64.2%, $n = 264$) had a lower quantity of MMEs in their discharge prescription ($165.45 \pm 61.36$ MME) than those who did not have a history of opioid use (35.8%, $n = 147$; $177.95 \pm 59.06$ MME; $p = 0.05$; Figure 2).

DISCUSSION

This study indicated that 94% of patients who underwent caesarean deliveries were given a discharge opioid prescription. This was consistent with other studies, where 94% to 97% were prescribed discharge opioids after caesarean deliveries. However, the current study contributes to the literature due to its rural setting and population, whereas previous studies have been conducted in large medical centers with more patients and more diverse samples that may not reflect rural communities. The current study was unique in that it explored the discharge opioid prescribing patterns for patients with caesarean deliveries in relation to the day of hospital stay that the discharge prescription was written, as well as if the surgery occurred before or after the publication of ACOG Committee Opinion 742.

The current study suggested that the quantity of discharge prescription MMEs, dosage, and doses per day did not differ between those that were written on the day of discharge and those that were written on a day prior to discharge. This result aligned with other studies that suggested post-operative discharge medications may be planned ahead of time, based on a preoperative evaluation rather than being determined on the day of discharge. However, an interesting difference between the groups was the minimum and maximum values of prescription dosage. For those written prior to day of discharge, 100% of the prescriptions had a dosage of 5 mg, while the dosage for prescriptions written on the day of discharge ranged from 2 mg to 50 mg. Although the average dosages between the two groups did not have a significant difference, there may be some implication to this result based on the dosages. When writing prescriptions prior to day of discharge, pain evaluation was not factored, so physicians more likely used a standard order, and in this case, the 5 mg dosage, leading to less variability in prescribing practices. This was consistent with another study that
suggested that when utilizing a standard order set, there was less variability in the prescribing patterns of discharge opioid medications.16

This study suggested that greater MME quantities and doses per day were prescribed for patients with caesarean deliveries that occurred prior to the publication of ACOG Committee Opinion 742 than those that occurred after the publication. This difference may be due to the increased awareness of the national problem leading to more initiatives overall. ACOG Committee Opinion 742 highlighted the significance of the issue for physicians and provided suggestions for postpartum discharge opioid medications to aid in minimizing opioid quantity.

The differences in MME quantity can be attributed to consistent efforts to decrease opioid prescriptions from July 1, 2017 through February 28, 2021. The peak of opioid prescriptions occurred in 2012, but there has been a consistent annual decline, with fewer opioids prescribed each year.1 Due to the stratification in the current study having one group of patients from July 2017 through July 2018 and the other group from August 2018 through February 2021, the significant decrease in MME quantity was likely reflective of the national trend.

Additionally, around the time that the ACOG document was published, there were increased initiatives involving physician awareness, national guidance, and a push on how to minimize opioid quantity given the decades-long opioid epidemic. These included quality improvement projects by Baruch and colleagues7, Osmadson and colleagues8, Prabhu and colleagues9, and Lavand’homme9, which were all published in 2018. These studies described strategies to reduce opioid quantity post-caesarean deliveries to continue the decline of opioid prescriptions in the U.S.

Prior studies have examined physician adherence to ACOG recommendations, but there was a lack of consensus on the extent to which physicians adhere to guidelines. One study suggested that physicians strongly adhered to ACOG guidelines regarding prenatal practices21, whereas another study suggested that physicians were highly non-adherent to guidelines.22 Conflicting reports of physician adherence to past ACOG guidelines challenged the assumption that the dissemination of ACOG Committee Opinion 742 was the single reason for the significant change in opioid quantity.

Not only was past opioid use significantly associated with a decreased MME in discharge opioid prescriptions, but there was also a significantly greater number of patients with past opioid use among those that delivered after the publication of the ACOG document. This might provide evidence that more people were exposed to opioids than in the past and reflects the opioid crisis. Additionally, this suggested that more people were exposed to opioids over time and revealed the importance of having measures to minimize future opioid quantity within prescriptions.

Finally, this study suggested that there were more discharge opioid prescriptions being written prior to day of discharge (17%, n = 25) before the publication of ACOG Committee Opinion 742 than after the publication (13%, n = 31). This was important because it is another aspect of prescribing practices that significantly changed over time. Suggested guidelines from prior studies7, as well as suggestions from ACOG Committee Opinion 742, stated the need for accounting inpatient opioid use the day prior to discharge and shared decision making as a way to minimize discharge opioid quantity. Simply writing discharge prescriptions on the day of discharge rather than on an earlier day allowed for the opportunity to utilize those suggestions. Because this aspect of prescribing practices significantly changed over time, before and after the publication of the ACOG document, it could indicate an avenue to make further strides in combating the opioid crisis.

As of September 2021, ACOG withdrew the Committee Opinion 742 on Postpartum Pain Management and replaced it with ACOG Clinical Consensus No. 1 Pharmacologic Stepwise Multimodal Approach for Postpartum Pain Management.23 The information regarding recommendations for discharge opioid medications remained the same in the updated document. However, when reaching out to ACOG, the authors of the current study were not given the specifics as to why the ACOG Committee Opinion 742 was replaced.

**Future Studies.** Future studies can examine obstetrician-gynecologists from other clinics that look to ACOG for guidelines to determine if a similar change in MMEs occurred following the publication of the ACOG guidelines regarding opioid prescribing. This process could reinforce the idea that increased awareness, initiatives, and overall public eye on the opioid crisis around that time made a significant difference in prescribing practices. More specifically, future research needs to be conducted to explore if similar relationships are found with different patient populations, as the current study had a majority population of White patients in a rural setting.

Additionally, while the current study did not find a difference in opioid quantity for prescriptions written on the day of discharge compared to those written on a day prior to discharge, this could have been due simply to not having enough patients that had their prescriptions written prior to discharge. It could be valuable to have a future study with a longer timeframe to include more patients that had their discharge opioid prescriptions written on a day prior to discharge and observe if the results are different.

**Limitations.** One weakness in the current study was the lack of patient diversity. Although this may make the results less generalizable, having all patients from one clinic allowed the investigators to control for fewer differences in how caesarean procedures were performed, prenatal care, and overall hospital stay. Another limitation was the cutoff for the two groups of patients who had their caesarean deliveries before and after July 1, 2018, the day that ACOG Committee Opinion 742 was published. Distribution and practice changes might have taken some time, but the current study assumed that it could have all occurred on July 1, 2018. Finally, as this study was a retrospective chart review, this study was limited by missing data; however, most of the missing data came from demographic or patient characteristic information. All variables of interest were included in the medical records.

**CONCLUSIONS**

Cesarean patients who had their discharge prescriptions written on the day of discharge versus a day that was prior to discharge had no differences in MMEs, doses per day, or dosage in their prescriptions.
Patients whose deliveries occurred after the publication of ACOG Committee Opinion 742 received discharge prescriptions with fewer MMEs and fewer doses per day than those whose deliveries occurred before the publication. However, the opioid dosage remained the same in the two groups.

In our study group, there was not a significant difference in how much postpartum opioid prescriptions patients were receiving based on what point of their stay the prescription was written. However, there has been a trend in decreasing amount of postpartum opioids being prescribed overall, as evidenced by the decline before and after the ACOG Committee Opinoid 742 published in July 2018.

**REFERENCES**


Idiopathic Orbital Inflammation Underlying Drug-Associated Thyroid Eye Disease

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INTRODUCTION

Alemtuzumab has been reported to cause thyroid eye disease in approximately 30% of patients being treated for multiple sclerosis (MS).¹ Treatment of alemtuzumab-induced thyroid ophthalmopathy mimics Graves' ophthalmopathy regimen, whereas systemic symptoms frequently require thyroidectomy. While Graves' ophthalmoplegia is clinically common, ophthalmoplegia has a wide differential diagnosis, which often can be narrowed via imaging and, of potentially more importance, tissue analysis.² We present an unusual case where thyroid eye disease and idiopathic orbital inflammation co-occurred, resulting in a hazy clinical picture. The unique findings in the combined disease processes are underscored and outcomes of the patient's management are presented.

CASE REPORT

A 41-year-old female presented for evaluation and treatment of thyroid eye disease. Three years prior to presentation, she was treated for relapsing, remitting multiple sclerosis with alemtuzumab. Three months prior to presentation, she developed eye pain, pressure, and binocular diplopia. Review of systems was otherwise negative and family history was unremarkable. Her prior lab work was consistent with Graves' disease and an outside provider began treating her with selenium.

The exam showed 20/25 vision in both eyes, mildly elevated intraocular pressure (25 mmHg in the right eye, 21 mmHg in the left eye) and a 2+ afferent papillary defect in the left eye. Motility showed -1 deficit with left abduction. Hertel measurements were 19 mm in the right eye and 23 mm in the left eye. Slit lamp exam showed 1+ edema and erythema of both upper eyelids. There was 1+ injection of the conjunctiva and caruncle with 1+ chemosis in both eyes. The remainder of her exam was unremarkable.

Thyroid labs showed a thyroid stimulating hormone of 0.6 mIU/L, low free T4 0.02 ng/dL, elevated thyroid stimulating immunoglobulin 4.9 IU/L, and elevated thyroid receptor antibody 4.78 IU/L. Complete blood count, angiotensin converting enzyme, lysozyme, anti-nuclear antibodies, erythrocyte sedimentation rate, c-reactive protein, myeloperoxidase, and proteinase-3 antibody were within normal limits. IgG subclass 4 was low < 0.3 mg/dL. Computed tomography (CT) of the orbits without contrast showed moderate left greater than right infiltrative soft tissue thickening in the superior and lateral intraconal and extraconal orbits with less involvement in the inferior orbit. These findings were non-specific, but were not suggestive of thyroid eye disease. The patient underwent left orbitotomy with biopsy of the abnormal tissue. The biopsy showed focal lymphoplasmacytic infiltrate, chronic inflammatory infiltrate. The findings were suggestive of a reactive process. Immunoglobulin gene rearrangement was negative, excluding lymphoma.

Oncology and endocrine services were consulted for a lymphoplasmacytic mass, with a concern for lymphoma versus inflammatory mass with concurrent thyroid eye disease. At three-month follow-up, monitoring of Graves' clinical activity scores showed no changes from baseline. Humphrey visual field results were borderline with normal right eye results and non-specific left eye changes. Positron emission tomography (PET) scan showed hypermetabolic activity in the posterior orbits bilaterally corresponding to the region of soft tissue thickening. The PET scan was not concerning for systemic lymphoma. Response to high dose steroids was minimal.

The medical oncology service started a three-week course of rituximab, after which the patient developed worsening proptosis. Prednisone 60 mg resulted in moderate improvement of the proptosis. Follow-up CT two months later showed mild improvement of left muscle thickening. The patient's condition was complicated by active COVID-19 infection during rituximab infusions and severe headaches from vision changes. The oncology service pursued radiation treatment of bilateral extraocular muscles, which resulted in gradual, moderate improvement in double vision, ability to close the eyelids, and proptosis without full resolution.

The patient received 4 Gray in 2 fractions to the bilateral orbits. With the endocrine service suggesting that Graves' disease played a major role in her symptoms, the patient underwent a near-total thyroidectomy one-month later. One-month post-operation, she was clinically euthyroid and the thyroidectomy was unremarkable. She was awaiting retroorbital surgery for continued ocular symptoms, unresolved by thyroidectomy.

DISCUSSION

This case highlighted the similarities between idiopathic orbital inflammation and thyroid eye disease. The patient was presumed to have thyroid eye disease given the associations in the literature with alemtuzumab and lab work was consistent with Graves' disease.¹ However, imaging showed foci consistent with orbital inflammation rather than muscle enlargement seen with Graves' ophthalmopathy.³ Inflammatory workup was negative, as was gene rearrangement. Biopsy demonstrating chronic inflammation confirmed the diagnosis of idiopathic orbital inflammation.

This case emphasized the importance of maintaining a broad differential when evaluating patients with symptoms suggestive of thyroid eye disease. Orbital imaging and histopathological analysis remain important diagnostic steps in distinguishing thyroid eye disease from other inflammatory processes and determining treatment course. This was demonstrated by the decision to administer a lower radiation dose than what would be used typically to treat clear-cut Graves' exophthalmos,³ due to reduced suspicion of Graves' disease based on her imaging and tissue analysis.

Case reports describing eye diseases masquerading as Graves'...
ophthalmopathy can be found in the literature; however, only a few cases demonstrated idiopathic orbital inflammation and thyroid eye disease occurring concurrently. While clinicians frequently order imaging in these cases, imaging is often inconclusive. The risk of unnecessarily initiating thyroid disease treatment versus obtaining minimally invasive biopsies under local anesthesia must be considered in each case. Imaging combined with histopathologic analysis tends to efficiently narrow the differential and orient toward a more specific treatment. Relying on purely non-invasive analysis risks neglecting a secondary inflammatory condition, such as in this patient.

This report described an interesting case where the clinical picture of alemtuzumab-induced thyroid eye disease was disconcerted by an underlying idiopathic orbital inflammation. The two conditions frequently were compared throughout the literature with plentiful discussion of how to distinguish the two diseases. While labs were consistent with thyroid eye disease, imaging suggested idiopathic orbital inflammation, which was proven by biopsy. This resulted in a more reserved style of management, relative to standard thyroid eye disease management, by all consulted providers. This case serves as a reminder of the importance of histopathologic analysis in cases of complicated thyroid eye disease.

REFERENCES

Keywords: alemtuzumab, thyroid, lymphoma, eye abnormalities, Graves' disease
INTRODUCTION
Lung cancer is the leading cause of death related to cancer in the United States. Of the various types of lung cancer, the majority are non-small cell lung cancer (NSCLC). A significant number of patients that present with NSCLC have distant metastases at the time of diagnosis, however, only a small percentage have abdominal metastasis.1,2

Abdominal metastases are most often squamous cell carcinoma and can be found in the liver, adrenal glands, pancreas, spleen, kidneys, gastrointestinal (GI) tract, peritoneum, or abdominal lymph nodes.1,3 Metastases to the GI tract are rare with a prevalence rate of 0.5 - 14% and are often asymptomatic but can present with abdominal pain, intestinal obstruction, bloody stool, diarrhea, or intestinal perforation.4,5 Colon metastasis often is not diagnosed during life, with up to one-third diagnosed during an autopsy.2 We present a female with a history of Stage IV NSCLC diagnosed with sigmoid colon metastases after complaints of bright red blood per rectum.

CASE REPORT
A 63-year-old female with a past medical history of bilateral deep vein thrombosis, ischemic stroke with patent foramen ovale, and stage IV non-small cell lung carcinoma, presented with melena and bright red blood per rectum. She was diagnosed with NSCLC of the adenocarcinomatous type with metastasis to the brain and abdominal wall two years prior and had completed treatment of carboplatin, pemetrexed, and pembrolizumab, along with radiation to the brain, abdomen, and lung.

Upon admission, computed tomography (CT) showed an infiltrative lesion obstructing the right upper lobe bronchus consistent with the patient's NSCLC history, as well as increased mesenteric and retroperitoneal lymphadenopathy. A previous pancreatic head mass also was increased. A new enhancing 1.9 cm lesion in segment 5 of the right hepatic lobe was found along with a peripherally enhancing mass in the mid-sigmoid colon extending into the mesocolon (Figure 1). Colonoscopy revealed a 50% circumferential bleeding sigmoid mass 30 cm from the anal verge. The patient underwent sigmoid resection with palliative intent showing a 4.5 cm ulcerated mass with carcinoma extending the entire thickness of the bowel with extensive tumor necrosis and lymphovascular space involvement. Pathology revealed moderately to poorly differentiated adenocarcinoma with 30 of 32 lymph nodes positive for metastasis. Immunohistochemical staining showed positive for TTF-1, Napsin-a, and CK7, but negative for CK20 and CDX2 consistent with lung adenocarcinoma. Her post-operative course was uneventful, and the patient opted for hospice on discharge.

REFERENCES

Keywords: non-small-cell lung carcinoma, colon, metastasis, cancer screening
Acute Chest Pain in an Acute Complicated Pancreatitis with Severe Hypophosphatemia
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INTRODUCTION
Acute chest pain is the second most common cause of admission to the emergency department after trauma. Causes of chest pain vary and can be cardiac or noncardiac. Angina triggered by cardiac ischemia can indicate an acute coronary syndrome. Upon suspicion of acute coronary syndrome, risk stratification for cardiac ischemia dictates management. In this case, an episode of angina in a patient is presented in the setting of intravenous phosphate supplementation in acute severe complicated pancreatitis. This was a case of acute chest pain associated with sodium phosphate intravenous infusion in complicated acute pancreatitis associated with severe hypophosphatemia.

CASE REPORT
A 46-year-old male patient with no past cardiac history presented for severe abdominal pain. He had a past medical history of cholecystitis treated with laparoscopic cholecystectomy 12 days prior to presentation. One day prior to his presentation, he underwent an endoscopic retrograde cholangiopancreatography (ERCP). He developed epigastric pain one hour after ERCP. The pain was radiating to the back, progressively worsening, and associated with subjective shortness of breath, decreased oral intake, and nausea.

On physical examination, the patient was in distress. His abdomen was diffusely tender to palpation, with guarding but no rebound pain. Chest exam showed tachypnea with no abnormal breath sounds on auscultation. Otherwise, vital signs were normal. His lipase level was > 7500 U/L, and his abdominal computed tomography (CT) scan showed fat stranding around the pancreas suggestive of pancreatitis (Figure 1). Blood urea nitrogen and hematocrit levels were normal with values of 18 mg/dl and 43.9%, respectively. Accordingly, the patient was diagnosed with ERCP-induced pancreatitis.

The patient received medical management for pain, was given intravenous fluids, and kept from food or drink intake for bowel rest until he could tolerate oral intake. He began to develop severe hypocalcemia, mild hypomagnesemia, and severe hypophosphatemia with levels reaching 5.6 mg/dl, 1.5 mg/dl, and 0.9 mg/dl, respectively. Thus, oral and intravenous supplementation were initiated. An abdominal CT scan performed on day two showed acute pancreatitis with development of peripancreatic collection measuring approximately 8 cm anteroposterior, 11.7 cm transverse, and 4.5 cm craniocaudal interposed between the pancreas and stomach (Figure 2).

When 40 mmol of intravenous sodium phosphate was initiated at a rate of 250 ml/hour, the patient experienced pressure-like substernal chest pain and worsened tachycardia reaching 127 bpm, which did not resolve until intravenous infusion was stopped. An electrocardiogram showed sinus tachycardia and nonspecific ST and T wave changes (Figure 3). Troponin I levels were elevated, reaching 0.71 ng/ml. Chest x-ray showed moderate left and mild right pleural effusion. Calcium level was 6.9 mg/dl.

The patient’s angina in the presence of elevated cardiac enzymes prompted treatment with aspirin, 324 mg, and intravenous heparin drip. Troponin trended down afterwards, reaching 0.09 ng/mL. A repeat abdominal CT scan (Figure 4) showed increased peripancreatic and mesenteric inflammatory changes concerning for worsening pancreatitis, no evidence of pancreatic necrosis, and a peripancreatic fluid collection superior to the pancreas extending from the head/proximal body into the left upper quadrant measuring 16.7 x 6.9 x 11.3 cm.
continued.

Figure 3. Electrocardiogram shows sinus tachycardia and ST and T wave changes.

Figure 4. Abdominal CT scan shows pancreatitis and expanding peripancreatic fluid collection.

The hospital course continued without cardiac disease manifestation and electrolytes were replenished. Intravenous potassium phosphate was infused at a slower rate of 187.5 ml/hour to supplement phosphate without causing side effects, which may have been attributed to the phosphate infusion. Chest pain resolved soon after the initiation of treatment and was discharged home safely. The patient remained asymptomatic afterwards, but required further follow-up on complications secondary to his pancreatitis.

Echocardiogram performed one month later showed no myocardial wall abnormality, ejection fraction of 60-65%, and no pericardial effusion.

DISCUSSION

Acute pancreatitis is a very common gastrointestinal disease and can present with varying severity spanning from a mild disease requiring conservative management to severe disease associated with a worse prognosis. Management of acute pancreatitis includes early aggressive fluid resuscitation and pain management.

The pathophysiology of acute pancreatitis includes activation of trypsinogen into trypsin within the acinar cells upon increased ductal pressures and adenosine triphosphate depletion resulting in increased intra-acinar calcium concentration which activates zymogens. This leads to the destruction of pancreatic parenchyma and the release of Damage Associated Molecular Patterns (DAMPs) that activate neutrophils and trigger the inflammatory cascade responsible for the systemic manifestation of acute pancreatitis. As a result, increased capillary permeability and damage of the endothelium results along with microvascular thrombosis that leads to multiorgan dysfunction syndrome (MODS).

Electrolyte abnormalities associated with pancreatitis include hypocalcemia and hypomagnesemia. The pathophysiology is not clear but suggested to be secondary to pancreatic enzymes digesting peripancreatic fat, and thus releasing fatty acids that bind free calcium. However, severe hypophosphatemia (< 1 mg/dl) in acute pancreatitis rarely was mentioned in the literature, and when it was, it often was attributed to alcohol in alcohol-induced pancreatitis. Intravenous supplementation of phosphate in critically ill patients has been documented to be safe and efficacious. In general, causes of hypophosphatemia were inadequate phosphate intake, extracellular to intracellular space phosphate shift, and increased phosphate excretion. Severe hypophosphatemia rarely was mentioned in acute pancreatitis, and its management is not explained in this context.

Side effects of intravenous phosphate supplementation are limited to confusion, weakness, lightheadedness, nausea, chest pain, irregular cardiac rhythm, numbness or tingling in extremities, weakness, decreased heart rate, weak pulse, or decreased respiratory rate. It can result in hypocalcemia as the infused phosphate binds the free calcium. This can precipitate vasospasms or arrhythmias leading to decreased blood supply to the cardiac muscle and precipitate anginal symptoms.

We speculate that the angina that our patient experienced might have been precipitated by decreased cardiac blood and oxygen supply secondary to phosphate supplementation directly or due to iatrogenic transient hypocalcemia and resulting in hypotension or transient arrhythmia. Guidelines for the assessment of acute chest pain recently were published to guide management of similar episodes. Another study suggested several biomarkers to differentiate between type I myocardial infarction, type II myocardial infarction, and myocardial injury. This can lead to more accurate diagnoses and understanding of the underlying pathophysiology of cardiac chest pain in the future. Further studies also are needed to assess the mechanism and guide treatment of severe hypophosphatemia in patients with acute severe pancreatitis.

Limitations of our case report included the absence of a troponin level prior to the chest pain incident, which did not provide an accurate temporal relationship between enzyme elevation and the chest pain.

REFERENCES


Keywords: acute chest pain, pancreatitis, hypophosphatemia, case report
Dacryocystitis Involving *Parvimonas micra* and *Bacteroides thetaiotaomicron* Infection

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INTRODUCTION

Dacryocystitis is an inflammation of the nasolacrimal canals. The disease is most prevalent in pediatrics and individuals above 40 years of age, following a bimodal age distribution, with predilection for white or female populations.¹ Dacryocystitis commonly is caused by acute infection of a ductal obstruction and appears as an erythematous, tender, inflamed medial orbit. Treatment of infectious dacryocystitis involves warm compress and oral antibiotics.

Common infectious organisms involved in dacryocystitis include *Staphylococcus* spp., *Streptococcus* spp., *Haemophilus influenzae*, and *Pseudomonas aeruginosa*.¹ No known cases were reported in the medical literature of lacrimal duct infection by *Parvimonas micra*, a gram-positive organism native to the human gastrointestinal flora and associated with blood and oropharyngeal infections after dental procedures,² or *Bacteroides thetaiotaomicron*, a component of gastrointestinal flora and fecal matter.³

This case of dacryocystitis presented with cultures positive for *P. micra* and *B. thetaiotaomicron*. Whereas common infectious organisms implicated in dacryocystitis are aerobic, *P. micra* and *B. thetaiotaomicron* are anaerobes with unique pharmaceutical resistances. Currently, empiric treatment consists of oral antibiotics with gram positive and negative coverage, such as amoxicillin/clavulanate or clindamycin.¹ Awareness of these novel causative agents of dacryocystitis can help tailor empiric antibiotic therapies.

CASE REPORT

A 50-year-old Hispanic female presented to the emergency department with two days of severe eye pain, increased tearing, decreased vision, and foreign body sensation involving only the right eye. Past medical history was significant for diabetes mellitus type 2 with hyperglycemia, hyperlipidemia, obesity, and one month of diagnosed hypertension. She reported two previous episodes of similar symptoms in 1994 and 2001, for which there was no available documentation. In 2001, she required incision and drainage, followed by amoxicillin.

Physical exam revealed an injected right conjunctiva with purulent discharge and a right eye pressure of 35 mmHg, bilateral middle ear effusions, and swollen right and left turbinate. The left eye was unremarkable. The patient reported pain with right head turn and physical exam revealed palpable right cervical lymphadenopathy; her history was otherwise unremarkable. The patient denied tobacco, alcohol, or illicit substance use. Vancomycin 20 mg/kg IV was started. The ophthalmology service was consulted.

Slit lamp exam revealed periorbital edema and ecchymosis as well as induration inferior to the right medial canthus. Conjunctiva showed 1+ injection; otherwise, anterior segment exam was normal. Dilated fundus exam revealed symmetric cup to disc ratios of 0.8. Computed tomography of the head and neck with contrast revealed right dacryocystitis with surrounding pre-septal cellulitis with subtle stranding in the medial extraconal fat along the posterior aspect of the fluid collection.

The patient was diagnosed with dacryocystitis with subsequent spread to the orbit based on induration inferior to the right medial canthus, in addition to orbital cellulitis. Piperacillin/tazobactam was started when the patient was admitted to inpatient services. On inpatient day one, the infectious disease service recommended switching from vancomycin to linezolid 600 mg/D5W 300 mL IV due to worsening infection. Rigid endoscopy was negative for sinus disease or bony erosion, but revealed a superficial pre-septal abscess. On inpatient day two, the patient was brought to the operating room and swabs from the medial canthus were sent for culture. The patient underwent dacryocystorhinostomy with tube placement, during which the abscess was drained and sent for culture.

On post-operative day two following dacryocystorhinostomy, the patient’s pain improved, and the infection began showing signs of clearing. On post-operative day four, the cultures and susceptibilities returned. Anaerobic culture showed moderate growth of *B. thetaiotaomicron* and heavy growth of *P. micra* alongside heavy growth of additional mixed flora. Aerobic culture showed moderate growth of *Staphylococcus lugdunensis* and three colonies of *Staphylococcus epidermidis*. Piperacillin/tazobactam was switched to ampicillin/subbacitam 3 g in 100 mL IV piggyback. The patient was discharged post-operative day six on amoxicillin/clavulanate 875 mg twice daily.

DISCUSSION

No known cases in the literature depicted dacryocystitis caused by *P. micra* or *B. thetaiotaomicron*. However, Barnett et al.⁴ reported several panophthalmitis cases involving *P. micra* infection, demonstrating *P. micra* can infect tissue with anatomic proximity to the tear ducts. *P. micra* has been reported as an infective cause of chronic periodontitis, endocarditis, renal abscesses, and psosas abscesses.⁵,⁶ These reported findings were expected, given the organism is a normal part of gastrointestinal, oral, genital, and potentially skin flora.²,⁸ *Staphylococcus lugdunensis* and *Staphylococcus epidermidis*, the aerobic infecting agents present in our patient’s tear duct culture, are also components of normal skin flora and commonly implicated in nasolacrimal duct infections.⁹,¹⁰ Because *S. lugdunensis*, *S. epidermidis*, and *P. micra* are components of skin flora, it would be logical to assume skin flora may have entered the tear ducts. Furthermore, the patient owned a dog and allowed the dog to lick her face; hence oral flora could have entered the tear ducts through direct contact of the adnexa oculi to canine saliva, resulting in *P. micra* infection.¹¹

*B. thetaiotaomicron*, the other anaerobic infective agent, is part of gastrointestinal tract flora.³ No evidence suggested *B. thetaiotaomicron* is a normal component of skin flora, reducing the likelihood of
our findings being due to contamination of cultures by skin microbes. Gastrointestinal and skin flora may have entered the tear ducts via poor hand hygiene after toilet use, followed by touching of the inner eye. The patient’s anaerobic infection played a large role in her dacryocystitis as suggested by the heavier growth in the anaerobic cultures relative to the aerobic cultures.

Both organisms display drug-resistances that should be considered during treatment. *P. micra* commonly exhibits resistance to doxycycline (11.3% resistant) and clindamycin (47.3% resistant). A study examining isolates of *B. thetaiotaomicron* showed resistance to moxifloxacin (44.9% resistant), clindamycin (51.0% resistant), and cefoxitin (14.3% resistant). Clindamycin is a common empiric dacryocystitis treatment.

This case reported that *P. micra* and *B. thetaiotaomicron*, which commonly exhibit clindamycin resistance, can be implicated in dacryocystitis. This report should allow clinicians to reassess whether clindamycin is a suitable empiric treatment choice for dacryocystitis, especially in patients with risk factors for *P. micra* and *B. thetaiotaomicron* infection. Additionally, this case informed clinicians that, if dacryocystitis is refractory to the listed antibiotics, these organisms should be considered. Lastly, consideration of infection by these agents may be warranted in patients with frequent facial exposure to canine oral flora.

**REFERENCES**

Dear Editor,

We read with interest the article by Rahimi et al.1 about a 67-year-old female with symptomatic SARS-CoV-2 infection beginning 10 days prior to admission, administration of the second dose of the Moderna anti-SARS-CoV-2 vaccine four days prior to admission, and admission for respiratory insufficiency (tachycardia, tachypnoea, and hypoxigenation) without fever or cough. Examination for sudden chest pain on hospital day two revealed Takotsubo syndrome (TTS). Myocardial infarction was ruled out by coronary angiography. Decreased systolic function improved within three weeks of hospitalization, but the overall outcome was not provided. The study was appealing but raised concerns.

Whether TTS was due to the SARS-CoV-2 infection or due to SARS-CoV-2 vaccination was not discussed. Since both occurred before the suspected onset of TTS and both have been reported as causes of TTS,1,2 it is crucial to delineate whether one or both were causative. It also should be considered whether TTS was triggered by respiratory insufficiency (there was severe hypoxigenation), which can cause severe anxiety, and whether TTS occurred prior to hospitalization or prior to SARS-CoV-2 vaccination.

Since SARS-CoV-2 infections or vaccinations can be complicated by myocarditis,3,4 the exclusion of myocarditis by cardiac magnetic resonance imaging with contrast medium or endo-myocardial biopsy is crucial. We should be informed of the results of creatine-kinase (CK), CK-MB, and pro-brain natriuretic peptide (proBNP) serum profile was not reported in addition to arterial hypertension. We should know if the patient had diabetes, hyperlipidemia, a history of stroke or myocardial infarction, or if she was smoking. There was no information about the treatment that the patient received for TTS.

Response:

Author Response:

Before Blaming SARS-CoV-2 Infection or Vaccination for Takotsubo, Differentials Should be Ruled out

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In response to the Letter to the Editor by Dr. Finsterer and Dr. Stollberger, we submit the following information.

1. Whether Takotsubo syndrome (TTS) was due to the SARS-CoV-2 infection or due to SARS-CoV-2 vaccination was not discussed.

Response: Based on the information provided, TTS was suspected to both the acute COVID-19 infection and possibly the vaccine. As documented in our case, IL-6 induced inflammation from the acute viral infection likely caused TTS,1 but as also cited by Fearon et al.2, there are cases of vaccine induced TTS, which based on our patient’s timeline makes this differential possible.

2. It also should be considered whether TTS was triggered by respiratory insufficiency (there was severe hypoxigenation), which can cause severe anxiety, and whether TTS occurred prior to hospitalization or prior to SARS-CoV-2 vaccination.

Response: Although this is a possibility, the underlying cause of the hypoxigenation and anxiety would be the COVID-19 infection and/or the COVID-19 vaccine.

REFERENCES


Keywords: SARS-CoV-2, COVID-19, Takotsubo cardiomyopathy, heart failure, complications
3. Since SARS-CoV-2 infections or vaccinations can be complicated by myocarditis, the exclusion of myocarditis by cardiac magnetic resonance imaging with contrast medium or endo-myocardial biopsy is crucial. We should be informed of the results of creatine-kinase (CK), CK-MB, and pro-brain natriuretic peptide (proBNP) serum levels.

**Response:** No cardiac MRI was available to assist with diagnosis, but given the severe troponin elevation with no signs of coronary ischemia, the likely cause of a hs-troponin > 3000 ng/L is myocarditis. No CK-mb or CK levels were collected as hs-troponin is a better barometer for myocardial tissue damage.

4. Since the patient had an “irregular tachycardia”, we should be informed whether this was classified as sinus-arrhythmia, supraventricular arrhythmia (particularly atrial fibrillation), or ventricular arrhythmia. Knowing the type of arrhythmias is essential as treatment varies between them.

**Response:** It was atrial fibrillation that was paroxysmal and resolved by discharge. Given the elevated CHAD-VASC score, the patient was discharged on anticoagulation. This was not placed in the report as it was not in relation to the TTS and given it had resolved with treatment for the inflammatory response was likely stress induced as well. This could be another area to consider for a future separate report.

5. We should know whether TTS also was seen on transthoracic echocardiography or only on ventriculography. According to the description, echocardiography revealed apical hypokinesia, but no apical ballooning. After how many days did apical ballooning resolve?

**Response:** Apical hypokinesia is synonymous with ballooning in the setting of basal wall hyperkinesis and it was noted in the report that the findings were collected by a transthoracic echocardiogram. The resolution was after 16 days, which was omitted as it was not relevant for the outcome of the report.

6. Since the onset of TTS remains unclear, we should know the results of the electrocardiogram (ECG) at admission, specifically whether upslanting ST elevation already was present on hospital day one.

**Response:** Although not noted in the original manuscript, there were no ST elevations on admission as could have been inferred, as the patient was admitted on BiPAP without being sent for cardiac angiography, which is standard of care if the patient was found to have ST elevations with signs of cardiopulmonary distress.

7. We should know if pulmonary embolism has been ruled out by spiral CT with contrast medium or if the patient just received a plain CT scan of the lungs.

**Response:** The report stated CT chest with contrast was negative for pulmonary embolism. This was a spiral CT as that was the indication for getting the CT.

8. Was there any evidence of acute right ventricular strain on echocardiography?

**Response:** No strain was noted.

9. A limitation of the study was that no reference limits for blood tests were specified.

**Response:** Standard normal values are used at our laboratory. The findings reported were significantly elevated such that any laboratory normal value could be inferred.