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REVIEW ARTICLES

ORIGINAL ARTICLES

CASE REPORT

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The Thai Journal of Surgery is the official publication of The Royal College of Surgeons of Thailand and is issued quarterly.

The Thai Journal of Surgery invites concise original articles in clinical and experimental surgery, surgical education, surgical history, surgical techniques, and devices, as well as review articles in surgery and related fields. Papers in basic science and translational medicine related to surgery are also welcome.

Aim & Scope

The Thai Journal of Surgery is dedicated to serving the needs of the members of The Royal College of Surgeons of Thailand, specifically the younger researchers and surgical trainees who wish to have an outlet for their research endeavors. The Royal College strives to encourage and help develop Thai Surgeons to become competent researchers in all their chosen fields. With an international outlook, The Thai Journal of Surgery welcomes submissions from outside of Thailand as well.

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References must be listed on a separate sheet in numeric order as referred to in the article, not alphabetically. A simplified Vancouver system is used. Only references mentioned in the text should be listed and should be selective with no more than 30 references except under unusual circumstances. Number references consecutively in the order in which they are first mentioned in the text. Identify references in text, tables, and legends by Arabic numerals (in superscript). The references must be verified by the author(s) against the original documents. Example forms of references are given below.

1. Standard Journal Article:

List all authors when three or less; when four or more, list only the first three and add et al.

- Soter NA, Wasserman SI, Austen KF. Cold urticaria: release into the circulation of histamine and eosinophil chemotactic factor of anaphylaxis during cold challenge. N Engl J Med 1976; 294:687- 90.

2. Corporate Author:

- The Committee on Enzymes of the Scandinavian Society for Clinical Chemistry and Clinical Physiology. Recommended method for the determination of gamma glutamyltransferase in blood. Scand J Clin Lab Invest 1976; 36:119-25.
- American Medical Association Department of Drugs. AMA drug evaluations. 3rd ed. Littleton: Publishing Sciences Group, 1977.

3. Personal Author(s):

- Osler AG. Complement: mechanisms and functions. Englewood Cliffs: Prentice - Hall, 1976.

4. Editor, Compiler, Chairman as Author:

- Rhooder AJ, Van Rooyen CE, comps. Textbook of virology:

for students and practitioners of medicine and the other health sciences. 5th ed. Baltimore: Williams & Wilkins, 1968.

5. Chapter in a Book:

- Weinstein L, Swartz MN. Pathogenic properties of invading microorganisms. In: Sodeman WA Jr. Sodeman WA, eds. Pathologic physiology: mechanisme of disease. Philadelphia: WB Saunders, 1974:457-72.

6. Agency Publication:

- National Center for Health Statistics. Acute conditions: incidence and associated disability, United States, July 1968-June1969. Rockville. Md.: National Center for Health statistics, 1972. Vital and health statistics. Series 10: Data from the National Health Survey, No. 69: (DHEW publication no. (HSM) 72-1036).

7. Newspaper Article:

- Shaffer RA. Advances in chemistry are starting to unlock mysteries of the brain: discoveries could help cure alcoholism and inso mnia, explain mental illness. How trhe messengers work. Wall Street Journal 1977 Aug 12:(col. 1), 10(col.1).

8. Magazine Article:

- Roueche B. Annals of medicine: the Santa Claus culture. The New Yorker 1971 Sep 4:66-81. 9.

9. The use of the article's Digital Object Identifier (DOI):

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- Chirappapha P, Arunnart M, Lertsithichai P, et al. Evaluation the effect of preserving intercostobrachial nerve in axillary dissection for breast cancer patient. Gland Surg 2019. doi:10.21037/gs.2019.10.06.
- Chirappapha P, Arunnart M, Lertsithichai P, et al. Evaluation the effect of preserving intercostobrachial nerve in axillary dissection for breast cancer patient. Gland Surg 2019;8:599-608. doi:10.21037/gs.2019.10.06.

Abbreviations

Use only standard abbreviations of commonly used approved abbreviations. Avoid abbreviations in the title. The full term for which an abbreviation stands should precede its first use in the text unless it is a standard unit of measurement.

Statistics

All statistical analyses and the statistical software used must be concisely described. Descriptive statistics for quantitative variables must include an appropriate central tendency measure (e.g., mean or median) as well as a corresponding measure of spread (e.g., standard deviation or range or interquartile range). Categorical variables must be summarized in terms of frequency (counts) and percentage for each category. Ordinal variables can be summarized in terms of frequency and percentage, or as quantitative variables when appropriate. Statistical tests must be named and p-values provided to 3 decimal places. P-values less than 0.001 should be written "< 0.001" and p-values approaching 1 should be written "0.999".

All statistical estimates (e.g., mean differences, odds ratios, risk ratios, hazard ratios, regression coefficients, and so on) must have corresponding 95% confidence interval limits. All statistical models used must be briefly described. Uncommon or unusual methods used should be referenced. Authors should refrain from over-modeling their dataset; for example, multivariable analyses of datasets with small sample sizes (e.g., < 100), or few outcomes (e.g. < 10), could be unreliable. Relative risks of categories in a categorical risk factor should be compared to its own reference category, which must be indicated, for example, in a table of multivariable analysis.

Randomized controlled trials should be analyzed using the intention-to-treat principle, and as treated analysis should be applied as well if there are significant cross-overs. Further details of statistical issues are available here (http://www.icmje.org/icmje-recommendations.pdf).

Standards of Reporting for Research Articles

Authors are advised that the Thai Journal of Surgery adheres to standards set by the International Committee of Medical Journal Editors (ICMJE) and the Committee on Publication Ethics (COPE). Reporting guidelines that authors should consult and follow include the CONSORT Guidelines for randomized controlled trials; PRISMA Guidelines for systematic reviews and meta-analyses of randomized controlled trials, MOOSE Guidelines for systematic reviews, and meta-analysis of observational studies; STROBE Guidelines for observational studies; and ARRIVE Guidelines for animal research. Details of these and other guidelines can be obtained from https://www.equator-network.org/reporting-guidelines/.

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(see Format https://bit.ly/3IaP4ZB)

Abstract: should be no more than 300 words in length, and written in a structured format, including the following headings: **Objective,** which can include some background material of 1 to 2 sentences in length, but mainly describing the research question; **Methods,** concisely describing the research design and data procurement; **Results,** describing the main findings of the study; and **Conclusion,** which should concisely answer the research question, and no more. Below the abstract, a list of keywords should be provided.

Main text: should be written in a structured format, including the following headings. **Introduction** should describe the rationale of the study within the context of current knowledge; the gap in knowledge with which the research study will fill must be clearly pointed out and a research question explicitly stated. **Methods (and patients, if applicable)** should clearly describe the details of research methodology and patient or research volunteer recruitment according to Guidelines for each type of research as listed above (…), and how the data was collected and analyzed. A short description of statistics used, and the software and references if appropriate, must be provided. A note on Ethics Committee approval, if applicable, must be given. **Results** should include data or summaries of patient or volunteer characteristics, summaries of risk factors or covariates and outcomes, presented in tabular, graphical or descriptions in the text as appropriate, without significantly duplicating one another. Results of statistical analyses must be clearly displayed and should include point estimates, standard errors, statistical tests, *p*-values, and 95% confidence intervals as detailed (…). Analyses not shown but

referred to must not change the conclusions or outcomes. **Discussion,** which must fully describe the implications of the research results, should include a concise literature review of previous published, related results. These related results must be compared with those of the authors' study, and the differences clearly stated along with plausible explanations. New unexpected findings, especially from subgroup analyses or those for which the research was not designed, should be considered hypothetical and stated as such. Any plausible, relevant clinical application should be indicated. Finally, any significant limitations of the study must be mentioned and possible extensions of research should be briefly provided. **Conclusion,** which should be concerned with answering the research question posed by the current study, should not be summarizing results of previous studies or recommendations. An **Acknowledgement** section can be added at the end of the article. The Reference list should be in the format as described previously.

Basic Science and Translational Research

Use the common format. Emphasis is on clinician comprehension. The **Abstract** uses the same common structured format. In the **Main text,** the **Introduction,** in addition to the usual context setting and rationale, should also contain explanations and descriptions of basic science concepts at the level of the educated layman. The **Methods** section should still be concise with sufficient detail for others to replicate the experiment, but one or two paragraphs in between explaining basic processes in plain English would be helpful. In the **Results** section, similar conciseness is still the rule, but a brief simplified summary of the findings should be provided. In the **Discussion,** clinical implications should be clearly stated. The **Conclusion,** again, should answer the research question.

Case Series and Case Reports

We encourage publication of case series or case reports if a comprehensive review of the literature is included, with the aim of helping the clinician manage rare and challenging diseases or conditions based on best available evidence in conjunction with practical, local experience. For the Thai Journal of Surgery, this implies that the case report format differs somewhat from that of the common format for research articles.

Abstract: Need not be structured. State objective of the case presentation, present a summary of the case, the outcome and learning points in one concise paragraph.

Main text: An **Introduction** is required to set the importance or relevance of the case within the current clinical context, based on a comprehensive literature review. A brief review of anatomy and pathology, or pathophysiology can be provided. **Report of the case** then follows with sufficient details on clinical presentation, diagnostic work up, interesting features, and decision making, to be useful for other surgeons. Surgical management should be concisely described and should be accompanied by high-resolution photographs or high-quality drawings and diagrams, if possible. Unique features of the case, and typical or general features should be distinguished. **Results** of management and follow-up information should be provided. **Discussion** then places the clinical, diagnostic, surgical and pathological features of the case within current knowledge or context and provides reasons for decision making and surgical management or otherwise. Wider implications of the case should be emphasized; for example, when management contradicts existing guidelines or when feasibility of some never-before performed surgery has been demonstrated. The **Conclusion** simply summarizes the case in terms of management implications.

Narrative Review Articles

Abstract: No structure is required. A description of the aims of the article and contents should be sufficient.

Main text: An **Introduction** serves to set the rationale or objective of the review. While systematic reviews focus on narrow research questions with aims of obtaining generalizable knowledge, the narrative review is education-based. The **main content** can be structured in anyway as is necessary for adequate comprehension. Finally, a **Conclusion** summarizes the content in greater detail than the abstract, emphasizing recent developments or future research.

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Abstract: A brief description of aims and content is sufficient.

Main text: An **Introduction** to set the aims of the article. The **main content** can be structured in any way. A **Conclusion** to summarize the content should be helpful, as well as to place some personal reflections.

Surgical Techniques

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Review Article

Management of Complicated Appendicitis: The Evolution from Conservative Treatment to Laparoscopic Surgery: Narrative Review Article

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Abstract The management of complicated appendicitis has always been controversial, with no consensus on the management of complicated appendicitis. Complicated appendicitis is defined as perforated appendicitis with or without abscess or phlegmon formation. The management has always been conservative with intravenous antibiotics and bed rest. The emergence of laparoscopic surgery has seen a trend in immediate or early surgery for the management of complicated appendicitis. Due to the absence of any proper guidelines for the management of this condition, the treatment is often decided by the surgeon managing the condition. We have conducted this narrative review article to investigate the current management of complicated appendicitis.

Keywords: Complicated appendicitis, Appendicular mass, Appendicular abscess, Appendicular phlegmon, Laparoscopic appendectomy

Introduction

Acute appendicitis is one of the most common emergencies that is encountered in general surgical practice, with the lifetime risk being 7%-8%. It is seen in patients between the age of 10 to 30 years, and the male-to-female ratio is 1.4:1. The challenge in acute appendicitis is to differentiate uncomplicated from complicated appendicitis. There is no universally agreed definition of complicated appendicitis, although attempts have been made.[1]

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The World Society of Emergency Surgery (WSES) attempted to define complicated appendicitis as perforation of the appendix in the presence of pus or purulent peritonitis or abscess. Most surgeons do agree with this definition.[2]

The European Association of Emergency Surgeons (EAES) defined complicated appendicitis as a gangrenous inflamed appendix with or without perforation, intra-abdominal abscess, peri-appendicular contained phlegmon or purulent free fluid.[3]

An attempt was made to classify complicated appendicitis into 5 grades according to the laparoscopic appearance, including the appendix and peritoneum. But the drawback of this classification is that it can only be made intraoperatively, and hence it has limited clinical use.[4]

A factor in the development of complicated appendicitis is the onset of symptoms to the development of complications like perforation and abscess formation, which varies from a duration of 1 to 2 days in children and 3 to 4 days in adults.[5]

Complicated appendicitis can be classified as 1) perforated appendicitis with abscess formation and 2) perforated appendicitis with phlegmon or appendicular mass. The management of complicated appendicitis has been evolving from conservative treatment, which includes intravenous antibiotics, intravenous fluids, and percutaneous drainage of an appendicular abscess, to surgical options like an appendectomy. The introduction of laparoscopic appendectomy has been slowly replacing open surgery in the management of complicated appendicitis.[5]

As there is no consensus on the definition and management of complicated appendicitis, we have conducted this review article to investigate this. A literature review was made on PubMed and Cochrane databases to look for original articles, observational studies, clinical trials, clinical reviews, review articles, and meta-analyses from 1995 to 2022. The following keywords were used "appendicular abscess", "perforated appendicitis", "gangrenous appendicitis", "complicated appendicitis", "appendicular phlegmon", "ruptured appendicitis", and "appendicular mass". All articles were in English language only, and further articles were obtained by manual cross-checking. Case reports and editorials were excluded. All articles, including adults and children, were included in this review. Pregnant patients with appendicitis were excluded.

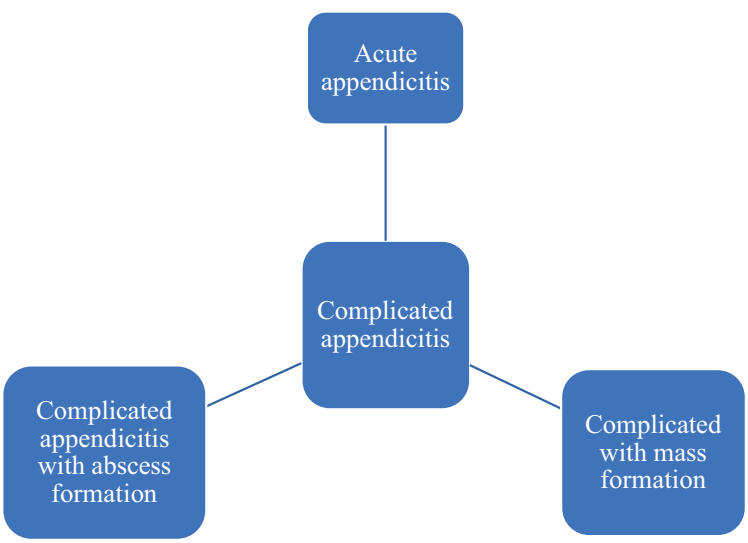

Figure 1 Flowchart for the differentiation of complicated appendicitis

Perforated appendicitis with abscess formation

For patients who present with perforated appendicitis with abscess formation, intravenous antibiotics should be started in these patients. The most common triple therapy includes an aminoglycoside, a beta-lactamase, and a regime covering anaerobes, although there is a growing trend in using broad-spectrum single or double therapy. The duration of antibiotic therapy should be based on clinical criteria and total white cell count. The most common regime is 5-day intravenous antibiotics

followed by 2 days of oral antibiotics. The addition of percutaneous drainage improves the success rate, and this decreases the chances of recurrent appendicitis. Percutaneous drainage is performed with an ultrasound of computerized tomography. The abscess size will determine the need for percutaneous drainage, which may be favored in selected patients. However, due to the paucity of studies, it is recommended that more randomized control trials are needed to determine the precise management.[6,7]

The effectiveness of percutaneous drainage of complicated appendicitis with abscess formation was compared with immediate surgery. These studies were more of a retrospective analysis, and the results showed that percutaneous drainage was effective and safe. The recovery and hospital stay was reduced than those that underwent emergency surgery. This confirmed the effectiveness of percutaneous drainage of appendicular abscess, but the patients may require frequent follow-up.[8-11]

These studies revealed that treatment of complicated appendicitis with percutaneous drainage of the appendicular abscess is highly successful and associated with low complications.

Demetrashvili et al. and Kim et al. conducted retrospective studies on the management of complicated appendicitis, comparing conservative management followed by percutaneous drainage of abscess with immediate appendectomy. The results were the same in both groups regarding infection and recurrence rates. It was concluded that there was no difference in both treatment options, and the surgeon should decide the most appropriate treatment option.[12-13]

Olsen et al. conducted a qualitative systemic review. From a pool of 48 studies and 3,772 patients, showed that conservative treatment and percutaneous drainage of the abscess was the preferred treatment option for children and adults. It was associated with lower complication rates and recurrence rates. The size of the abscess was important, with percutaneous drainage recommended for abscess more than 5cm in size. Operative treatment is reserved for failure of conservative treatment.[14]

Simillis et al. conducted a meta-analysis comparing conservative treatment versus early appendectomy for complicated appendicitis. A total of 16 studies with 1,572 patients were included, 847 underwent conservative treatment, and 725 underwent appendectomy. The conservative group was associated with a lower wound infection rate, reduced abscess formation, and reduced ileus. In conclusion, conservative treatment of complicated appendicitis was associated with decreased complication rates when compared with appendectomy. The drawback of this meta-analysis was the significant heterogeneity of the studies.[15]

Coccolini et al. investigated the management of complicated appendicitis in adults and children. For adults, a systemic review was done looking at the duration of hospital stay, duration of antibiotic therapy, overall complication rate, and reoperation rate. This review included 1,572 patients, of which 847 underwent conservative treatment, and 725 underwent appendectomy. There was no overall difference in the duration of hospital stay; infection rates were the same, except that the reoperation rate was higher in the appendectomy group. This review showed that conservative treatment was associated with decreased complications and reoperation rates. For children, there is no consensus regarding the optimal treatment of complicated appendicitis among surgeons due to the lack of studies like randomized trials, and it was proposed that early appendectomy should be the treatment of choice.[16]

Fugazzola et al. performed a meta-analysis on the management of complicated appendicitis in children. Conservative treatment was compared to immediate appendectomy. 14 studies were included, 2 randomized control trials and 12 observational studies. There was a total of 1,288 patients, of which 622 underwent conservative treatment and 666 immediate appendectomies. This meta-analysis showed that conservative treatment of complicated appendicitis was associated with better complication rates and re-admission rates. The pooled success rate is 90%, and the relapse rate is 15.4%. This showed that conservative treatment of complicated appendicitis should be the first treatment of choice, with appendectomy reserved for failure of conservative treatment.[17]

The conclusion of these studies is that complicated appendicitis with abscess formation is best treated with intravenous antibiotics and percutaneous drainage, which can be done via ultrasonography or computerized tomography. The drawback of these studies was that they were retrospective in nature.

Table 1 Conservative treatment and percutaneous drainage of abcess

Study	N = numbers	Complication rates (%)	Recurrence rate (%)	Study type
Shinde et al.	25	0	0	Prospective study
Cheng Luo et al.	150	5.7	6.79	Retrospective study
Miftaroski et al.	15	13	N/A	Retrospective study
Dementrashvili et al.	23	4.3	13	Retrospective study
Olsen et al.	3,772	0-17	15	Systemic review
Kim et al.	28	15.3	13	Retrospective study
Tingsteldt et al.	50	9	8	Retrospective study

Summary of the studies that involved conservative treatment and percutaneous drainage of appendicular abscess for the management of complicated appendicitis.

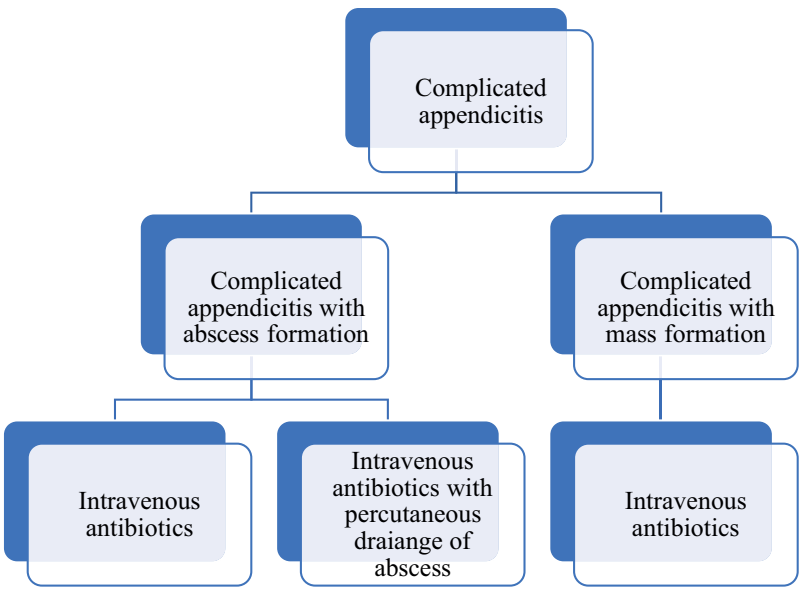

Figure 2 Flow chart on the management of complicated appendicitis

Perforated appendicitis with mass or phlegmon formation

This is defined as a walled-off appendicular perforation which includes the perforated appendix, omentum, and surrounding bowel without an abscess.[18]

The treatment of perforated appendicitis with mass or phlegmon formation was popularized by Ochsner and Sheeren in 1901. The treatment includes keeping the patient nil by mouth and starting intravenous antibiotics. The patient is advised to rest in bed, and upon completion of treatment, the patient will undergo interval appendectomy in 6 to 8 weeks' time. This approach obviates the risk of complications of surgery during the acute phase, and interval appendectomy eliminates the risk of recurrence. This treatment option is still popular in many regions, but it is being challenged by the introduction of laparoscopic surgery.[19]

Yilmaz et al. performed a retrospective study on managing complicated appendicitis, dividing the treatment into conservative treatment and immediate appendectomy. A total of 97 patients were included in the study, 54 underwent conservative treatment, 36 underwent appendectomy, and 7 underwent right hemicolectomy. The recurrence rate was low in this study, and the conclusion of this study was that conservative treatment without interval appendectomy should be the treatment of choice for complicated appendicitis, and interval appendectomy should be reserved for cases of recurrence. The drawback

of this study was its retrospective nature and small sample size.[20]

Elaasdy conducted a prospective study on the management of appendicular mass. A total of 169 patients, of which 121 patients underwent conservative treatment, 106 were successful, and there was a failure of treatment in 15 patients. The remaining 48 patients underwent appendectomy. The study concluded that conservative treatment was a safe and effective treatment, and the recurrence rate was low to justify interval appendectomy. Appendectomy was recommended for patients who present with recurrence, and follow-up with a colonoscopy and computed tomography was preferred for older patients.[21]

Van Amstel conducted a systemic review and meta-analysis on the management of appendicular mass in children.14 studies were included and a total of 1,355 patients, of which 333 were included in the appendectomy group and 1,022 in the conservative treatment group. The complication rate was 25.5% in the appendectomy group and 12.2% in the conservative treatment group. The most common complication was an intra-abdominal abscess in the appendectomy group and failure of conservative therapy in the conservative treatment group. This study concluded that conservative treatment for appendicular mass in children is associated with reduced overall complication rates than an appendectomy, but the evidence is uncertain. The drawback of this review is that it included small retrospective studies.[22]

Gavriilidis et al. conducted a systematic review and meta-analysis on the use of early appendectomy or conservative treatment in the management of appendicular mass.[21] studies were included,[17] retrospective studies, one prospective study, and 3 randomized trials. A total of 1,864 patients, of which 810 underwent appendectomy and 932 conservative treatments. The conclusion was that conservative treatment was associated with lower incidences of wound infection and abscess formation when compared to the appendectomy group. The meta-analysis concluded that the management of complicated appendicitis was controversial and that factors like local infrastructure, surgeons' expertise, and preference influenced its treatment. The drawback of this study was that it was retrospective in nature with a limited number of randomized trials.[23]

Clinical reviews by Becker and Tannoury et al. on the management of complicated appendicitis concluded that conservative treatment was the treatment of choice, and surgery is reserved for cases of failure of conservative treatment. Immediate surgery is associated with a higher risk of abscess formation and wound infection rate. However, immediate surgery is indicated for cases where percutaneous drainage of the abscess is impossible. For patients above the age of 40, follow-up is required with investigations like colonoscopy or computerized tomography.[24-25]

Gillick et al. reviewed the management of appendicular mass in children. 427 patients, of which 411 underwent conservative treatment, and 16 underwent immediate appendectomy. Failure of conservative treatment was seen in 15.8% of the cases, but the incidence of wound infection and recurrence was low. This study showed that conservative treatment followed by interval appendectomy is effective for children's appendicular mass.[26]

Andersson et al. conducted a systemic review and meta-analysis on the conservative treatment of appendicular mass. A total of 20 studies with 59,488 patients were included. The failure rate was 7.2%, morbidity was 13.5%, and the recurrence rate was 8.9% in the conservative treatment group. The conclusion from the meta-analysis showed that conservative treatment of appendicular mass was the treatment of choice, and interval appendectomy was not indicated. Patients should be informed about the risk of recurrence, and follow-up may be required with investigations like colonoscopy and computed tomography.[27]

A systemic review by Teixeira et al. investigated the risk of hidden malignant tumors in patients with an appendicular mass. A total of 13,244 patients were included in this review, and results showed the rate of neoplasms is 10-29% in patients who present with an appendicular mass. The most common tumors are neuroendocrine tumors. A population-based study by Lietzen et al. on the appendiceal neoplasm risk associated with complicated appendicitis showed that the most common tumor was neuroendocrine tumors of the appendix, and the prevalence was 1.24%.[28-29]

The conclusion from these studies was that conservative treatment is successful in the management of appendicular mass, and interval appendectomy is not generally required but is reserved in patients who present with recurrence. The risk of missing hidden malignancies after conservative treatment is also low. The major drawback of these studies was that they were retrospective in nature.

Table 2 Conservative treatment with mass

Study	N = numbers	Success rate (%)	Complication rate (%)	Recurrence rate (%)	Study type
Elaasdy et al.	121	88	9.5	6	Retrospective study
Van Amstel et al.	1,365	88	12.7	34	Meta-analysis
Gillick et al.	427	84	2.3	15.8	Meta-analysis
Anderson et al.	59,488	92.8	2.3	15.4	Meta-analysis

Summary of the studies that favor conservative treatment of complicated appendicitis with mass.

Interval appendectomy after conservative treatment

Upon successful completion of conservative treatment of complicated appendicitis, interval appendectomy is usually done after 8 to 12 weeks' time to prevent recurrence and so as not to miss any other diagnosis like tuberculosis or Crohn's disease. Prospective studies were done for conservative treatment without interval appendectomy. The recurrence rate was 2%, and the success rate was 86.4%.[30]

The role of interval appendectomy is now being questioned as most patients who have undergone successful conservative treatment can be followed up with investigations like computerized tomography and colonoscopy. Interval appendectomy is reserved for patients who present with recurrent symptoms.[31-32]

The assessment of the severity of recurrence appendicitis was retrospectively done by Dixon et al., who concluded that the recurrent attacks were milder and could be treated effectively by interval appendectomy.[33]

Al-Qahtani et al. concluded that interval appendectomy could be used selectively for patients who only present with recurrent symptoms and need not be done as a routine.[34]

The pathological findings following interval appendectomy by Fouad et al. showed that chronically inflamed appendix was the most common finding, followed by acute on chronic inflammation of the appendix and appendicular fecalith. They were no neoplastic lesions reported.[35]

The presence of appendicolith also affects the success of interval appendectomy in children after the completion of conservative treatment. The study by James et al. showed that patients with appendicolith were associated with a higher risk of treatment failure and earlier admission for recurrent symptoms.[36]

The predictors of recurrent attacks of appendicitis after conservative treatment are persistent symptoms after recovery and the presence of appendicolith on imaging; hence interval appendectomy will be required in these patients.[37]

These studies conclude that interval appendectomy is only indicated for patients who present with recurrent symptoms and does not need to be performed as a routine.

Open appendectomy and laparoscopic appendectomy for complicated appendicitis

Bahram conducted a prospective study on 46 patients who underwent immediate appendectomy for complicated appendicitis. The superficial and deep wound infection rates were low, and the mean hospital stay was 3 days. The conclusion from the study was that early appendectomy was feasible for the management of complicated appendicitis and was safe. It avoids the consequence of missing the diagnosis.[38]

Retrospective studies were done to investigate the role of immediate open appendectomy in the management of complicated appendicitis. The wound infection rates and length of hospital stay were comparable to patients who had undergone conservative treatment. The conclusion of the studies was that immediate appendectomy was a safe and effective alternative to conservative treatment of complicated appendicitis. The improvements in surgical technique and post-operative care have made immediate surgery a better option for conservative treatment in the management of complicated appendicitis.[39-41]

Israr et al. performed an observational study on 60 children who were presented with complicated appendicitis. All the patients had undergone an immediate appendectomy, the wound complication rates were 23%, and the mean hospital stay was 4 days. The conclusion

from this study was that immediate appendectomy was a safe and feasible option in the treatment of complicated appendicitis.[42]

Kim et al. undertook a retrospective analysis of the cost-effectiveness and outcomes of conservative treatment and immediate appendectomy in the management of complicated appendicitis. 79 patients were diagnosed with complicated appendicitis, 43 underwent conservative treatment, and 36 underwent immediate appendectomy. The morbidity and mortality were the same in both groups, but the cost of immediate surgery was much less than those patients who underwent conservative treatment. The conclusion of this study was that immediate appendectomy should be an option for the treatment of complicated appendicitis.[13]

Several retrospective studies on the management of complicated appendicitis with laparoscopic appendectomy were done to investigate its efficacy, wound infection rates, and length of hospital stay. The postoperative infection rates were low, and the average hospital stay was 4 to 6 days. The advantages of laparoscopy were that the visualization of the peritoneal cavity was better and post-operative pain was less. The patients were also able to mobilize and ambulate better. The risk of adhesion formation was much less. This study showed that laparoscopic appendectomy is safe and feasible in the management of complicated appendicitis. The drawback of this study was the low patient numbers and the retrospective nature of the studies.[43-49]

Several prospective studies were done to look at the efficacy of laparoscopic appendectomy in the management of complicated appendicitis. The wound infection rate was lower in the laparoscopic appendectomy group, but the duration of the operation was longer. The studies concluded that laparoscopic appendectomy could be performed safely with low post-operative complications and a faster recovery. Laparoscopic appendectomy can be used in the management of complicated appendicitis.[50-54]

Cheng Yu et al. conducted a systemic review and meta-analysis on the feasibility of laparoscopic appendectomy for the management of complicated appendicitis.16 studies were included in 2 randomized control trials and 14 retrospective cohort studies. The study showed that laparoscopic appendectomy could reduce the surgical site infection rate, but the rate of post-operative abscess formation is the same. The length of operative time was longer in the laparoscopic appendectomy group, but the length of hospital stay was reduced. This study concluded that laparoscopic appendectomy was feasible and safe in the management of complicated appendicitis. The limitations of this study were that most of the studies were retrospective in nature.[55]

Guler et al. performed a prospective study on the development of postoperative wound infection in patients with complicated appendicitis who underwent open and laparoscopic appendectomy. A total of 103 patients with complicated appendicitis were included. 59 underwent laparoscopic appendectomy and 44 open appendectomies. The post-operative wound infection rate was 15.9% for those who underwent open appendectomy and 6.8% for the laparoscopic appendectomy group. This study showed that laparoscopic appendectomy is associated with decreased incidence of post-operative wound infection in the management of patients with complicated appendicitis.[56]

These studies concluded that immediate laparoscopic appendectomy should be indicated in the management of complicated appendicitis as it is associated with better outcomes and reduced cost. The drawback of these studies was that they were retrospective in nature, and further randomized trials may be needed to evaluate this.

Table 3 Complicated appendicitis with immediate appendectomy

Study	N = numbers	Complication rate (%)	Study type
Bahram et al.	46	17	Prospective nonrandomized study
Kaya et al.	47	27	Retrospective study
Das et al.	48	-	Retrospective study
Israr et al.	60	23	Observational study
Deelder et al.	34	17.6	Retrospective study

Summary of the studies that performed immediate open appendectomy for complicated appendicitis.

Table 4 Laparoscopic appendectomy for complicated appendicitis

Study	N = numbers	Complication rate (%)	Study type
Chowdhury et al.	30	6.7	Prospective observational study
Thambidurai et al.	51	2.1	Retrospective study
Galli et al.	106	1.9	Retrospective study
Rai et al.	91	5.6	Retrospective study
Shindholimath et al.	19	15.7	Retrospective study

Summary of the studies on laparoscopic appendectomy for complicated appendicitis

Conclusion

The conclusion that we can gather from the evidence is that there is no uniform guide on the management of complicated appendicitis. The management can be divided into conservative treatment, including intravenous antibiotics and percutaneous abscess drainage. Operative management in the form of open or laparoscopic appendectomy is becoming popular, but due to a lack of randomized clinical trials, there is no consensus on the management of this condition. The world society of emergency surgeons (WSES) recommended that if laparoscopic surgery is available, then immediate surgery showed be offered in the management of complicated appendicitis. Due to the absence of any proper guidelines on the management of complicated appendicitis, the treating surgeon will still decide on the management of this condition.

It is my recommendation that all cases of complicated appendectomy should be managed with laparoscopic appendectomy where possible and conservative treatment is reserved in cases where there is non-availability of laparoscopic services.

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Review Article

Management of Rectal Injury

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Abstract Rectal injury is also challenging for surgeons regarding diagnosis and treatment planning. Delayed diagnosis and treatment can lead to severe complications and fatality. The diagnosis should be distinguished between the intraperitoneal or extraperitoneal type. Treatment of intraperitoneal rectal injury is mimicking to colon trauma. Proximal diversion is less required, except in unfavorable situations. Although current evidence suggests proximal diversion as a mainstay treatment of the extraperitoneal rectal injury. Primary repair should be attempted if the injured site can be visualized and accessible.

Keywords: Rectal injury, Rectal trauma, Management of rectal injury

Introduction

Management of acute rectal injury is currently a challenging issue in trauma surgery. There was a high mortality rate of 60-75% in World War I,[1] and after launching diverting colostomy in the World War II era, the mortality rate declined to 53-59%.[2] In the Vietnam War, the development of **"4D"**, which included **D**irected primary repair, proximal **D**iversion, **D**istal rectal washout, and presacral **D**rainage, was a famous treatment method for acute rectal injury. The mortality rate decreased to less than 30% after this era. However, many evidences suggest that not every rectal injury requires 4D and treating rectal injury should be personalized.

Incidence of rectal injuries is approximately 1-3% of all injuries in a developed country.[1] The most common mechanism is gunshot (71-85%), followed by blunt injury, which usually refers to pelvic fractures (5-10%), and stab injury (< 5%).[3] Another mechanism that increases in incidence is the rectal foreign body.[4] Associated injuries include urogenital trauma (43%) and pelvic vascular injury (50%) in penetrating rectal injury, and pelvic fracture especially anteroposterior compression type (75%) in blunt rectal trauma.[1] The current mortality rate is 3-10%,[5] with a morbidity rate of 18-21%.[5,6]

The rectum is located in the pelvic cavity, with 12-15 cm in length, and is divided into two portions, intraperitoneal and extraperitoneal rectum. The intraperitoneal rectum refers to 2/3 upper anterior portion and 1/3 upper posterior portion of the whole rectum, which is covered with the peritoneum. In contrast, the extraperitoneal rectum locates deep down out of the peritoneal cavity. The distal rectum connects with the anus

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at the dentate line. The location of the injury is essential to define appropriate treatment in terms of peritoneal contaminations, developing deep abscesses, and difficult accessibility and repairable.[7] The American Association for the Surgery of Trauma (AAST) launched a rectal injury scale as in Table 1.[8]

Table 1 Rectum injury scale

Grade	Type of injury	Description of injury
I	Hematoma	Contusion or hematoma without devascularization
	Laceration	Partial-thickness laceration
II	Laceration	Laceration < 50% of circumference
III	Laceration	Laceration ≥ 50% of circumference
IV	Laceration	Full-thickness laceration with extension into the peritoneum
V	Vascular	Devascularized segment

Advance one grade for multiple injuries up to grade III

Diagnosis

Diagnosing rectal injury is challenging because the rectum lies within the deepest part of the pelvic cavity, especially the extraperitoneal rectum, which usually has no significant abdominal signs. The rectal injury usually occurs with high-risk mechanisms, such as a high-speed motor vehicle accident with a pelvic injury, pelvic gunshot, or stab wound of the pelvic and perineum. Aihara et al. reported a 2.2% incidence of rectal injury in fractured pelvic patients and three times increasing incidence in the presence of widened pubic symphysis.[9] Patients with urethral injury, bladder injury, anterior-posterior compression types pelvic fractures, or pelvic vascular injuries are highly concerned about rectal injury.[1,9]

1. Digital rectal examination (DRE) has a 33-53% sensitivity with a high false negative rate of 63-67% for diagnosing rectal injury.[10] DRE is operator-dependent and may have confounding factors, such as perineal hematoma or wound. The presence of rectal bleeding is most often used to diagnose rectal trauma. However, the blood may come from the colon without injury to the rectum.[10-12]

2. Proctoscopy has a sensitivity of 71% for diagnosing rectal trauma and 88% for extraperitoneal rectal injury. Intraperitoneal rectal injury may not visualize in a proctoscope examination.[13]

3. Computed tomography (CT scan) can be utilized in a stable hemodynamic patient with suspicious rectal trauma. CT scan may have a role in trajectory identification in penetrating injury. Signs of rectal injury are extravasation of intraluminal contrast, full-thickness rectal wall defect, symmetrical extraluminal free air foci, or hemorrhage within the rectal wall.[1,14] However, in case of no suspicious signs in the CT scan with highly concerned clinical signs of rectal injury, it may require further investigation, such as proctosigmoidoscopy, which is usually done in the operating room as a double set-up.[4] CT scan has a false negative rate of 20%. There is no sufficient evidence support routine use of intraluminal contrast to enhance diagnostic value of CT scan.[1,14]

4. Proctosigmoidoscopy should be performed in the operating room after adequate anesthesia, and the patient should be placed in the lithotomy position. With this method, the sensitivity for diagnosing rectal trauma increases to more than 90%.[4,13] Endoscopic sign of rectal injury is the presence of a rectal wound or blood in the rectum. The previous study showed a higher sensitivity for diagnosing rectal injury at 78% in rigid endoscopy compared to 51% in DRE, and rigid proctosigmoidoscopy can detect 58% of intraperitoneal rectal traumas with the 88% detection rate for extraperitoneal injuries.[13] No current study compares rigid and flexible proctosigmoidoscopy in rectal traumas. Some previous studies in low rectum cancer showed no significant difference in detection, diagnosis, and post-procedure complications between rigid and flexible proctosigmoidoscopy, but more patient's comfortable and more accessible biopsy in flexible proctosigmoidoscopy.[15-17]

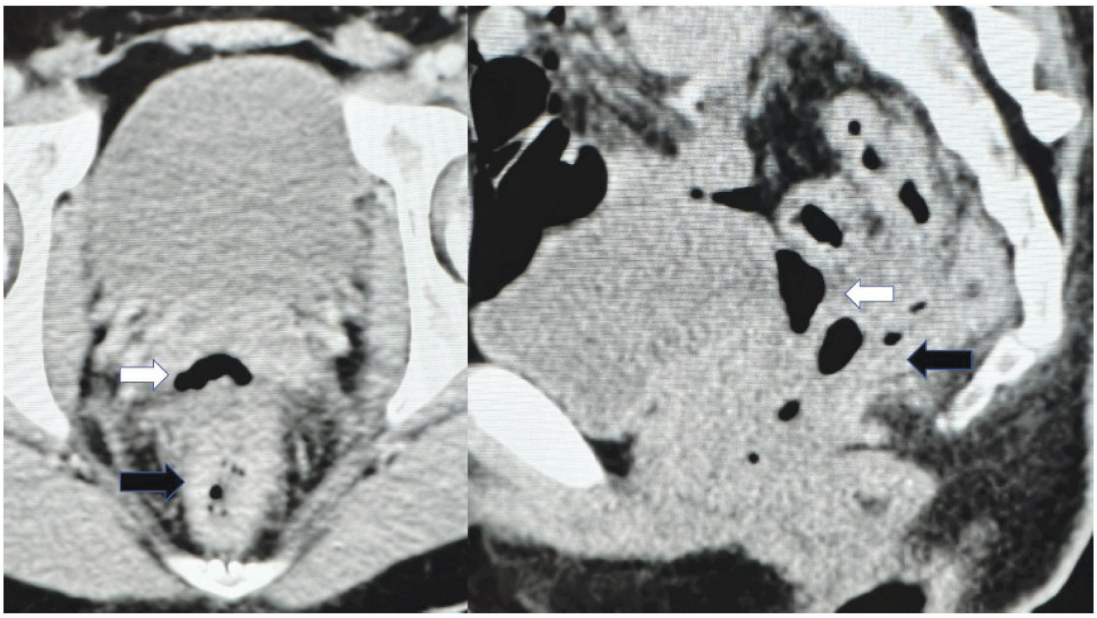

Figure 1 Contrast-enhanced CT scan without intraluminal contrast of extraperitoneal rectal injury (left; axial view, right; sagittal view)
White arrow – extraluminal free air within anterior mesorectal space
Black arrow – non-enhancing anterior lower rectal wall, likely injured site

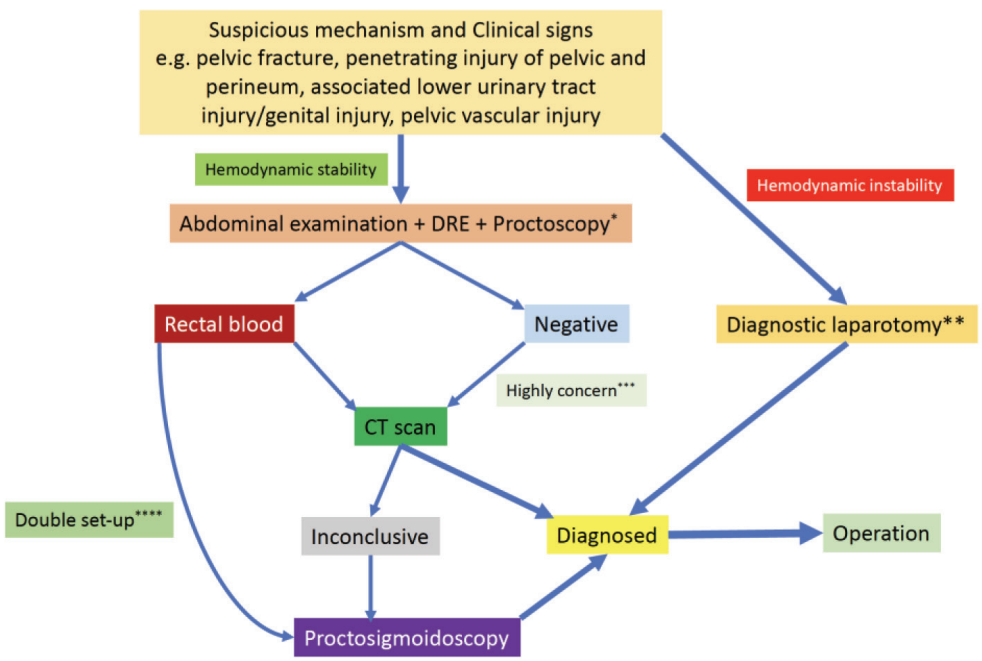

Figure 2 Diagnostic workup of rectal injury
*Bedside diagnostic tool, false positive in GI tract trauma and false negative in intraperitoneal rectal injury or low-grade injury
**Intraperitoneal rectal injury can be found, and may require proctoscopy/proctosigmoidoscopy if suspicious extraperitoneal injury
*** Highly concern in suspicious mechanism, trajectory identification
**** Intraoperative evaluation included proctoscopy under anesthesia

Management

1. Intraperitoneal rectal injury

Current management of the intraperitoneal rectal injury is mimicking to colon trauma. In hemodynamically unstable, the patient must be treated with damage control surgery (DCS), including perforated site closure, bleeding control, temporary abdominal closure, and physiologic restoration in the intensive care unit. The definitive repair should be performed after achieving optimal patient conditions.[18] However, the study in 2017 reported lower ischemic changes after primary bowel repair and anastomosis in DCS compared to conventional DCS, with a mortality rate of 8.3% in primary anastomosis group compared to 16.9% in primary discontinuity ($p = 0.096$).[19] The Eastern Association for the Surgery of Trauma (EAST) reported a meta-analysis of penetrating rectal traumas, which showed a high anastomosis leakage rate in the patient with delayed repair (> 12 h), hypotension, multiple injuries, requiring > 6 units of packed red cells (PRC) transfusion, or concomitant left-sided colon injury. EAST preferred to avoid proximal diversion in the first operation of DCS because it may increase the risk of surgical site infections (SSI) and cause difficult subsequent fascial closure. Additionally, the proximal diversion has no mortality benefit in patients who require DCS. They also suggested resection and primary anastomosis in the exemplary operation rather than proximal diversion.[20] The Western Trauma Association (WTA) also suggested primary repair or resection with primary anastomosis in definitive operation. However, WTA advised proximal diversion in the patient with ongoing shock or unexplained acidosis, concomitant pancreatic or genitourinary injuries, major chronic illness, receiving immunosuppressant, suboptimal perfusion, or inability to fascial closure at the second laparotomy.[18]

In hemodynamic stability intraperitoneal rectal trauma, the patient should be classified into two groups, destructive or non-destructive injury. The non-destructive injury refers to < 50% circumferential bowel wall laceration with no vascular injury. Another hand, destructive injury means severe laceration of the rectal wall with devascularization, which mostly requires resection and anastomosis.[1,4,18] Stone et al. compared primary repair with a proximal diversion in colorectal injuries and found a statistically signific ant lower SSI rate in the primary repair group with ten times increased postoperative complications in the proximal diversion group.[21] Vertree et al. conducted a one-year follow-up on treating soldiers with colorectal traumas from the war in 2003-2006. They reported that the primary repair or anastomosis was the safest choice in isolated colorectal injury. There was no significant difference in postoperative complications compared to the proximal diversion. However, the proximal diversion group may lead to complications after the closure ostomy operation.[22] The prospective trial in 2002-2008 compared stable colorectal traumas, which required < 4 units of PRC and performed the primary repair within eight hours, and the unstable group performed proximal diversion. This study showed lower SSI and ventral hernia rates in the primary repair group compared with proximal diversion.[23]

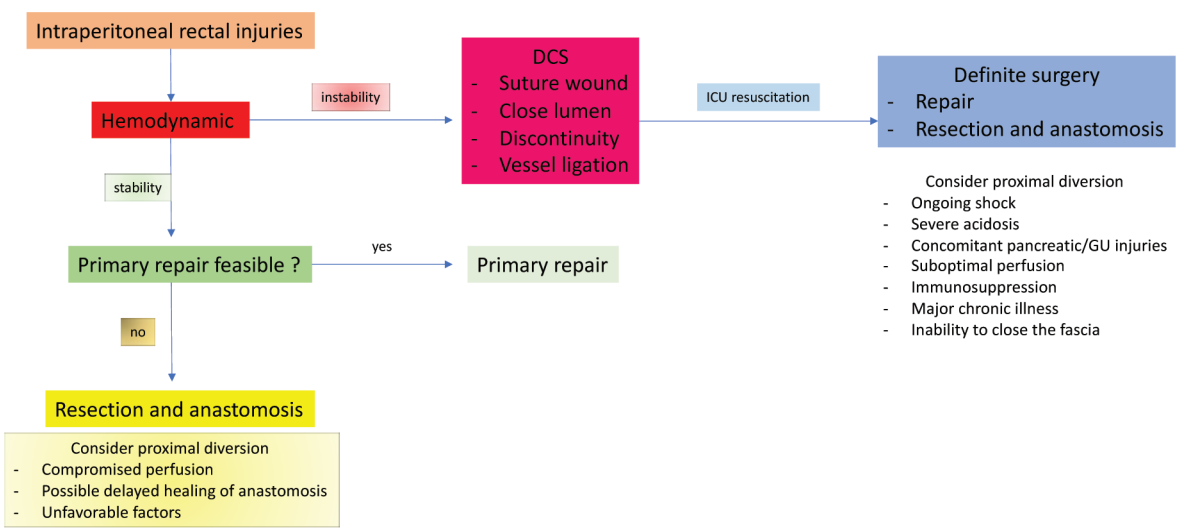

Figure 3 Management of intraperitoneal rectal injury

The systematic reviews of blast colorectal traumas showed no statistically significant difference in treatment outcome of the primary repair and proximal diversion.[24] Current studies showed no difference in outcome between primary repair and proximal diversion.[25-27] EAST suggested primary repair or resection with primary anastomosis in stable intraperitoneal rectal injury.[20] However, WTA still recommended proximal diversion in stable intraperitoneal rectal injury with compromised rectal wall perfusion, risk of compromised anastomosis healing, and unfavorable local environment.[18] The management algorithm of intraperitoneal rectal injury is shown in Figure 3.

2. Extraperitoneal rectal injury

Extraperitoneal rectal injury is challenging to repair because it lies out of the peritoneal cavity, which may be complexly accessible. The current 4D treatment is a famous and widely accepted option among surgeons. This treatment option has details and supporting evidence as follows.

1) Proximal diversion

Proximal diversion primarily aims to prevent further fecal contamination and decrease the risk of intraabdominal infections (IAI). Burch et al. conducted a retrospective study of extraperitoneal rectal traumas in soldiers and reported an IAI rate of 11% with a mortality of 4% in the proximal diversion. They suggested proximal diversion as the essential procedure in extraperitoneal rectal injuries.[26] Proximal diversion was also beneficial in civilian extraperitoneal rectal injuries.[4,28-31] EAST conducted a meta-analysis of 14 studies and reported that proximal diversion reduced the IAI rate from 18.2% to 8.8%. They recommended proximal diversion as the essential procedure for treating extraperitoneal rectal traumas.[32] Recommended proximal diversion methods are;[33]

1. Loop colostomy
2. Loop colostomy with the distal limb closure
3. End colostomy with mucous fistula (double-barrel colostomy)
4. Hartmann's procedure; destructive rectal wall injury
5. Abdominoperineal resection; combined with destructive anal sphincter injury

A comparison study between loop and end colostomy revealed no significant difference in postoperative complications and mortality rate.[34] Mattox et al. suggested loop colostomy rather than others due to rapid and low complication rates. The reversal timing typically occurs after 6-8 weeks, but there was no consensus.[4]

Laparoscopic surgery is increasingly utilized in trauma patients. Studies of diagnostic laparoscopy with diverting loop sigmoid colostomy showed no significant difference in postoperative complications rate compared with open loop sigmoid colostomy. This method would be an appropriate option in an experienced center.[35-38] The advantage of laparoscopic surgery is less invasive, less pain, rapid return to regular activity, and decreased hospital length of stays.

2) Presacral drainage

The purpose of presacral drainage is to contaminate drainage from the presacral space and prevent perineal abscess.[28] The procedure begins with a curve transverse incision at the pre-coccygeal area (1-2 cm anterior to the coccygeal tip). The anococcygeal ligament must be cut to enter the presacral space, and then a soft flat tubular drain must be inserted and fixed.[39] Jon M. Burch indicated proximal diversion could reduce infection rate and suggested proximal diversion rather than presacral drainage.[33] Steinig et al. reported no different infection rate between presacral drainage and no drainage.[40] Gonzalez et al. demonstrated an increased infection rate in presacral drainage compared to no drainage (8% vs 4%).[41] EAST also indicated increased complications and mortality rates in presacral drainage. They against advised to perform presacral drainage in extraperitoneal rectal traumas routinely.[32] However, some studies still suggested presacral drainage in the presence of retro-rectal fluid collection.[5,32]

3) Distal rectal washout

Lavenson et al. proposed distal rectal washout in the Vietnam war, including saline wash to remove feces in the rectum. They demonstrated 0% mortality in the distal rectal washout group compared to 22% in no washout with a lower complication rate (10% vs. 72%).[42] Shannon et al. compared distal rectal washout and no washout in rectal traumas and reported lower complications in the distal rectal washout group, such as pelvic infection, abscess, or fistula.[43] Different from the later retrospective study, which was conducted in penetrating rectal injuries, found no significant difference in developing a pelvic abscess in distal rectal washout compared to no washout (4.7% vs. 4.5%).[44] However, a retrospective study in the Iraq and Afghanistan war showed no statistically significant correlation between distal rectal washout and postoperative complications.[45] Current EAST guidelines showed no significant difference in infectious complications in non-destructive penetrating extraperitoneal rectal inju-

ries performing distal rectal washout compared with no washout (10.3% vs. 9.99%) and mortality rate (1.37% vs. 0.99%). They recommended no required distal rectal washout in non-destructive penetrating extraperitoneal rectal injuries.[32] However, the distal rectal washout may potentially benefit in selected patients, such as proximity to pelvic fractures or large tissue defect (destructive injury).[1,45]

4) Primary repair

Levine et al. conducted a retrospective study of 6 extraperitoneal rectal injuries, 5 cases underwent transanal repair, and one underwent laparotomy with primary repair. All patients were discharged home with no significant complications.[46] Recent studies supported primary repair in non-destructive extraperitoneal rectal injuries, which can be easily visualized and accessible.[4,30,47] The management algorithm of extraperitoneal rectal injury is shown in Figure 4.

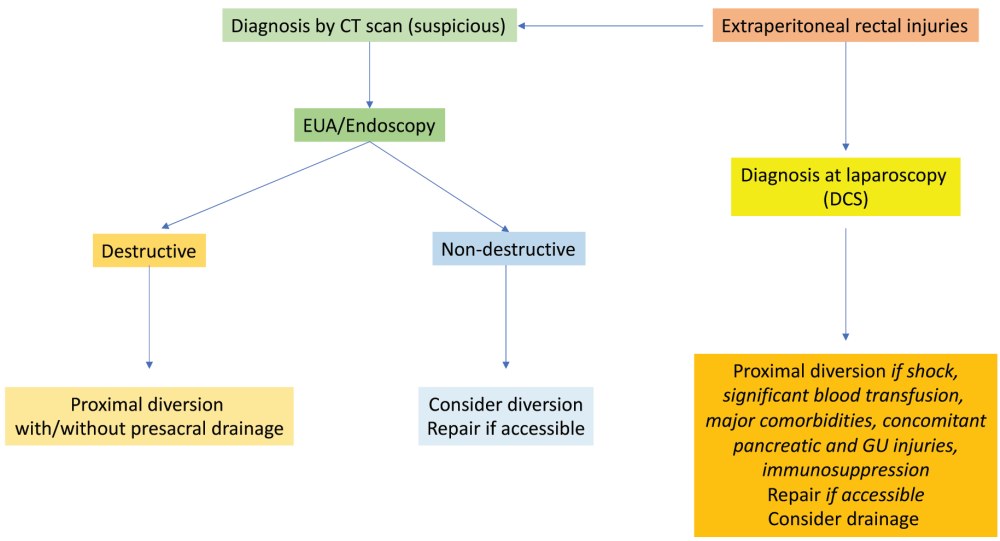

Figure 4 Management of extraperitoneal rectal injury
Non-destructive injury: AAST grade I-II, selected grade III injury (typically do not require significant debridement)
Destructive injury: AAST grade III-V (typically require resection)

Conclusion

Rectal injury is also challenging for surgeons regarding diagnosis and treatment planning. Delayed diagnosis and treatment can lead to severe complications and fatality. The diagnosis should be distinguished between the intraperitoneal or extraperitoneal type. Treatment of intraperitoneal rectal injury is mimicking to colon trauma. Proximal diversion is less required, except in unfavorable situations. Although current evidence suggests proximal diversion as a mainstay treatment of extraperitoneal rectal injury. Primary repair should be attempted if the injured site can be visualized and accessible.

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บทคัดย่อ การรักษาการบาดเจ็บของไส้ตรง

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ไส้ตรงเป็นอวัยวะที่ได้รับบาดเจ็บแล้ววินิจฉัยพลาดได้บ่อย สิ่งสำคัญในการรักษาการบาดเจ็บของไส้ตรงคือ “การตรวจหาให้พบ” และ “ให้การรักษาที่เหมาะสม” เพื่อลดภาวะแทรกซ้อนและการเสียชีวิต เมื่อวินิจฉัยการบาดเจ็บของไส้ตรงได้แล้วต้องทราบให้ได้ว่าการบาดเจ็บเกิดขึ้นกับส่วนที่อยู่ในเยื่อบุช่องท้อง หรือนอกเยื่อบุช่องท้อง ไส้ตรงในเยื่อบุช่องท้องให้การรักษาเหมือนการบาดเจ็บของลำไส้ใหญ่ส่วนอื่น โดยส่วนใหญ่ไม่จำเป็นต้องยกลำไส้เปิดที่หน้าท้อง ตรงกันข้ามกับการบาดเจ็บของไส้ตรงที่อยู่นอกช่องท้องแนะนำให้รักษาด้วยวิธีการยกลำไส้เปิดที่หน้าท้อง และหากจุดที่ได้รับบาดเจ็บอยู่ต่ำใกล้ทวารหนักมากสามารถทำการเย็บซ่อมผ่านทางทวารหนักได้

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Original Article

Predictive Factors for Evaluation Diaphragm Injuries Following Left-sided Thoraco-abdominal Penetrating Wounds in Maharat Nakhon Ratchasima Hospital

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Abstract

Background: Diaphragmatic injuries occur in 3% to 5% of patients with penetrating chest traumas. Diagnosing diaphragmatic injuries is difficult based on physical examination and investigation unless obvious signs and symptoms are present. Diagnostic Laparoscopy (DL) is an efficient technique to diagnose and treat diaphragm injuries at the early stage among hemodynamically stable patients. Routine laparotomy for every penetrating thoracoabdominal wound increases the negative laparotomy rate (5% - 40%), leading to more complications, longer hospital stays, and increased costs. Although DL diminishes the negative laparotomy rate, there are some complications. However, laparoscopic intervention is needed to prevent morbidity from unnecessary operations and negative operative findings.

Objectives: The purpose of this study was to determine the predictive factors to evaluate the left diaphragm injuries undergone by Diagnostic Laparoscopy at Maharat Nakhon Ratchasima Hospital (MNRH) and to discuss the outcomes of the findings between patients with diaphragm injuries and patients without diaphragm injuries

Materials and Methods: This Prospective study was conducted among the patients with left-sided thoracoabdominal penetrating wounds admitted to the MNRH from January 1, 2021, to January 31, 2023. The primary outcome of the study was predictive factors of diaphragmatic injuries. The secondary outcome was the length of stays. Stata/SE v11.1 would analyze all data. Chi-square was used to describe predictive factors between the two groups. *P* value less than 0.05 would be considered the statistical significance.

Results: The total of 52 patients were included. Six individuals (11.53%) had diaphragm injuries. The locations of the injuries below ICS 7th had significant predictive factors of diaphragm injuries, with the odds ratio of 8.73 (95% CI 1.02, 74.95) $p = 0.048$. The length of stay of the two groups had no significant differences between 5.51 ± 11.19 days in normal and 12.93 ± 26.91 days in diaphragm injuries (95% CI 0.98, 1.05), $p = 0.519$. There were no significant predictive factors of gender, age, mechanism, CXR, FAST, and multiple sites of injuries.

Conclusion: The locations of injuries below ICS 7th had significant predictive factors of diaphragm injuries. The study limitations were the small population size and the high percentage of unfavorable intraabdominal results. The length of stay of the two groups had no significant differences, similar to other factors.

Keywords: Diagnostic laparoscopy, Penetrating thoracoabdominal injury, Diaphragm injury

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Introduction

Injuries to the diaphragm occur in 3% to 5% of patients who sustain penetrating chest trauma.[1,2] Early diagnosis of diaphragm injury is difficult based on physical examination and imaging modalities unless obvious signs and symptoms are present.[3-5] Delayed diagnosis and treatment may lead to a diaphragmatic hernia that may cause morbidity or even death.[1] Diagnostic Laparoscopy (DL) is an efficient technique to diagnose and treat diaphragm injury at early stage[6] in hemodynamically stable patients.[7]

Routine laparotomy in penetrating thoracoabdominal wounds increases the negative laparotomy rate (5% - 40%), leading to longer hospital stays, more complications, and increased costs.[8] Although DL diminishes the negative laparotomy rate, there are still some complications.[9,10] However, individual decision-making for laparoscopic intervention is needed to prevent the morbidity of an unnecessary operation under an emergent setting due to high rates of negative intraabdominal findings.[9,11] This study aimed to establish the predictive factor for evaluating left diaphragm injuries following left-sided thoracoabdominal penetrating wounds. It may help to reduce negative-non therapeutic exploration/laparoscopy and preventable complications from diagnostic laparoscopy for stable patients in Maharat Nakhon Ratchasima Hospital.

Practice Management Guideline from the Eastern Association for the Surgery of Trauma recommends for evaluation and management of traumatic diaphragmatic injuries (TDI) (2018)[12]; recommendations were made in favor of laparoscopy over computed tomography for diagnosis, nonoperative versus operative approach for right-sided penetrating injuries, abdominal versus thoracic approach for acute TDI, and laparoscopy (with the appropriate skill set and resources) versus open approach for isolated TDI. No recommendation could be made for the preferred operative approach for delayed.[12]

Correlate with Prospective Evaluation of Laparoscopy in Penetrating Injuries to the Left Lower Chest for Occult Injuries to the Diaphragm (1998), The incidence of occult diaphragmatic injuries in penetrating trauma to the left lower chest is high, 24%. These injuries are associated with a lack of clinical and radiographic findings and would have been missed had laparoscopy not been performed.[3] Patients with penetrating trauma to the left lower chest with no other indication for a celiotomy should undergo a videoscopic evaluation of the left hemidiaphragm to exclude an occult injury.[13]

A retrospective review indication for Using Video-Assisted Thoracoscopic Surgery (VATS) to diagnose Diaphragmatic Injuries (DI) After Penetrating Chest Trauma studied all patients undergoing VATS after penetrating chest trauma at a level 1 trauma center over an 8-year. The diagnostic algorithm was made by if history or physical examination identifies two or more independent predictors of DI (≥ 2 in the algorithm) should undergo VATS to evaluate the hemidiaphragm. Independent predictors of DI are abnormal CXR, associated abdominal injury, high-velocity injury, inferior to nipple line, and right-side wound.[2]

Materials and Methods

This prospective study was conducted in patients with left-sided thoracoabdominal penetrating wounds admitted to Maharat Nakhon Ratchasima Hospital, the 1200-bed tertiary hospital in the Northeast of Thailand with a general surgery residency training program, from January 1, 2021 to January 31, 2023.

The study collected data from electronic medical records and was approved by the Institutional Review Board. All patients met the criteria of being more than 15 years old with hemodynamic stability and no sign of peritonitis, diagnosed with left-sided thoracoabdominal penetrating injuries, and had undergone diagnostic laparoscopic surgery at Maharat Nakhon Ratchasima Hospital. Patients who had a blunt thoracoabdominal injury, hemodynamic unstable, peritonitis, and undergone other surgery were excluded from our study. The following data were collected: age, sex, mechanism of injury, location of the wound, chest X-ray finding as normal or abnormal, FAST/EFAST as normal or abnormal, associated injuries, and length of hospital stay. Patients presented with left-sided thoracoabdominal penetrating wounds who had left diaphragm injuries were assigned to the cases group. Patients who presented with left-sided thoracoabdominal penetrating wounds and did not have left diaphragm injuries were assigned to the control group. The primary outcome of the study was predictive factors of diaphragmatic injuries. The secondary outcome was the length of stays between the two groups.

Statistical Analysis

All data would be analyzed by Stata/SE v11.1. Continuous variables will be presented as mean, SD, median, and IQR where appropriate. Categorical variables will be presented as numbers and percentages. Univariate and multivariate logistic regression were used. Chi-square was used to describe predictive factors between the two groups. Fisher's exact test was used to describe p-value less than 0.05 would be considered as the statistical significance.

Results

From the method of our study, a total of 52 patients were included and received treatment at Maharat Nakhon Ratchasima Hospital. There were 6 individuals (11.53%) who had diaphragm injuries. (5 male patients and 1 female patient). Patients' characteristics were studied and reported in Table 1.

Table 1 Patient characteristics

Variables	Normal (n = 46)	Diaphragm injury (n = 6)	Total (n = 52)	*p*-value
Gender (n %)				
Male	44 (95.65)	5 (83.33)	49 (94.23)	0.588
Female	2 (4.35)	1 (16.67)	3 (5.77)	
Age (n %)				
< 29 y	11 (23.91)	3 (50.00)	14 (26.92)	1.000
≥ 29 y	35 (76.09)	3 (50.00)	38 (73.08)	
LOS (n %)				
< 14 days	44 (95.66)	5 (83.33)	50 (96.15)	0.448
≥ 14 days	2 (4.34)	1 (16.67)	2 (3.85)	
Mechanism (n %)				
Stab	42 (91.30)	6 (100)	48 (92.31)	0.456
GSW	4 (8.70)	0 (0.00)	4 (7.69)	
Weapon (n %)				
Knife	39 (84.78)	6 (100.00)	45 (86.54)	0.355
Gun	4 (8.70)	0 (0.00)	4 (7.69)	
Other	3 (6.52)	0 (0.00)	3 (5.77)	

There were no statistically significant differences in baseline characteristics between the two groups, indicating that the patient characteristics of the entire study population were not variables that would affect the primary and secondary outcomes.

The majority of the injuries discovered were caused by stabbing (92.31%), with knives accounting for 86.54% of the stabbing mechanism and other close objects such as iron, wood, glass bottles, darts, and other sharp objects. Another 7.69% were shot with a gun. The injuries were caused by physical assault, accidents, self-harm, and traffic accidents, in that order.

We found that the location of injuries below ICS 7th was significant for diaphragmatic injury ($p < 0.027$). Positive FAST has the risk of diaphragmatic injury ($p < 0.017$)

The LOS of patients without diaphragmatic injury was significantly shorter than that of diaphragmatic injury (5.51 ± 11.19 day and 12.93 ± 26.91 day for $p = 0.830$) but had no statistical significance. However, other factors had no statistically different (Table 2).

Table 2 Univariable logistic regression for predictive factor

Variables	Normal (n = 46)	Diaphragm injury (n = 6)	Total (n = 52)	Odds ratio	*p*-value	95% CI
Gender (n %)						
Male	44 (95.65)	5 (83.33)	49 (94.23)	4.43	0.206	0.44, 44.52
Female	2 (4.35)	1 (16.67)	3 (5.77)			
Age (mean ± SD)	32.04 ± 12.42	31.64 ± 12.16	32.01 ± 12/36			
Median Age (IQR)	29 (21-39)	28.5 (23-34)	29 (21.5-39)	0.90	0.903	0.17, 4.74
LOS (mean ± SD)	5.51 ± 1.19	12.93 ± 26.91	6.16 ± 13.33	0.71	0.830	0.03, 17.04
Median LOS (IQR)	3 (2-5)	5.5 (4-7)	4 (2-5.5)			
Mechanism (n %)						
Stab	42 (91.30)	6 (100.00)	48 (92.31)	0.92	0.943	0.08, 9.91
GSW	4 (8.70)	0 (0.00)	4 (7.69)			
CXR (n %)						
Normal	26 (56.52)	2 (33.33)	28 (53.85)	4.16	0.105	0.74, 23.30
Abnormal	20 (43.48)	4 (66.67)	24 (46.15)			
FAST (n %)						
Normal	43 (93.48)	5 (83.33)	48 (92.31)	1.44	0.722	0.19, 10.64
Abnormal	3 (6.52)	1 (16.67)	4 (7.69)			
Location ICS (n%)						
Above ICS 7th	20 (43.48)	1 (16.67)	21 (40.38)	1.00		
Below ICS 7th	26 (56.52)	5 (83.33)	31 (59.62)	9.30	0.038*	1.44, 76.27
Location site (n%)						
Anterior	31 (67.39)	5 (83.33)	36 (69.23)	0.50	0.437	0.09, 2.88
Posterior	15 (32.61)	1 (16.67)	16 (30.77)			
Multiples (n%)						
Single	38 (82.61)	5 (83.33)	43 (82.70)	1.12	0.910	0.16, 7.90
Multiple	8 (17.39)	1 (16.67)	9 (17.30)			

However, we need to study which factors are associated with diaphragmatic injury in left penetrating thoracoabdominal injuries, so we used a multivariable survival analysis and regression model that included all of the factors to determine the association for diaphragmatic injury. Especially the location of injuries below ICS 7th was significant for diaphragmatic injury in both univariable and multivariable logistic regression.

The locations of the injuries below ICS 7th had significant predictive factors of diaphragm injuries, with the odds ratio of 8.73 (95% CI 1.02, 74.95) $p = 0.048$. After analyzing the data, it was found that gender, age, mechanism of injury, chest X-ray results, Focused Assessment with Sonography for Trauma (FAST) findings, entrance wound location, number of injury sites, and length of hospital stay did not have any significant predictive value (Table 3).

Table 3 Multivariable logistic regression for predictive factor

Variables	Normal (n = 46)	Diaphragm injury (n = 6)	Total (n = 52)	Adjusted Odds ratio	*p*-value	95% CI
Gender (n %)						
Male	44 (95.65)	5 (83.33)	49 (94.23)	3.62	0.271	0.37, 35.85
Female	2 (4.35)	1 (16.67)	3 (5.77)			
Age (mean ± SD)	32.04 ± 12.42	31.64 ± 12.16	32.01 ± 12/36			
Median Age (IQR)	29 (21-39)	28.5 (23-34)	29 (21.5-39)	0.98	0.515	0.91, 1.05
LOS (mean ± SD)	5.51 ± 1.19	12.93 ± 26.91	6.16 ± 13.33			
Median LOS (IQR)	3 (2-5)	5.5 (4-7)	4 (2-5.5)	1.01	0.519	0.98, 1.05
Mechanism (n %)						
Stab	42 (91.30)	6 (100)	48 (92.31)	0.75	0.813	0.07, 8.07
GSW	4 (8.70)	0 (0)	4 (7.69)			
CXR (n %)						
Normal	26 (56.52)	2 (33.33)	28 (53.85)	3.63	0.136	0.67, 19.70
Abnormal	20 (43.48)	4 (66.67)	24 (46.15)			
FAST (n %)						
Normal	43 (93.48)	5 (83.33)	48 (92.31)	1.35	0.765	0.19, 9.52
Abnormal	3 (6.52)	1 (16.67)	4 (7.69)			
Location ICS (n%)						
Above ICS 7th	20 (43.48)	1 (16.67)	21 (40.38)	8.73	0.048*	1.02, 74.95
Below ICS 7th	26 (56.52)	5 (83.33)	31 (59.62)			
Location site (n%)						
Anterior	31 (67.39)	5 (83.33)	36 (69.23)	0.56	0.518	0.09, 3.29
Posterior	15 (32.61)	1 (16.67)	16 (30.77)			
Multiple site (n%)						
Single	38 (82.61)	5 (83.33)	43 (82.70)	1.19	0.861	0.17, 8.47
Multiple	8 (17.39)	1 (16.67)	9 (17.30)			

In the prospective study from 2021 to 2023, of the 52 patients with left-sided thoracoabdominal penetrating wounds, 6 patients had diaphragm injuries. The majority of these injuries were 90% stab wounds and 5% gunshot wounds. The causes of injuries were body assaults, accidents, self-harm, and traffic accidents, respectively. The populations were male 94.23%, female 5.77%. The average age was 32 years old.[14]

The 33.33% (2 patients) of cases with diaphragmatic injuries were successfully treated by laparoscopic repair, while 66.67% (4 patients) of cases were converted to exploratory laparotomy. The reason for conversion to laparotomy was concomitant injury to other intraabdominal organs, e.g., colon (50%), stomach (50%), spleen (25%), omentum (25%), and large diaphragmatic laceration (25%).

Discussion

The location of the injury below the 7th intercostal space was associated with the diaphragm injury: odds ratio 8.73 (95% CI 1.02, 74.95, $p = 0.048$) consistent with a position below ICS 4[2] and the location of the wound at the 6th-7th intercostal spaces caused a significant injury to the diaphragm.[4]

Patients with left diaphragmatic injuries had a longer hospital stay compared to patients without diaphragmatic injuries, which is not statistically significant.[15]

However, it can last longer with the patient's underlying disease, such as cirrhosis, hepatic encephalopathy, or other complications, such as pneumonia and atelectasis.

The use of diagnostic laparoscopic surgery to detect diaphragmatic injuries in 80 patients with thoracoabdominal penetrating injuries, 72.5% of cases had no diaphragmatic injuries and did not require further open abdominal surgery, while 27.5% had a diaphragmatic injury. In this group, open abdominal surgery was performed to evaluate other abdominal injuries. Among patients with diaphragmatic injuries, other organ injuries were 23% of the spleen, 9% of the liver, and 14% of the stomach.[15,16]

Our study's limitation is an inadequate sample size due to just launching a case series, so some of the data may be different compared to other studies. Moreover, incomplete medical records such as operative technique, site of injury, or size of diaphragmatic defect need to correct and methodically recorded for further study. For the General surgery department of our hospital, we could hopefully obtain more information on a larger sample size and longer period for surveillance to overcome limitations.

Conclusion

We recommended a laparoscopic approach for the diagnosis of diaphragmatic injury in left-sided thoracoabdominal penetrating patients, especially below the 7th ICS position, with stable hemodynamics and without peritonitis. This approach may help to reduce negative-non therapeutic exploration/laparoscopy, minimal invasiveness, and the ability to treat diaphragmatic injury. In this research, other organs injury can be found in these penetrating patients, such as the colon, stomach, spleen, and omentum.

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บทคัดย่อ

ปัจจัยทำนายการบาดเจ็บต่อกะบังลมจากบาดแผลแทงทะลุในตำแหน่งช่องอกและช่องท้องด้านซ้ายในโรงพยาบาลมหาราชนครราชสีมา

กองศิลป์ แวงสันเทียะ, พบ., ปรัชญา อินทร์หมื่นไวย, พบ.

กลุ่มงานศัลยกรรม โรงพยาบาลมหาราชนครราชสีมา

ความเป็นมา: การบาดเจ็บของกะบังลมในผู้ป่วยบาดเจ็บจากบาดแผลแทงทะลุพบได้ร้อยละ 3-5 การวินิจฉัยการบาดเจ็บของกะบังลมจากการตรวจร่างกายหรือการส่งตรวจเพิ่มเติมทำได้ยากหากไม่มีอาการและอาการแสดงของการบาดเจ็บที่ชัดเจน การผ่าตัดส่องกล้องเพื่อการวินิจฉัย (Diagnostic laparoscopy) สามารถวินิจฉัยและให้การรักษาการบาดเจ็บของกะบังลมตั้งแต่ระยะแรกในผู้ป่วยที่มีสัญญาณชีพคงที่ การผ่าตัดช่องท้องในผู้ป่วยที่บาดเจ็บจากบาดแผลแทงทะลุบริเวณช่องอกและช่องท้องทุกราย พบว่าให้ผลผ่าตัดเป็นลบได้ถึงร้อยละ 5-40 ทำให้เกิดภาวะแทรกซ้อนมากขึ้น ระยะเวลานอนในโรงพยาบาลเพิ่มขึ้น และเพิ่มค่าใช้จ่ายที่มากขึ้นด้วย ถึงแม้ว่าการผ่าตัดส่องกล้องเพื่อการวินิจฉัยสามารถลดอัตราการผ่าตัดที่ให้ผลลบ แต่ก็ยังอาจเกิดภาวะแทรกซ้อนจากการผ่าตัดได้ อย่างไรก็ตามการผ่าตัดแบบส่องกล้องก็ยังมีความจำเป็นในการป้องกันการบาดเจ็บหรืออันตรายจากการผ่าตัดช่องท้องที่ไม่จำเป็นและการผ่าตัดที่ให้ผลเป็นลบได้

วัตถุประสงค์: เพื่อหาปัจจัยทำนายการบาดเจ็บต่อกะบังลมด้านซ้ายโดยผ่านการผ่าตัดส่องกล้องเพื่อการวินิจฉัยในโรงพยาบาลมหาราชนครราชสีมาและอภิปรายผลที่ได้ระหว่างกลุ่มผู้ป่วยที่มีการบาดเจ็บของกะบังลมและในกลุ่มที่ไม่มีการบาดเจ็บของกะบังลม

วิธีการศึกษา: เป็นการศึกษาแบบไปข้างหน้าในผู้ป่วยที่ได้รับบาดเจ็บแบบแทงทะลุบริเวณช่องอกและช่องท้องด้านซ้ายที่เข้ารับการรักษาที่โรงพยาบาลมหาราชนครราชสีมาระหว่างวันที่ 1 มกราคม 2563 ถึงวันที่ 31 มกราคม 2565 ผลการศึกษาหลักคือปัจจัยทำนายการบาดเจ็บต่อกะบังลมด้านซ้าย ผลการศึกษารองคือระยะเวลาการนอนรักษาตัวในโรงพยาบาล ข้อมูลที่ได้จะถูกวิเคราะห์โดยใช้โปรแกรม Stata/SE v11.1 ใช้ Chi-square อธิบายปัจจัยทำนายระหว่างข้อมูลประชากรสองกลุ่ม โดยกำหนดให้มีนัยสำคัญทางสถิติเมื่อค่า p-value น้อยกว่า 0.05

ผลการศึกษา: ผู้ป่วยจำนวน 52 รายถูกนำเข้ามาในการศึกษา พบว่า 6 ราย (ร้อยละ 11.53) มีการบาดเจ็บของกะบังลม โดยตำแหน่งการบาดเจ็บที่ต่ำกว่าช่องที่ 7 ของกระดูกซี่โครงเป็นปัจจัยทำนายการบาดเจ็บของกะบังลมที่สำคัญ โดยมีอัตราส่วนความเสี่ยง(ความเชื่อมั่นร้อยละ 95): 8.73 (1.02, 74.95); $p = 0.048$ ระยะเวลาการนอนโรงพยาบาลไม่มีความแตกต่างกันระหว่างกลุ่มที่ไม่มีการบาดเจ็บของกะบังลม 5.51 ± 11.19 วัน และ 12.93 ± 26.91 วันในผู้ป่วยที่มีการบาดเจ็บของกะบังลม (ความเชื่อมั่นร้อยละ 95) : 0.98, 1.05; $p = 0.519$ ปัจจัยด้านเพศ อายุ กลไกการบาดเจ็บ ผลเอกซเรย์ทรวงอก ผลการตรวจด้วยคลื่นเสียงความถี่สูงของช่องท้อง และจำนวนของบาดแผลไม่มีผลต่อการทำนายการบาดเจ็บของกะบังลม

สรุปผลการศึกษา: ตำแหน่งการบาดเจ็บที่ต่ำกว่าช่องที่ 7 ของกระดูกซี่โครงเป็นปัจจัยทำนายการบาดเจ็บของกะบังลมที่สำคัญ ข้อจำกัดคือประชากรในการศึกษามีขนาดเล็กและมีการบาดเจ็บในช่องท้องที่ไม่พึงประสงค์สูง ระยะเวลาการนอนโรงพยาบาลของทั้งสองกลุ่มและปัจจัยอื่นๆ ไม่มีความแตกต่างกัน

คำสำคัญ: การส่องกล้องเพื่อการวินิจฉัย, การบาดเจ็บช่องอกและช่องท้องแบบแทงทะลุ, การบาดเจ็บของกะบังลม

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Original Article

Oncologic Outcomes of Total Pelvic Exenteration in Locally Advanced Rectal Cancer Without Neoadjuvant Treatment: A Retrospective Cohort Study

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Abstract

Background: The retrospective analysis in total pelvic exenteration (TPE) in locally advanced rectal cancer to find the clinicopathologic variables in preoperative (age, gender, tumor size, site, tumor stage, lymph node involvement) and intraoperative (operative time, blood loss) that can be used to predict long-term survival in patients receiving total pelvic exenteration for advanced primary rectal cancer without neoadjuvant therapy.

Methods: 104 individual medical records with curative total pelvic exenteration for locally advanced rectal cancer had they are reviewed. On long-term survival, the effects of several clinical factors were examined.

Results: The five-year survival rate after total pelvic exenteration was 62.5 percent. The five-year survival rate was 88.9% in Stage II and 57.0% in Stage III, with zero 30 days mortality rate. Univariate analysis showed that postoperative survival was affected by tumor stage, lymphovascular invasion (LVI), intraoperative blood loss, operative time, postoperative complication, occur local recurrence, and occur distant metastasis.

Conclusion: TPE can offer long-term survival and effective local control for patients with clinical T4 or locally advanced rectal cancer.

Keywords: Rectal cancer, Pelvic exenteration, 5 years survival, Local recurrence, Non-neoadjuvant

Introduction

Colorectal cancer is the world's third most prevalent cancer diagnosis and the fourth major cause of cancer-related death. One-third of the tumors occurred in the rectum.[1] Locally advanced rectal cancer (LARC), including T3 and T4 cancers and malignancies involving locoregional lymph nodes, has traditionally been difficult to treat. Surgical excision has been difficult and morbid because of the limitations of the bony pelvis near the anal sphincter and the requirement to maintain autonomic nerves. Following neoadjuvant long-course chemoradiotherapy (LCRT) or short-course hypofractionated radiation (SCRT), total mesorectal excision (TME) is the widely accepted guideline of care for LARC. But some guideline has a variant in indication, such as predicted circumferential margin ≤ 1 mm (CRM), advanced T3 substages (T3c/T3d), and extramural vascular invasion (EMVI), which define the probability of both local recurrence and/or synchronous and future metastatic illness.[2,3]

But the resources in radiotherapy were limited in Thailand, and the delay in treatment led to worst oncologic outcomes later. Achieving a clear margin in rectum cancer is difficult due to its close relation to or growth

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in adjacent organs. Total pelvic exenteration (TPE), an exenterative procedure for these advanced cancers, entails the rectum, bladder, and internal genital organs being removed simultaneously. This study aims to demonstrate the result in patients undergoing complex operative procedures. Prognostic factors for local control or survival were evaluated, along with mortality, local recurrence, disease-free survival, and overall survival rates.

Methods

Cohort Study in the medical record of patients from 2012-2017 AD. This included the middle and lower third of rectal cancer patients diagnosed with stage II or III preoperatively and underwent total pelvic exenteration at …… hospital. The inclusion criteria were 1 diagnosis of middle rectal cancer, 2 denied to radiotherapy after consent. The exclusion criteria were 1 patient unable to have surgery, 2 patients did not accomplish follow-up after surgery, 3 patients had a previous surgery due to an emergency condition of rectal cancer such as obstruction, and 4 patients denied to received adjuvant treatment after surgery. The following information was retrieved for analysis: patient characteristics, cancer information, surgery information, resection margin status, postoperative problems, and length of hospital stay. All patients underwent preoperative staging with colonoscopy and CT chest with the whole abdomen, but some patients underwent pelvic MRI in suspicious T4 from the CT scan. This study's ethics approval was given by the Ethical broad committee ….. hospital. The definition of exenterations was classified as either partial or total, as previously reported.[4] The margin of resection was classified into three categories: macroscopically involved (R2), microscopically involved (R1), and microscopically devoid of malignant cells (R0). The work has been reported in line with the STROCSS criteria.[5]

Statistical Analyses

The statistical program SPSS version 20.0 was used for all statistical analyses. For categorical data, descriptive statistics included frequency and percentage; for continuously distributed variables, mean and standard deviation; or median and range in other cases. If applicable, patient characteristics were compared between two groups using the Chi-square test for categorical data and the Mann-Whitney U test for continuous variables. A Cox proportional hazard model with repeated measures was used to estimate cohort survival. Kaplan-Meier survival curves were produced to retrospectively showed survival outcomes, and significance was shown using a log-rank test to assess the overall survival risk. P 0.05 was regarded as statistically significant for all tests.

Results

A total of 123 cases excluded 10 patients from loss follow-up, 7 patients underwent ostomy procedure before TPE due to obstruction, and 2 patients denied adjuvant treatment. The average age in the remaining 104 cases was 56.96 ± 6.74 years (min-max, 40 - 66 years). Patients' sex was predominantly male in 62 patients (59.6%). The common clinical presentations were bleeding per rectum in 27 (26%), pelvic pain in 26 (25%), and asymptomatic in 20 (19.2%). The patient's demographic showed in Table 1. The organ to be invaded by tumor was the prostate in 41 (39.4%), bladder in 32 (30.8%), vagina and bladder in 11 (10.6%), uterus and bladder in 10 (9.6%), anterior organ to rectum with sacral bone in 8 (7.7), and combined

Table 1 Patient's demographic data

Variable (patients' characteristics)	No. of Patients
Sex (%)	Number (%)
Male : female	62 : 42 (59.6 : 40.4)
Clinical presentation (%)	
Bleeding per rectum	27 (26)
Pelvic pain	26 (25)
Asymptomatic	20 (19.2)
Colonic obstruction	11 (10.6)
Pelvic abscess	7 (6.7)
Fecaluria	7 (6.7)
Urinary tract infection (UTI)	6 (5.8)
Underlying disease (%)	
Cardiovascular disease	34 (32.7)
Diabetes mellitus	15 (14.4)
Rheumatoid arthritis	1 (1)
Chronic kidney disease	1 (1)
Tumor location (%)	
Middle third of rectum	72 (69.2)
Lower third of rectum	19 (18.3)
Anal canal	13 (12.5)
Operation (%)	
Total pelvic exenteration	85 (81.7)
Total pelvic exenteration with sacrectomy and lateral pelvic node dissection	19 (18.3)

of vagina-uterus and bladder in 2 (1.9%). The average preoperative CEA level was 46.66 ± 53.05 ng/ml (min-max, 1.40 - 454.0).

All patients underwent total pelvic exenteration, an average operative time was 343.55 ± 83.49 minutes (min-max, 200-600), and an average blood loss was 712.98 ± 426.14 milliliters (ml) (min-max, 200-2,500). The postoperative complications showed pneumonia in 17 (16.3), wound infection in 13 (12.5), and deep vein thrombosis (DVT) in 3 (2.5) but no mortality in this study. The pathological result was negative circumferential margin (CRM) and R0 in all patients, and the cell differentiation was well and moderate. More pathology information is in Table 2.

Table 2 Pathological result

Variables	
Circumferential margin (mm) (mean ± SD)	4.62 ± 2.66
Distal rectal margin (cm) (mean ± SD)	4.70 ± 2.82
Number harvested lymph node (mean ± SD)	23.48 ± 9.69
Number positive lymph node (mean ± SD)	5.66 ± 4.26
Positive lymphovascular invasion (%)	38 (36.5)
Pathological stage (%)	
II	18 (17.3)
III	86 (82.7)

Abbreviation: millimeters-mm, centimeters-cm

An Oncologic result. According to the stage of disease, the 5 years of survival in Stage II-88.9% and Stage III 57.0%. Figure 1 showed 5 years survival rate among stages. Table 3 showed univariate analysis factors associated with 5 years survival rate. The 3 years survival rate in stage II was 88.9%, and in stage III, is was 79.1%. The local recurrence in stage II was 5.6%, and stage III was 20.9%. The average time to local recurrence is 38.10 ± 38.93 months (min-max, 16-180), and the median time to recurrence is 26 months. Univariates analysis factors associated with local recurrence are in Table 4. The metastasis rate in stage II is 22.2%, and in stage III is 52.3%. The site of metastasis shows in Table 5. The average time to metastasis is 34.59 ± 12.88 months (min-max, 18-64), and the median time to metastasis is 30 months. All patients underwent adjuvant chemoradiation therapy according to their stage of disease.

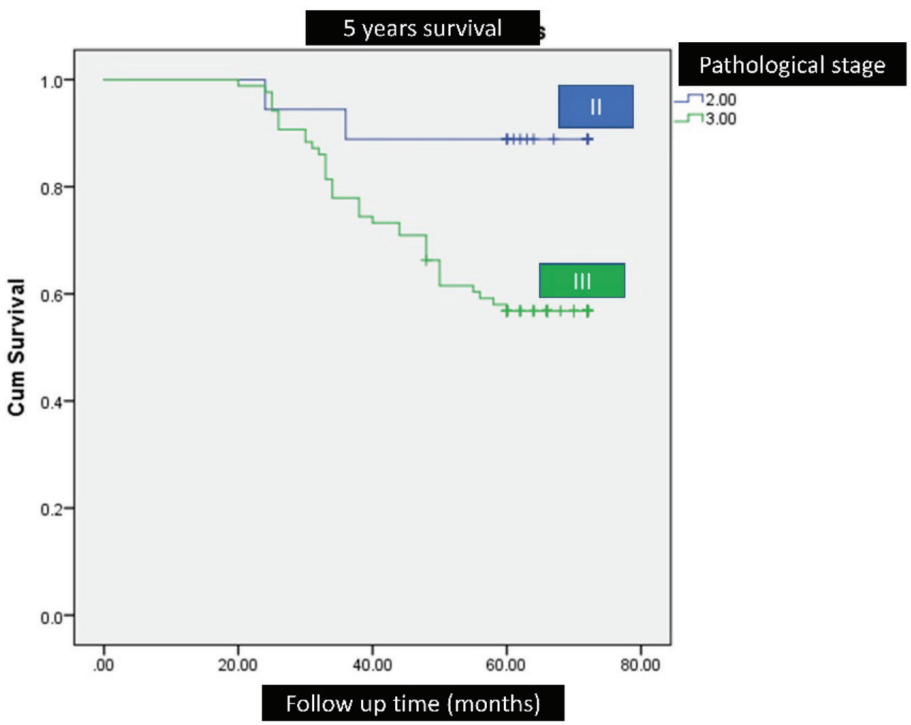

Figure 1 5 years survival among stages of the disease

Table 3 Factors associated to 5 years survival rate

Factor	5 years survival rate		*p*-value
	No	Yes	
Pathological stage (%)			0.014
II	2 (11.1)	16 (88.9)	
III	37 (43)	49 (57)	
LVI positive	27 (71.1)	11 (28.9)	< 0.001
Harvested lymph node	21.79 ± 11.17	24.49 ± 8.61	0.171
Number of positive lymph node	6.10 ± 3.66	5.43 ± 4.60	0.44
Intraoperative blood loss (ml) (mean ± SD)	1,131 ± 567.94	619.41 ± 324.13	< 0.001
Operative time	401.05 ± 102.24	330.70 ± 73.42	< 0.001
Postoperative complication	26 (78.8)	7 (21.2)	< 0.001
Occur local recurrence (%)	15 (78.9)	4 (21.1)	< 0.001
Occur distance metastasis (%)	39 (79.6)	10 (20.4)	< 0.001

Table 4 Factors associated to local recurrence

Factor	Local recurrence		*p*-value
	No	Yes	
Sex			0.037
Male (%)	55 (88.7)	7 (11.3)	
Female (%)	30 (71.4)	12 (28.6)	
Intraoperative blood loss (ml) (mean ± SD)	619.41 ± 324.13	1131 ± 567.94	< 0.001
Operative time	330.70 ± 73.42	401.05 ± 102.24	< 0.001

Table 5 Metastasis site according to the stage of disease

Metastases site	Stage II (%)	Stage III (%)
Liver	-	4 (8.69)
Lung	-	13 (28.26)
Lung & liver	2 (50)	19 (41.30)
Bone	-	1 (2.17)
Brain	1 (25)	3 (6.52)
Carcinomatosis	1 (25)	6 (13.04)

Discussion

Rectal cancer that invasion nearby pelvic organs (especially the urinary bladder) locally, but no distant metastasis could be managed with the aggressive surgical procedure known as pelvic exenteration. It includes a range of operations such as pelvic organ resections, urine diversion, bowel or diversions. This radical procedure induces a significant modification of the quality of life. Previous studies reported 5 years survival rate of 40-52%[6-9] in all locally advanced rectal cancer. The majority of publications that have been published have emphasized survival and complication rates with various treatment approaches.

A margin negative (R0) resection is the main element influencing enhanced survival. It could be technically difficult to obtain negative margins when there is an advanced malignancy with a big volume tumor in the restricted pelvic region and concomitant anatomical deformity. Differentiating between tumor invasions, radiation-induced fibrosis, or local inflammation during intraoperative in these circumstances is one of the most challenging tasks.[10]

Previous studies showed that patients who underwent curative resection with R0 had 5 -a year survival rate of 75%, while no patient with R1 or R2 resection survived for more than two years.[11] In this study, all of the patients achieve R0 resection. Nowadays, the CRM

is a factor of margin resection that is significant in the prognosis of recurrence / metastasis / survival one in refer to margin resection. The study shows it is significantly associated with recurrence and metastasis at a hazard rate (HR) of 6.3 and 2.9 in positive, respectively.HR 2.0 and 1.7 in negative CRM.[12] Recent meta-analysis study show the significance of CRM in oncologic result in positive CRM showed an odd ratio (OR) of 3 years, 5 years local recurrence of 4.35, 4.67, respectively, and OR of 5 years survival is 3.21.[13] Most of the studies recommend CRM at least 1 mm.[14-16] However to keep more CRM negative is likely to advantage to survival; multivariate analysis revealed a 32.4% increase in cancer-specific mortality in the group (> 1 and 5 mm) when compared to another group (> 5 and 10 mm).[17] The main advantage of PE is the much-increased likelihood of resecting the tumor package without exposing malignant cells to the dissection plane.[7]

Regarding the local recurrence rate, this study exhibited a stage III or node-positive rate of 20,9%, which was marginally higher than the 16% in the prior study.[18] Additionally, the study's findings indicate that radiotherapy is an effective local treatment for patients with rectal cancer. A significant finding of research comparing neoadjuvant therapy for rectal cancer to surgery first was a decrease in local recurrence from 8.2% to 2.4%.[19] Insist on the benefit of neoadjuvant treatment, citing a multicenter study that showed a drop in the local recurrence rate from 11% to 5%.[20] This study showed that male, intraoperative blood loss and operative time were associated with local recurrence. The possible explanation is that the male pelvis's anatomy was deep and narrow, leading to difficult assessment and dissection, especially in locally advanced rectal cancer.

About the postoperative complication that affects oncologic outcomes. This study had the common were pneumonia, wound infection, and DVT. The previous study showed that intraabdominal abscess, sepsis, bleeding, and urine leak from ureter anastomosis were common after TPE.[21] Most hypotheses link local recurrence or distant metastasis of cancer to patients' worse survival rates when they have complications. First, exfoliated tumor tissue is implanted in the pelvis, increasing the likelihood of a local recurrence.[22] Second, in terms of infectious consequences such as intra-abdominal abscess, abdominal infection, and pneumonia, the lower survival rates seen in our study and earlier study may be due to immune suppression that causes cancer recurrence and lower survival rates.[23,24] Infections following surgery trigger cytokine cascades that are pro-inflammatory. Tumor necrosis factor-alpha (TNF-), interleukins 1, 6, and 8, natural killer cells, cytotoxic T lymphocytes, and antigen-presenting cells are examples of inflammatory cytokines that may impair their functionality[25-27] and infectious complication following surgery cause delay in the start of adjuvant treatment, which could reduce survival even more.[28,29]

Regarding LVI's positive status. This study shows in a similar way to previous studies. For example, the study in stage II and III colorectal cancer with positive LVI has 5 years of survival at 73% and worsens in positive LVI and perineural invasion(PNI) at 56%.[30] Another study in colorectal cancer showed 5 years survival rate of LVI + patients were significantly lower ($p < 0.001$) compared with that of LVI-negative tumors, resulting as being 44.9% (SE 3.0; median survival 44 months) vs. 64.1% (SE 1.2; median survival 104 months).[31] LVI is now widely recognized as a strong unfavorable prognostic factor and is classified by NCCN recommendations as one of the high-risk features for colon and rectal cancer, alongside positive margins, intestinal obstruction, 12 lymph nodes investigated, perineural invasion, localized perforation, and poorly differentiated histology.

After neoadjuvant was accepted worldwide in locally advanced rectal cancer, the previous study showed a 5 years survival of 56.8% in stage II and 42.3% in stage III,[32] similar to a recent study that showed no difference in overall 5 years survival in comparison between neoadjuvant and adjuvant therapy,[33] but the local recurrence rate is 11.4%.[32] The role of neoadjuvant therapy was improved local control.[34,35]

The study's limitation was the failure to gather some pathological features, such as perineural invasion (PNI) and tumor budding, due to a lack of historical control in the pathology report. The second was selection bias on the decision to TPE was based on an imaging study, CT or MRI, or both. The study of 71 patients showed that 50% of patients diagnosed with T4 rectal cancer who underwent entire TPE had T3 tumors and in another study. who reported that only 61% of 46 patients who underwent TPE for suspicion of bladder involvement had a definitive invasion.[9,36] Finally, the complication was not classified using the Clavien-Dindo system for universal significance.

Conclusion

From our study, TPE can be performed with low morbidity and no perioperative mortality. With a precise and wide margin of surgical dissection, we can achieve a comparable outcome to the previous study,[37,38] especially in the early stages of cancer.

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Case Report

Cutaneous Calcinosis Caused by Parenteral Nutrition Extravasation in a Neonate Treated by Surgical Debulking: Report of a Case

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Abstract Calcinosis cutis is an abnormal deposition of calcium compounds in the subcutaneous tissue that can result from various causes, including malignancy, metabolic diseases, and iatrogenic. In this report, we described a case of calcinosis cutis occurring in a newborn infant following extravasation of parenteral nutrition in neonatal intensive care. Due to its large size and an impending loss of the overlying skin, surgical removal of the calcinotic mass, followed by a full-thickness skin grafting. Evidence from energy-dispersive X-ray spectroscopy suggested that extravasation of the parenteral nutrition and precipitation of calcium phosphate and calcium carbonate explained the pathophysiology of calcium salt precipitation. This report addresses a potential complication from parenteral nutrition extravasation and suggests early management that might prevent the necessity for a major operation.

Keywords: Calcinosis cutis, Parenteral nutrition, Surgery

Introduction

Calcinosis cutis (or cutaneous calcinosis) is defined as the subcutaneous deposition of insoluble calcium compounds. The condition can be idiopathic or associated with various systemic diseases such as systemic sclerosis, lupus erythematosus, metastatic cancers, and chronic renal failure. Rarely were there reports of calcium precipitation caused by an iatrogenic injection of calcium salts or parenteral nutrition containing calcium.[1,2] Deposition of calcium salts is mostly asymptomatic. However, intraarterial precipitation of the crystal may block microcirculation, leading to ischemia and pain, which is known as calciphylaxis.[3]

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This report demonstrates a newborn patient who developed localized cutaneous calcinosis at the foot after receiving parenteral nutrition in a neonatal intensive care unit. Since the calcium-containing lump was associated with skin ischemia, surgical debridement of the deposit was performed. The specimen was sent for microscopic and chemical analysis.

Case Presentation

A 20-day-old male neonate was admitted to our neonatal intensive care unit with a problem of transient tachypnea of the newborn and hypoglycemia. The baby was born via Cesarean delivery to a 38-year-old mother at the gestational age of 37 weeks. The birth weight was 2,850 grams. Shortly after birth, the patient had tachypnea and jitteriness, which prompted admission to the NICU for intensive monitoring and ventilation therapy. With hypoglycemia during the initiation of enteral feeding, supportive parenteral nutrition was given during post-natal days 5-10. The composition of the parenteral nutrition was shown in Supplementary Table 1. Intravenous lipid (4.0 grams/kg/day) was given in a separate container. All the solutions were administered via peripheral intravenous cannular size 24G. On post-natal date 14, the baby was noticed to have a swelling at the dorsum of his right foot. Initially, there was mild erythema of the overlying skin. Phlebitis was impressed, and local therapy was offered with cold compression and antibiotic (cloxacillin). After a week of conservative management, although the inflammation could be improved, the lump did not disappear, and the skin became purplish; surgical consultation was decided.

On radiologic examination of the right foot, a 4.7 × 2.1 × 0.8 cm^3 well-defined elliptical heterogeneous opacities situated in the plane of subcutaneous fat along the dorsum of right foot with mild swelling of the surrounding soft tissue (Figure 1). Complete blood count showed hemoglobin 11.8 g/dL, white blood count 19,830 cells/cu.mm, platelet 612,000 cells/cu.mm. Blood chemistries were as followed: blood urea nitrogen 8.6 mg%, creatinine 0.26 mg%, Na^+ 139.5 mEq/L, K^+ 4.76 mEq/L, Cl- 102.5 mEq/L, CO_2 23.2 mEq/L, Ca^{2+} 10.3 mmol/L and PO^{4-} 6.0 mmol/L. There was no history of endocrine disease in the family. The mother had recent uneventful course of SARS-CoV-2 infection.

On surgical exploration with a circumferential incision made over the ischemic skin area, there were stony hard gritty materials underneath the non-viable skin at the dorsum of his right foot. The foreign body and the covering skin were removed with wound bed left open and cared with negative pressure dressing. The initial defect area was 4.5 × 4 cm^2, which contracted to 3 × 4 cm^2 in one week. The negative pressure of 80-100 mmHg was applied over a polystyrene foam for 7 days until the wound began to have granulation tissue and was covered with a full-thickness skin graft. Histopathology revealed necrosis of the skin and subcutaneous adipose tissue with inflammatory cell deposition (Figure 2).

Supplementary Table 1 Composition of the parenteral nutrition given to the child

Composition	Amount given in 24 hours (per Kg body weight)
Volume	120 ml
Dextrose	12 grams (10% weight/volume solution)
Amino acid	3 grams
NaCl	1.0 mM
Na acetate	1.0 mM
K acetate	0.5 mM
K_2HPO_3	1.0 mM
Ca (gluconate)	1.0 mM
Mg	0.2 mM
Others: Vitamin mixture 2 ml, Heparin, Zn 300.0 micrograms	

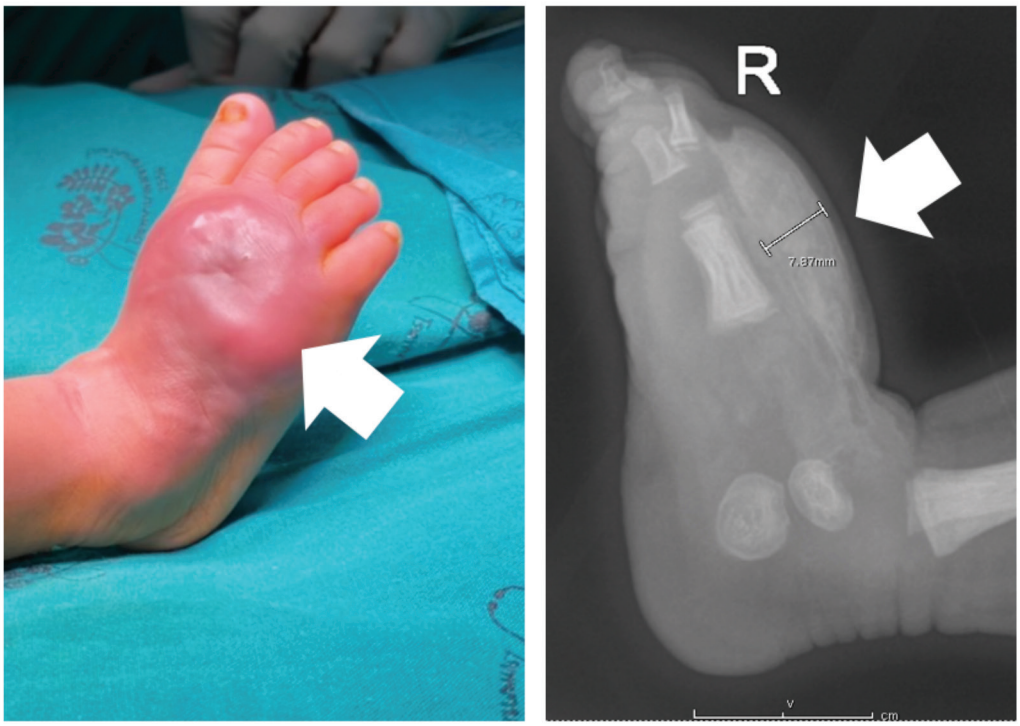

Figure 1 Clinical and radiological picture of calcinosis cutis in this case. Note the swollen skin that was detaching from the underlying tissue because of this mass.

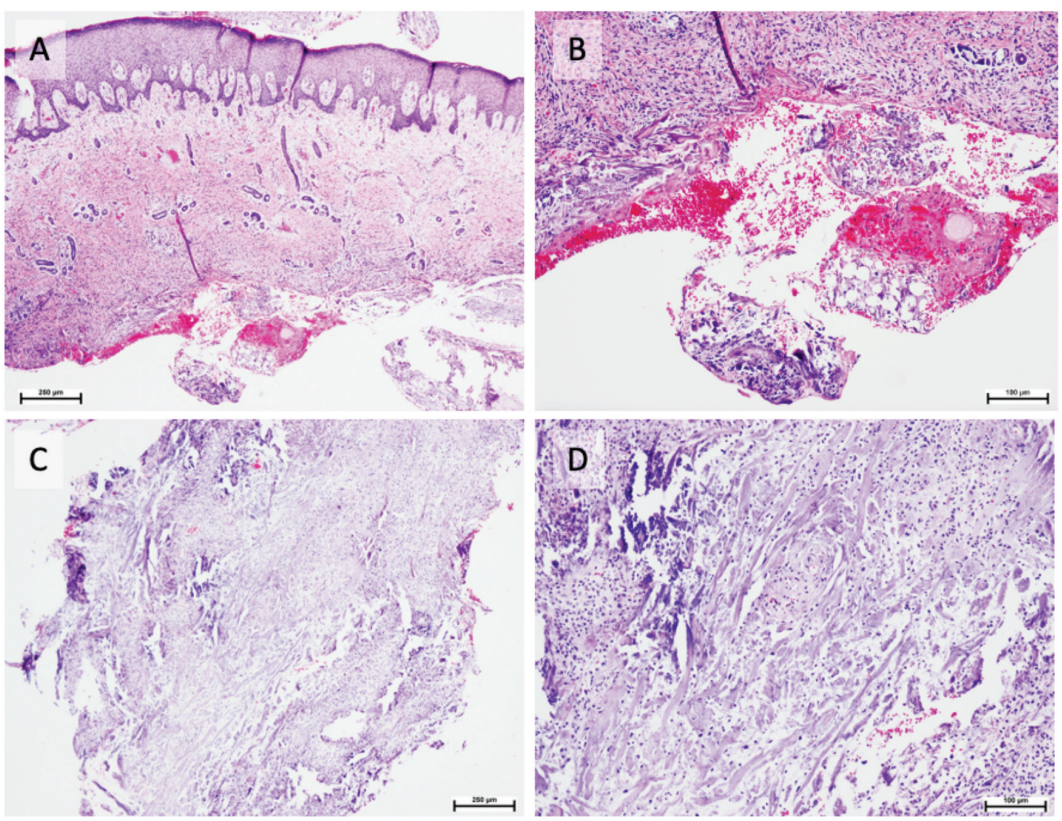

Figure 2 Histopathology of calcinosis cutis in this case. A-B: Deposition of amorphic calcium crystal in the subcutaneous fat C-D: ischemic necrosis of the surrounding tissue

Scanning electron microscopy of the surgical specimen revealed amorphous solid materials situating within adipose tissue (Figure 3). Quantitative compositional analysis using energy-dispersive X-ray spectroscopy (Hitachi SU3900, Japan) reported weight percentage of components as C 53.5%, O 32.1%, Ca 8.1%, P 4.3%, Na 0.8%, Cl 0.5%, S 0.3%, Mg 0.2% and K 0.2% (Figure 4). Fourier Transform Infrared Spectrometer (FTIR) (Bruker Vertex70, Germany) gave an interferogram compatible with a mixture of calcium carbonate and calcium phosphate compound (Figure 4).

On follow-up visit at 6 months following the operation, the wound nicely healed and there was no scar contracture. The patient never developed a cutaneous nodule anywhere else. At the age of 12 months, the patient began to walk in accordance with the developmental milestone.

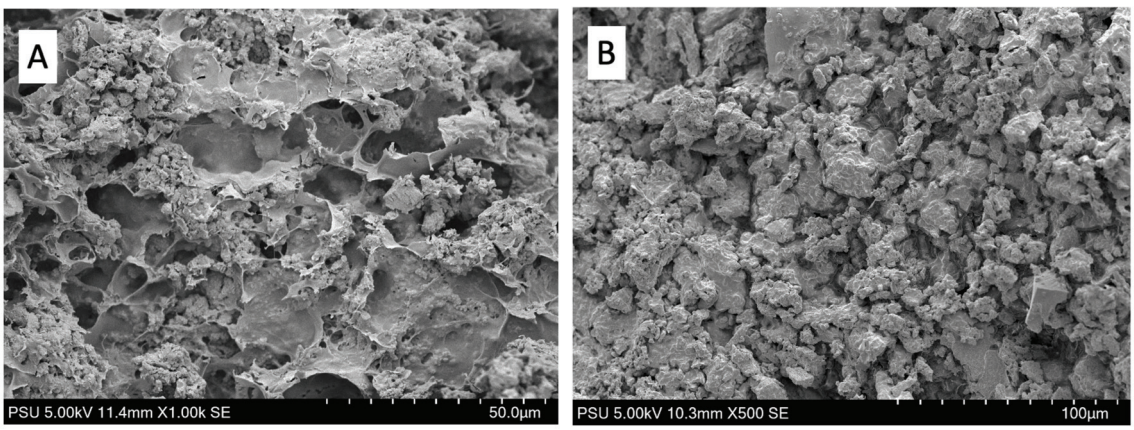

Figure 3 Scanning electron micrograph of the pathological tissue derived from surgical debridement. A:1000X magnification showing precipitation of inorganic crystal within the adipose tissue B:500X magnification

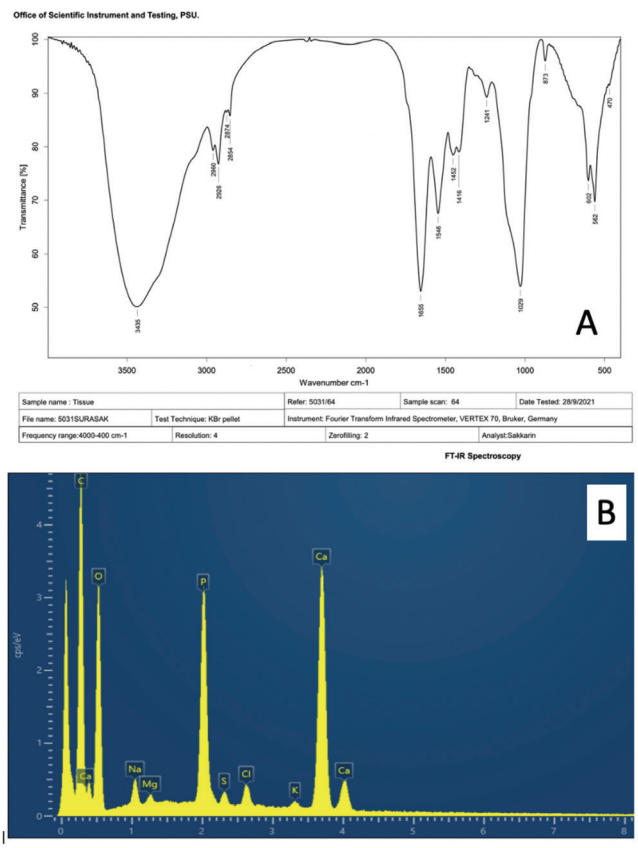

Figure 4 A: Interferogram from a Fourier Transform Infrared Spectrometer which was compatible with mixture of calcium phosphate and calcium carbonate compound B: energy-dispersive X-ray spectroscopy

Discussion

There are at least five types of calcinosis cutis reported in humans which include 1. dystrophic calcinosis, 2. metastatic calcification, 3. idiopathic calcification[4], 4. iatrogenic calcification, and calciphylaxis. Patients with dystrophic calcinosis usually have underlying inflammation that leads to microtrauma of the soft tissue. Such calcification occurs despite normal serum calcium and phosphorus. In metastatic calcification, diffuse calcification develops secondary to hypercalcemia and hyperphosphatemia. The pathology in our case belongs to iatrogenic calcification, and the most likely cause of abnormal calcification was the precipitation of calcium salt from the parenteral nutrition. Although the composition of calcium in the parenteral solution was not abnormally high, hyperphosphatemia, in this case, may predispose the leaked calcium to precipitation in the subcutaneous tissue. Most iatrogenic calcinosis cutis in newborn patients are caused by calcium gluconate extravasation.[5,6] Since the year 1997, skin necrosis following parenteral nutrition as in our case, has been reported.[7] In the report, the wrong calculation of parenteral nutrition led to hyperphosphatemia and calciphylaxis. Consistent with the report, the indication for surgery in our patient was necrosis of the overlying skin.

Electron micrography and chemical analysis in our case by FTIR suggested that the precipitation was a mixture of 2 calcium salts, calcium carbonate and calcium phosphate. The postulation was supported by the results of energy-dispersive X-ray spectroscopy which showed high percentage of carbon, oxygen, calcium, and phosphate in the amorphous crystals laid within the subcutaneous adipose tissue. To our knowledge, this is the first report of details chemical analysis of the calcinosis cutis that occurs following iatrogenic extravasation of parenteral nutrition.

There were reports of successful treatment of iatrogenic calcinosis cutis caused by extravasation of phosphate-containing solution with topical sodium thiosulfate.[8-10] The treatment might help if it could have been started early after the extravasation happened. In our case, surgical decision was made to remove the entire calcinosis because of impending necrosis of the overlying skin at the dorsum of foot, which was a result of a relatively large size of the lesion. With an awareness that residual calcification may act as a foreign body and interfere with the musculoskeletal functions of the foot, copious irrigation and gentle curettage of the subcutaneous plane was done. Following the procedures, the wound surface can be later closed with a full-thickness skin graft, and the child could return to normal development. For discrete tiny calcinosis such as those found in rheumatoid disease, systemic pharmacologic therapies may help improving lesions.[11]

In conclusion, we report a case of iatrogenic calcinosis cutis caused by extravasation of parenteral nutrition. Surgical treatment was given with acceptable outcome.

Acknowledgement

Presentation of clinical materials has been approved by the Human Research Ethic Committee, Faculty of Medicine, Prince of Songkla University. Dave Patterson edited English language in the manuscript.

Conflict of interest

The authors possess no competing interests to declare.

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