Blunt pancreatic trauma: A Western Trauma Association critical decisions algorithm

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BACKGROUND: The Western Trauma Association (WTA) has undertaken publication of best practice clinical practice guidelines on multiple trauma topics. These guidelines are based on scientific evidence, case reports, and best practices per expert opinion. Some of the topics covered by this consensus group do not have the ability to have randomized controlled studies completed because of complexity, ethical issues, financial considerations, or scarcity of experience and cases. Blunt pancreatic trauma falls under one of these clinically complex and rare scenarios. This algorithm is the result of an extensive literature review and input from the WTA membership and WTA Algorithm Committee members.

METHODS: Multiple evidence-based guideline reviews, case reports, and expert opinion were compiled and reviewed.

RESULTS: The algorithm is attached with detailed explanation of each step, supported by data if available.

CONCLUSION: Blunt pancreatic trauma is rare and presents many treatment challenges. (*J Trauma Acute Care Surg.* 2023;94: 455–460.

KEY WORDS: Blunt trauma; pancreatic trauma; abdominal trauma; Western Trauma Association; algorithm.

This is a recommended evaluation and management algorithm from the Western Trauma Association (WTA) Algorithms Committee addressing the management of adult patients with blunt pancreatic injury (BPI). Because there is a paucity of published prospective randomized clinical trials that have generated class I data, these recommendations are based primarily on a thorough literature review of published prospective and retrospective cohort studies, clinical guidelines, and expert opinion of the WTA members. The final algorithm is the result of an iterative process including an initial internal review and revision by the WTA Algorithm Committee members and then final revisions based on input during and after presentation of the algorithm to the full WTA membership.

Because of the retroperitoneal location of the pancreas and the rarity of the injury, occurring fewer than five times per year at high-volume centers, pancreatic trauma presents many diagnostic and treatment challenges with limited high-level evidence to guide management.[1–5] The overall mortality rate ranges from 10% to 30% and is typically related to associated injuries.[6,7] Overall morbidity rates are reported to be as high as 60%, with pancreas-related complication (PRC) rates reported up to 40%.[2,5–8]

The algorithm (Fig. 1) and accompanying comments represent a safe and sensible approach to the evaluation of the patient with blunt pancreatic trauma. We recognize that there will be multiple factors that may warrant or require deviation from any single recommended algorithm and that no algorithm can completely replace expert bedside clinical judgment. This is intended for use as a general framework in the approach to these patients and to be adapted to better suit the specifics of that program or location.

ALGORITHM

The following lettered sections correspond to the letters identifying specific sections of the algorithm shown in Figure 1.

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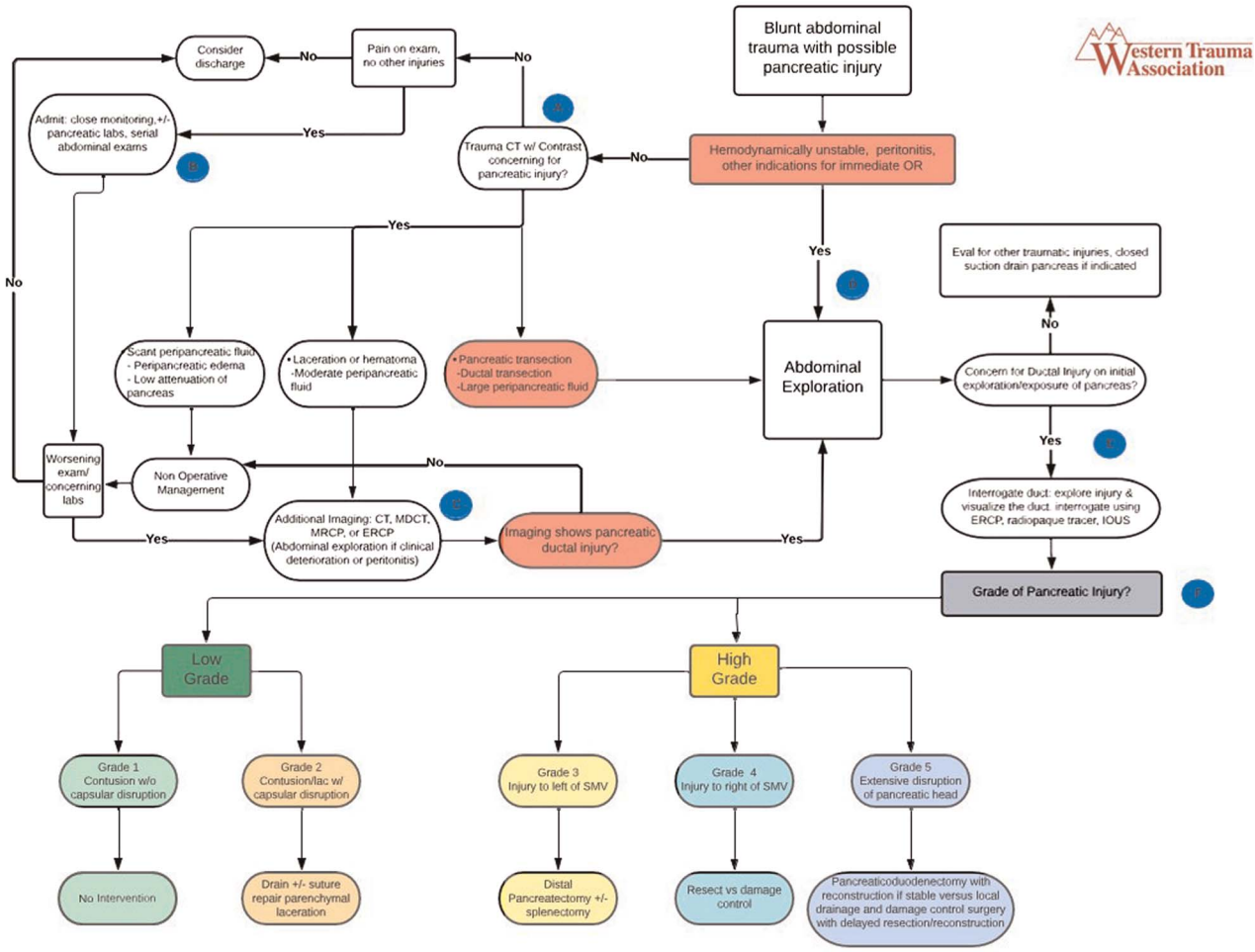

Figure 1. Western Trauma Association algorithm for the evaluation and management of patients with BPI. Circled letters correspond to sections in the associated article.

In each section, we provided a brief summary of the important aspects and options that should be considered at that point in the evaluation and management process. Among patients with BPI, approximately 20% have indications for immediate laparotomy and will have an intraoperative diagnosis (letter "D").

A. Initial evaluation: The diagnosis, classification, and treatment of BPI remains a challenge. Because of the imprecise detail of injury and the retroperitoneal location of the pancreas, pancreatic trauma is often overlooked on initial clinical, laboratory, and radiographic examinations.[5,9] A high degree of clinical suspicion is needed; therefore, high-risk mechanisms and signs such as "handlebar injury" should prompt further imaging.[10] A delayed presentation or clinical deterioration of the patient may be the first clue of an underlying occult or undetected injury. Delayed diagnoses can result in an increased morbidity and mortality of up to 62%; thus, these patients should undergo computed tomography (CT) as part of their initial trauma workup.[11–13] It is important to note that early clinical signs of BPI are vague, and laboratory tests may be nonspecific, while imaging results may be subtle or even falsely negative.

1. Computed tomography scan: CT is the primary modality used to diagnose BPI in hemodynamically stable blunt abdominal trauma patients.[14] This scan is often performed in the initial trauma assessment with intravenous (IV) contrast. The sensitivities for detecting BPI are variable, ranging from 47% to 79%, with specificities between 90% and 95%.[15,16] Although not available at all facilities, multidetector CT scanners, which provide 64 thin-slice imaging cuts, have been shown to improve the specificity of diagnosis of pancreatic duct injury (PDI) to as high as 91% to 100%.[14,15,17] Increased risk of PDI is associated with lacerations involving greater than 50% of the width of the pancreas, pancreatic contusions, and active hemorrhage on CT.[18] The findings of transection of the pancreas or main pancreatic duct (MPD), or a large amount of peripancreatic fluid, should lead to operative exploration given the likelihood of PDI and the need for surgical management.[11,16,17] On the other hand, nonspecific findings of peripancreatic

fluid or fat stranding are compatible with low-grade injury and should be managed nonoperatively.[12,19] Other imaging findings that are not as clear-cut can be deemed "intermediate." Intermediate findings warrant further investigation (letter "C"). A 2021 study by Ball et al.[20] demonstrated the difficulty in accurately diagnosing PDI on screening CT. Varying performances were seen among 24 blinded faculty across 4 different specialties: ductal injury was detected by 44% of general surgeons, 56% of trauma surgeons, 83% of radiologists, and 89% of pancreatic surgeons.[20]

B. Admission with serial monitoring

1. Serial abdominal examinations: Patients admitted without definitive imaging evidence of BPI should be monitored with serial abdominal examinations. Worsening abdominal pain/tenderness, feeding intolerance, fever, or worsening leukocytosis may herald an occult injury and should prompt further imaging.[10,19]
2. Laboratories: Both amylase and lipase have proven nonspecific for BPI; however, if one enzyme were to be used, lipase has been shown to be slightly better at indicating pancreatic injury.[21] One prospective study found elevated enzyme levels to predict BPI when imaging was nondiagnostic within 6 hours after injury.[22] Other studies have shown that serum pancreatic enzyme values are not specific enough to diagnose or exclude BPI, although elevated levels should heighten concern for occult injury.[17,21–23] Buechter et al.[24] reported that enzymes collected on admission and through day 7 were nonspecific. Although elevated pancreatic enzymes are not reliable in either isolated or serial settings to diagnose pancreatic trauma, they have been seen to correlate with BPI >6 hours after initial injury. These elevations seen hours after injury may be useful in diagnosing late or missed injury and should prompt additional imaging.[25,26]

C. Additional imaging: The diagnosis of BPI requires high clinical suspicion. Therefore, if the initial CT scan appears normal but objective findings of an elevated lipase or amylase >6 hours from time of injury, and/or subjectively the patient has worsening abdominal pain, concern for BPI should prompt additional imaging.[10,22] As many as 40% of CT scans in patients with pancreatic injury are initially interpreted as normal.[25] Repeat CT with IV contrast is recommended if clinical concern remains. In the patient with nonspecific findings as previously mentioned, and a clinical concern for injury, pancreatography is recommended to direct further management.

1. Magnetic resonance cholangiopancreatography (MRCP): Magnetic resonance cholangiopancreatography is the primary modality for noninvasive imaging of the pancreatic duct.[17,27,28] The previous WTA algorithm suggested MRCP for evaluation of PDI, but the accuracy of MRCP has subsequently been called into question.[10] Rosenfeld et al.[29] found that when comparing MRCP to CT in pediatric patients, MRCP was found to identify the duct but CT was superior in confirming the presence or absence of injury.[30] Magnetic resonance cholangiopancreatography should still be considered first-line imaging for PDI, but findings should be interpreted cautiously if they do not match clinical suspicion.
2. Endoscopic retrograde cholangiopancreatography (ERCP): Endoscopic retrograde cholangiopancreatography is one of the most sensitive tools to detect ductal injury.[17,31] Advantages of ERCP include the ability to evaluate main duct versus branch duct injuries and to perform therapeutic sphincterotomy or pancreatic duct stenting. Although stenting has been discussed as an adjunct to nonoperative management (NOM), a recent WTA multicenter trial found that this is rare and that two thirds of stents were placed to manage PRCs.[2,8] Enthusiasm for primary stenting is further tempered by the findings of Kim et al.[32] and Bhasin et al.,[33] who reported an association of early pancreatic stenting with pancreatic duct strictures, local and systemic sepsis, and potential worsening of the injury.

D. Operative exploration: In a contemporary series, 21% of BPI was diagnosed intraoperatively.[34] For those undergoing laparotomy, a complete exploration is mandatory. The pancreaticoduodenal complex should be examined via Kocher maneuver and lesser sac exploration if a pancreatic injury is suspected.[10,35]

1. Diagnosis of a PDI: The major determinant of management is the presence or absence of MPD injury. Intraoperative criteria for ductal injury described by Heitsch et al.[36] include complete pancreatic transection, direct visualization of duct injury, laceration through more than half the diameter of the pancreas, central pancreatic perforation, or severe maceration of the pancreas. These clinical criteria have proven helpful in identifying patients most likely to require resection but are not perfect.[37,38] Intraoperative pancreatography via ERCP, transcystic cholangiopancreatography, or transduodenal pancreatography would seem to offer a more objective means of evaluating the MPD, but these techniques have largely fallen out of favor because of logistical challenges and potential morbidity.[20] Indeed, Schellenberg et al.[39] reported a series in which 94% of patients were managed based on visual inspection alone; 6% had intraoperative pancreatography, and the studies were all inconclusive. Intraoperative ultrasound has gained popularity in recent years by trauma and hepatobiliary surgeons, allowing for an efficient and highly sensitive method to evaluate the MPD.[40–42]

E. Treatment: The American Association for the Surgery of Trauma Organ Injury Score is relevant to the management of BPI. Grades I and II (i.e., low grade) injuries are contusions and lacerations that spare the pancreatic duct.[15] Grades III and V injuries are considered "high-grade" injuries. Grade III injuries include MPD injury to the left of the superior mesenteric vein. Grade IV injuries include MPD injuries to the right of the superior mesenteric vein, while grade V involves disruption of the head.[15] At this time, high-grade injuries require definitive surgical treatment. Prior studies found low complication rates (10–14%) of NOM for Grades I and II pancreatic injuries.[4,43,44] More recently, Biffl et al.[8] noted a 4% rate of PRCs in patients with NOM. The goal for high-grade injuries is early exclusion of

the MPD to avoid duct-related complications that carry a morbidity of up to 60%.[10,14]

1. Low grade: Although PDI is associated with a significant increase in PRCs, there can still be significant morbidity associated with low-grade injuries.[5,8] Based on the recent multicenter WTA trial, the lowest rate of PRCs is seen after NOM (4%), which is recommended in those patients who have no other indication for laparotomy.[8] For low-grade injuries diagnosed intraoperatively, drain placement is recommended only if there is pancreatic capsule disruption. This is based on an incidence of PRCs of 26% after drainage of blunt low-grade injuries.[8] If there is evidence of capsular disruption, drainage is recommended to control the leakage. However, resection of low-grade injuries should be avoided, as the occurrence of PRCs (42%) is significantly higher after resection compared with other management strategies.[8]
2. High grade: With insufficient data to support NOM in adults, operative management of high-grade injuries is recommended.

   a. Grade III: Distal pancreatectomy has long been recommended for grade III injuries. Biffl et al.[2] noted that there was no difference in PRCs between patients treated with resection (41%) compared with those treated with drainage (29%), raising the possibility that drainage may be a noninferior option. Until this is studied prospectively, distal pancreatectomy remains the recommendation for grade III injuries. [2,34,37]
   b. Grade IV: Although drainage of pancreatic head injuries has been increasingly performed based on reports from Memphis, there was no confirmation of MPD injury.[37,38] In the recent WTA and AAST multicenter trials, there were concerning trends suggesting potentially higher rates of PRCs after drainage versus resection.[2,34,45] A retrospective study from 1995 to 2020 evaluated management and outcomes of 36 patients with Grade IV pancreatic injuries. When comparing resection versus nonresection, patients with a Grade IV pancreatic injury appear to benefit from resection with fewer pancreatic complications, shorter hospital stay, and better quality of life.[8,46] Although none of these studies are sufficient to make firm conclusions, the current recommendation is to perform resection if adequate surgical expertise is available. If adequate surgical expertise is not available, drainage is recommended; similarly, in the setting of physiologic compromise, damage control with drainage and a staged procedure is recommended.[2,47] Surgical treatment options include extended distal pancreatectomy, near total pancreatectomy, or roux-en-y pancreaticojejunostomy.[2,35] To avoid endocrine dysfunction, 20% of the gland should be preserved.[4]
   c. Grade V: For Grade V injuries, pancreaticoduodenectomy will generally be required. As with Grade IV injuries, those patients with physiologic compromise or inability to perform the definitive procedure, damage control surgery, drain placement, and, ultimately, a staged procedure are recommended.[2,47]

F. Pancreatic related complications: Complications from pancreatic injuries carry significant morbidity and mortality, including fluid collections, leaks, hemorrhage, fistulae, and chronic sequelae of pseudocysts. For patients with drains, amylase levels should be followed on days 1 and 3 after placement. Those with drain amylase less than that of serum can be removed.[10] Persistent pancreatic leak should prompt further imaging and possible intervention.

G. Postadmission management: Isolated BPI is rare. When mining the National Trauma Data Bank, Siboni et al.[9] found that isolated pancreatic injuries occurred in 0.7% of those admitted with abdominal trauma. This single study found that the median hospital stay for patients with low-grade injury was 9 days and 11 days for those with high-grade injury; however, these later patients had compounding injuries including chest and head. Recommendations regarding intensive care unit admission, diet, activity, and prophylactic anticoagulation for deep vein thrombosis have not been studied in isolated blunt pancreatic trauma. Clinical judgment based on accompanying injuries should guide treatment and care.

AREAS OF CONTROVERSY AND EXISTING KNOWLEDGE/RESEARCH GAPS

There are many areas of this algorithm that lack high-quality evidentiary support and where further focused research is required. There were several areas that generated significant discussion and

TABLE 1. Top Identified Knowledge and Research Gaps Related to BPI

Topic or Research Gap	Algorithm Section
1. What is the utility/performance of pancreatic amylase and lipase 6 h after injury?	B: Initial evaluation — laboratories
2. Is the role of ERCP in initial diagnose and treatment of pancreatic injuries obsolete? What are the risks and complications?	C: Imaging — ERCP
3. What is the sensitivity and specificity of intraoperative ultrasound in the diagnosis of pancreatic injury, and how does it compare to more invasive techniques?	D: Diagnosis of PDI
4. Is drainage superior to operative management in Grade III pancreatic injuries?	E: High grade — grade III
5. What is the role for NOM of pancreatic injuries with ductal involvement?	F: Management of pancreatic injuries
6. What are the outcomes and costs associated with operative management versus NOM of high-grade blunt pancreatic injuries?	F: Management of pancreatic injuries
7. For patients with isolated blunt pancreatic trauma, what are the best management guidelines following admission?	G: Postadmission management

debate within the committee during the development of this algorithm and from the WTA membership during the period of public commentary. Regarding the initial diagnosis of BPI, there was disagreement about the utility and reliability of pancreatic enzyme levels including amylase, lipase, or both. While there was general agreement that an initial enzyme level obtained shortly after injury has limited value, there was debate about whether serial enzyme levels provide added diagnostic benefit to observation with serial examinations and cross-sectional imaging. There was also significant debate about the accuracy of abdominal CT scan for identifying BPI and whether MRCP provides any greater diagnostic yield compared with a modern high-quality CT scan with multiplanar reconstructions. There was general agreement that both modalities can miss a major pancreatic injury with duct involvement when performed early after the initial trauma and that repeat imaging with either modality should be liberally used based on any clinical suspicion or with equivocal findings on the initial CT or MRCP.

Several areas around the management of high-grade BPI (Grades III to V) also generated significant debate and differing approaches. The data comparing resectional versus nonresectional management are not definitive. Drainage is generally a safe approach. There are concerns over the long-term outcomes, as there is currently no reliable treatment for a pancreatic fistula. This requires prospective study. For the intraoperatively discovered pancreatic injury, there was no consensus on the optimal approach to evaluate for the presence of a concomitant injury to the pancreatic duct. Commonly used options included local exploration of the wound and visual inspection only, on-table contrast imaging via the gallbladder or cystic duct, or on-table ERCP. Evolving data around the use of intraoperative ultrasound were reviewed and appear to offer a highly reliable and noninvasive method to make this distinction and guide the choice of intervention. There was recognition that this option may not be available because of the lack of required equipment or expertise of the surgeon. However, trauma surgeons should be trained to be proficient in ultrasound.

Table 1 provides a list of existing research "gaps" related to this topic that were identified by the authors during the development of this algorithm and the discussions within the Algorithms Committee and during the presentation of this algorithm at the 2022 WTA Annual Meeting.

SUMMARY AND CONCLUSION

Nonoperative management for low-grade injuries and operative management for high-grade injuries have become the mainstay of treatment for blunt pancreatic trauma. Clinicians need to maintain a high degree of suspicion in diagnosing pancreatic injury and a low threshold for repeat imaging in patients who are admitted for nonoperative of blunt abdominal trauma.

AUTHORSHIP

A.M.M. and M.J.M. contributed in the conception and design. A.M.M. contributed in the acquisition of data. A.M.M., W.L.B., C.G.B., E.E.M., and M.J.M. contributed in the analysis and interpretation of data. A.M.M. contributed in the drafting of the manuscript. M.J.M., C.V.R.B., E.E.M., W.L.B., E.J.L., J.L.H., M.d.M., J.A.W., D.V.S., C.G.B., and R.S.C. contributed in the critical revision of the manuscript. A.M.M., W.L.B., C.G.B., and E.E.M. contributed administrative, technical, or material support. A.M.M., M.J.M., W.L.B., C.G.B., and E.E.M. contributed in the supervision. All authors have seen and approved the final manuscript as submitted. The first author (A.M.M.) had full access to all data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.

DISCLOSURE

The authors declare no conflicts of interest.
The results and opinions expressed in this article are those of the authors and do not reflect the opinions or official policy of any of the listed affiliated institutions.

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