

# Conservative versus operative management in stable patients with penetrating abdominal trauma: the experience of a Canadian level 1 trauma centre

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**Background:** The goal of conservative management (CM) of penetrating abdominal trauma is to avoid nontherapeutic laparotomies while identifying injuries early. Factors that may predict CM failure are not well established, and the experience of CM has not been well described in the Canadian context.

**Methods:** We searched a Canadian level 1 trauma centre database for all penetrating abdominal traumas treated between 2004 and 2014. Hemodynamically stable patients without peritonitis and without clear indications for immediate surgery were considered potential candidates for CM, and were included in the study. We compared those who were managed with CM with those who underwent immediate operative management (OM). Outcomes included mortality and length of stay (LOS). Further analysis was performed to identify predictors of CM failure.

**Results:** A total of 72 patients with penetrating abdominal trauma were classified as potential candidates for CM. Ten patients were managed with OM, and 62 with CM, with 9 (14.5%) ultimately failing CM and requiring laparotomy. The OM and CM groups were similar in terms of age, sex, injury severity, mechanism and number of injuries. There were no deaths in either group. The LOS in the intensive care (ICU)/trauma unit was  $4.8 \pm 3.2$  days in the OM group and  $2.9 \pm 2.6$  days in the CM group ( $p = 0.039$ ). The only predictor for CM failure was intra-abdominal fluid on computed tomography (CT) scan (odds ratio 5.3, 95% confidence interval 1.01–28.19).

**Conclusion:** In select patients with penetrating abdominal trauma, CM is safe and results in a reduced LOS in the ICU/trauma unit of 1.9 days. Fluid on CT scan is a predictor for failure.

**Contexte :** L'objectif du traitement conservateur des traumatismes abdominaux pénétrants est d'éviter les laparotomies non thérapeutiques tout en ciblant rapidement les blessures. On n'a pas réussi à établir clairement des facteurs permettant de prédire la probabilité d'échec de ce type de traitement, ni bien décrit les paramètres d'utilisation de ce dernier dans le contexte canadien.

**Méthodes :** Nous avons recensé dans la base de données d'un centre de traumatologie canadien de niveau 1 tous les cas de traumatismes abdominaux pénétrants traités entre 2004 et 2014. Les patients dont l'état hémodynamique était stable, qui ne souffraient pas de péritonite et qui ne nécessitaient pas manifestement une chirurgie immédiate ont été inclus dans l'étude en tant que candidats potentiels pour le traitement conservateur. Nous avons comparé les patients ayant reçu le traitement conservateur avec ceux ayant tout de suite été opérés. Nous avons entre autres évalué la mortalité et la durée de séjour. D'autres analyses ont été effectuées pour mettre en évidence des indicateurs de l'échec du traitement conservateur.

**Résultats :** Au total, 72 patients affichant des traumatismes abdominaux pénétrants ont été classés comme des candidats potentiels pour le traitement conservateur. De ce nombre, 10 ont été opérés, et 62 ont reçu le traitement conservateur. Ce dernier a échoué chez 9 patients (14,5 %), qui ont dû subir une laparotomie. Les 2 groupes étaient semblables sur le plan de l'âge, du sexe, de la gravité des blessures et du mécanisme et du nombre de blessures. Aucun décès n'a été observé parmi les 2 groupes. La durée du séjour à l'unité de soins intensifs ou de traumatologie était de  $4,8 \pm 3,2$  jours pour les patients ayant été opérés et de  $2,9 \pm 2,6$  jours pour les patients ayant reçu le traitement conservateur ( $p = 0,039$ ). Un seul indicateur de l'échec du traitement conservateur a été analysé, soit la présence de fluide intra-abdominal sur le tomodensitogramme (rapport de cotes 5,3; intervalle de confiance à 95 % 1,01–28,19).

**Conclusion :** Chez un sous-groupe de patients souffrant de traumatismes abdominaux pénétrants, le traitement conservateur est sécuritaire et se traduit par une durée de séjour inférieure de 1,9 jour. La présence de fluide détectée par tomographie est un indicateur de l'échec du traitement.

**M**andatory laparotomy for all penetrating abdominal trauma was considered the standard of care for the majority of the first half of the 20th century.<sup>1</sup> In the absence of findings to suggest intra-abdominal injuries, laparotomy was performed primarily to rule out or intervene upon potential catastrophic injuries early. In hemodynamically stable, asymptomatic patients, laparotomy has been found to be nontherapeutic in up to 70% of cases,<sup>2</sup> leading to clinically significant complication rates.<sup>3</sup> Increasingly, conservative management (CM) of select patients with penetrating abdominal trauma is being used by trauma surgeons.<sup>1,4,5</sup> A fairly common modern practice for stab wounds, CM has even recently been adopted for select patients with gunshot wounds to the abdomen.<sup>1,6</sup> Conservative management consists of a thorough trauma assessment to rule out contraindications, computed tomography (CT) to assess intra-abdominal pathology, close hemodynamic monitoring, serial physical examinations and serial labwork. Contraindications to CM include hemodynamic instability, peritonitis on clinical examination and concomitant head injury or other condition precluding reliable serial examinations.<sup>5</sup> Evisceration is largely considered to be a relative contraindication to CM.<sup>5</sup> The majority of the literature pertains to adult patients; however, CM has also been shown to be safe in children.<sup>7</sup>

A 2012 Cochrane review<sup>8</sup> identified only 1 randomized controlled trial (RCT)<sup>9</sup> comparing operative to nonoperative management for any type of abdominal trauma in hemodynamically asymptomatic patients. That 1996 RCT by Leppäniemi and Haapiainen<sup>9</sup> randomized 51 stable, asymptomatic patients without evisceration to either mandatory laparotomy or observation. They found a 55% nontherapeutic laparotomy rate, with CM failing in 17% of the observed patients, ultimately requiring laparotomy. There was no difference between the groups in mortality or morbidity, and hospital stay in the observation group was 3 days shorter.<sup>9</sup>

The primary objective of the present study was to compare the clinical outcomes of initial operative management (OM) with CM in hemodynamically stable, asymptomatic patients. A secondary objective was to identify predictive factors for patients in whom CM ultimately fails, leading to laparotomy. With relatively low volumes of penetrating trauma occurring in Canadian trauma centres compared with many centres in the United States or internationally, the role of CM has not been well studied in the Canadian context. The present study aims to describe the role and outcomes of CM in a Canadian level 1 trauma centre.

## METHODS

We performed a retrospective analysis of a prospectively collected trauma database to identify all patients who received a diagnosis of penetrating abdominal trauma between 2004

and 2014 at The Ottawa Hospital (TOH), a Canadian level 1 trauma centre. The database captures all patients with an injury severity score (ISS) of 12 or greater or for whom a trauma team activation was initiated. At TOH, all penetrating abdominal injuries initiate a trauma team activation. We reviewed the charts of all patients with a diagnosis of penetrating abdominal trauma to identify those who were considered to be candidates for CM. Candidates for CM included patients aged 18 years or older with evidence of peritoneal penetration who were hemodynamically stable throughout the trauma team assessment, who were found not to have peritonitis on examination, and in whom there was no absolute indication for operative management (e.g., retained foreign body, CT evidence of bowel injury, other severe intra-abdominal injury). Hemodynamic stability and peritonitis were determined based on the recorded interpretation of the treating surgeon. The CT images were obtained using intravenous contrast, but without oral or rectal contrast. Patients who were treated with CM were admitted to either the intensive care unit (ICU) or trauma unit, with 1:2 nursing and continuous monitoring. They were managed with serial examinations by the on-call trauma surgeon or resident every 2–3 h and repeat bloodwork every 6–8 h.

## Statistical analysis

We collected descriptive demographic data on the included patients. We compared patients based on initial management (operative v. CM) using  $\chi^2$  or Student *t* tests. Outcomes of interest were in-hospital mortality, hospital length of stay (LOS), combined LOS in the trauma unit/ICU, nontherapeutic laparotomy rate, and rate of failed CM requiring laparotomy. Analysis was performed among patients treated with initial CM to identify predictive factors for failure of CM; this was done using frequency tables and the Fisher exact test for categorical variables and the Student *t* test for continuous variables. We performed the statistical analyses using SAS software version 9.3 (SAS Institute Inc.).

## RESULTS

A total of 167 patients were identified as having penetrating abdominal trauma between 2004 and 2014 (Fig. 1). Of these, 95 were excluded. Common reasons for exclusion were no evidence of peritoneal penetration on either physical exam or CT (*n* = 33), CT findings requiring operative management (*n* = 21) and hemodynamic instability (*n* = 20). Other reasons included retained foreign bodies requiring retrieval, and transfer from an outside centre after emergency laparotomy. Therefore, 72 patients were identified as having penetrating abdominal trauma with peritoneal violation and were considered candidates for CM. Injury locations included 29 anterior, 18 flank, 15 thoracoabdominal and 3 back, and 7 patients had injuries in more than 1 anatomic location. Among these

patients, 10 were managed operatively while 62 were initially managed conservatively. Of those managed conservatively, CM ultimately failed in 9 (14.5%), requiring laparotomy. Table 1 displays the demographic characteristics and main presenting features of all 3 groups (OM, successful CM, and failed CM). No significant differences between the groups were found in terms of age, sex, ISS, mechanism and number of injuries, or vital signs. The mean age of included patients was  $30.1 \pm 14.3$  years, and there was only 1 female patient.

Among the 10 patients managed operatively, 3 underwent laparoscopy and 7 underwent laparotomy. There was no surgical repair required in 6 patients, repair of abdominal wall bleeding in 2, repair of gastric laceration in 1, and placement of a Jackson-Pratt (JP) drain for a liver laceration in 1. The 6 cases resulting in no surgical repair were evenly split between laparotomy and laparoscopy, resulting in a negative laparotomy rate of 42.9% (or 57.1% if including the JP drain placement). In the failed CM group, the mean time to the operating room (OR) was 27.15 h; however, this was affected by 1 significant outlier (124.9 h) who had persistent pain due to hemoperitoneum. Removing this outlier, the mean time to the OR was  $14.9 \pm 11.25$  h, which approaches the median time to the OR of 15.3 h. Reasons to operate on a CM patient included development of peritonitis on examination ( $n = 3$ ), reports of worsening pain ( $n = 3$ ), hemodynamic changes ( $n = 2$ ) and dropping hemoglobin value ( $n = 1$ ). The operative findings in the failed CM group included 2 small bowel injuries requiring repair,

1 gallbladder injury requiring cholecystectomy, 3 abdominal wall bleeding vessels requiring repair, 1 liver laceration requiring suture repair, and 2 operative explorations without repair. Only 1 patient in the entire cohort underwent a procedure by interventional radiology; this was a hepatic artery embolization of a patient successfully treated by CM.

There were no deaths or major septic complications in either the OM or CM groups. The combined LOS in the trauma unit/ICU was  $2.9 \pm 2.6$  days in the CM group and  $4.8 \pm 3.2$  days in the OM group ( $p = 0.039$ ). The patients in the CM group who did not require an operation had an LOS in the trauma unit/ICU of 2.79 days, whereas the 9 patients in whom CM failed had a stay of 3.56 days. The overall hospital LOS was  $4.4 \pm 4.1$  days in the CM group and  $16.4 \pm 18.5$  days in the OM group ( $p < 0.001$ ); however, this result was confounded by an increased proportion of self-inflicted injuries among the OM group, resulting in longer stays under the psychiatric service.

Using frequency tables and  $t$  tests, multiple factors were evaluated as possible predictors for the failure of CM. Factors found to be nonpredictive were age ( $p = 0.77$ ), initial heart rate on presentation in the emergency department (ED;  $p = 0.18$ ), serum ethanol level ( $p = 0.44$ ) and single versus multiple abdominal injuries ( $p = 0.23$ ). There was a nonsignificant trend toward successful CM in patients who were assaulted compared with those who were self-harmed (odds ratio 0.21, 95% confidence interval [CI] 0.04–1.1). The only factor found to be predictive of CM failure was the presence of free

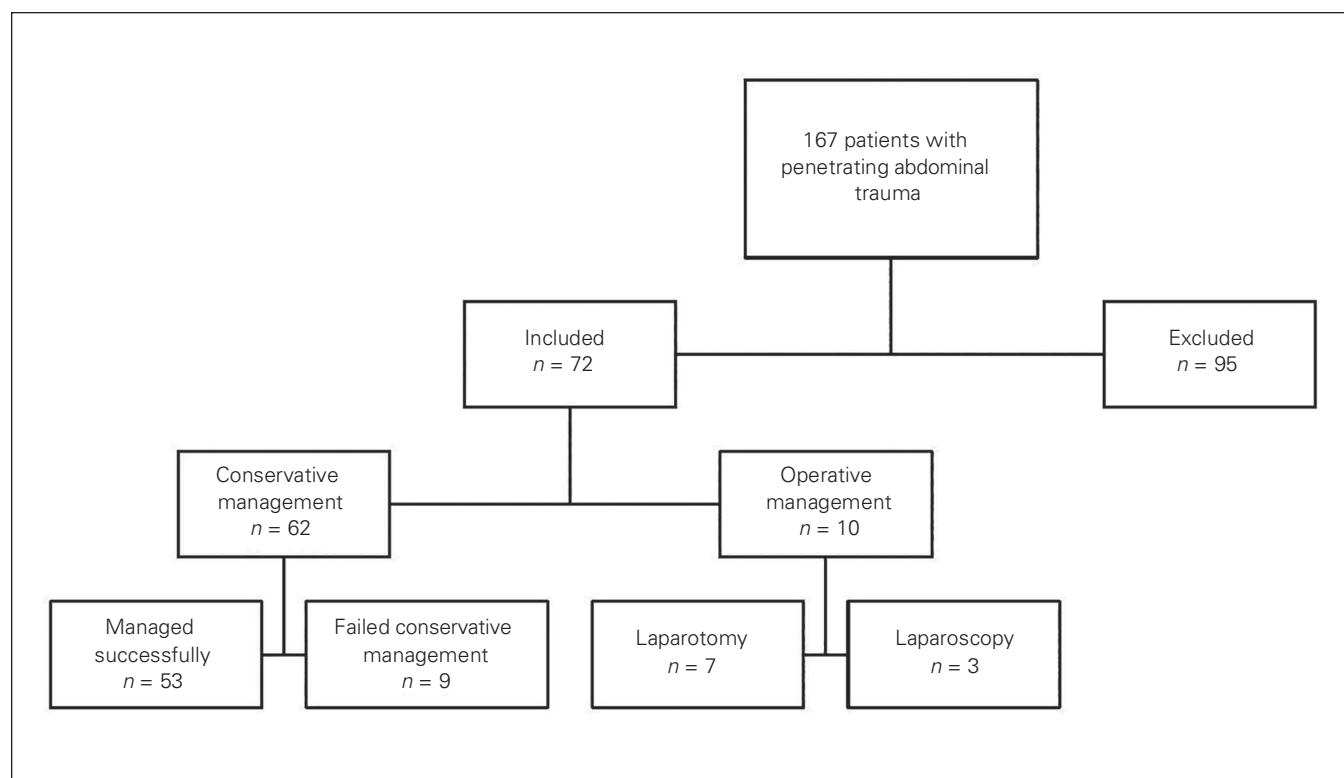


Fig. 1. Study patients with penetrating abdominal trauma identified from the trauma database.

intra-abdominal fluid on the initial CT scan (odds ratio 5.3, 95% CI 1.01–28.19). In other words, CM eventually failed in 7 of 28 (25%) patients with free fluid on CT, requiring laparotomy. Comparatively, CM failed in 2 of 34 (5.9%) patients without free fluid on CT. Hence, free intra-abdominal fluid on CT demonstrates a sensitivity of 77.8%, a specificity of 60.4%, a positive predictive value of 25%, and a negative predictive value of 94.1% for requiring laparotomy.

**DISCUSSION**

The selective use of conservative management for penetrating abdominal trauma has become a well-established and accepted approach over the past few decades. As can be seen in the present study, 86% of patients identified as stable and asymptomatic between 2004 and 2014 at TOH were initially managed nonoperatively. Furthermore, this study demonstrates that CM can result in equally low rates of short-term mortality and morbidity as OM, while avoiding a negative laparotomy rate of 42.9% and reducing the LOS in the trauma unit/ICU by approximately 2 days. Both this negative laparotomy rate and reduction of LOS are comparable to results of other studies.<sup>9,10</sup> We also highlight the importance of close clinical monitoring of patients treated with CM, as 14.5% ultimately required laparotomy. Similar failure rates can be seen in the literature.<sup>11,12</sup> Peritonitis alone, in the absence of hemodynamic changes, was found in 1 study to have positive intra-abdominal injuries in 97% of cases.<sup>13</sup> Therefore, these patients need repeated clinical exams, not just simple reassurance of normal vital signs. The presence of intra-abdominal free fluid on CT scan was an independent predictive factor for failure of CM, with 25% of these patients requiring laparotomy. This finding should increase a clinician’s suspicion of failure and could be a relative indication for diagnostic laparoscopy. While laparoscopy can certainly be a useful diagnostic and therapeutic tool in patients

with penetrating abdominal injuries, it cannot entirely rule out intra-abdominal pathology. In particular, laparoscopy has been found to have a sensitivity of only 18% for gastrointestinal injuries.<sup>14</sup> It can, however, be of great value for evaluating diaphragmatic injury in patients with thoracoabdominal injuries, which are not well assessed with CT scan.<sup>14</sup> To increase sensitivity for diagnosing intestinal injury, the addition of oral and rectal contrast material before CT scan (triple-contrast CT) is used in some centres and has shown high accuracy in identifying the need for laparotomy.<sup>15,16</sup> The technique performed in our centre for patients with penetrating abdominal trauma is intravenous contrast alone, which has also been shown to be effective.<sup>17</sup> No comparisons between the techniques could be found in the literature.

To the best of our knowledge, the correlation between free fluid on CT and CM failure is unique in the literature. Free fluid in the peritoneal cavity can be blood, bile, or fluid secondary to peritoneal irritation. It has often been considered to be a concerning finding,<sup>1</sup> but has been shown in the present study to have an odds ratio of 5.3 for failure of CM. Identifying free intra-abdominal fluid as a poor prognostic factor for patients receiving CM should help guide clinical decision-making and increase a clinician’s suspicion for intra-abdominal injury.

Another important strength of this study is the robustness of the prospectively collected database. A dedicated database manager records extensive clinical data on all trauma team activations and patients presenting to the ED with an ISS of 12 or greater. These data span the entire course of the patient’s hospital admission, from initial presentation to discharge. The breadth of data helps to ensure that the OM and CM groups in this study are comparable on many important factors. Furthermore, demonstrating the safety and potential benefit of CM in a Canadian trauma centre is important. While safe monitoring for CM patients requires an experienced trauma team, the present

**Table 1. Demographic characteristics and presenting features of all patients**

Category	Group; mean ± SD*			p value
	OM (n = 10)	Successful CM (n = 53)	Failed CM (n = 9)	
Age, yr	38.4 ± 22.8	28.6 ± 12.5	29.9 ± 10.5	0.14
Male sex, %	100	98.1	100	0.83
ISS	6.5 ± 6.9	10.9 ± 7.2	7.9 ± 5.2	0.13
Mechanism of injury				0.62
Stab wound	9	48	9	
Gunshot wound	1	5	0	
No. of external injuries				0.19
Single	5	36	8	
Multiple	5	17	1	
Initial heart rate, bpm	108 ± 20	98 ± 20	88 ± 22	0.11
Initial systolic BP, mm HG	142 ± 30	132 ± 23	130 ± 16	0.35

BP = blood pressure; CM = conservative management; ISS = injury severity score; OM = operative management; SD = standard deviation.  
\*Unless indicated otherwise.

study has demonstrated its feasibility in a centre with a relatively low volume of penetrating trauma.

### Limitations

The present study is limited by its retrospective nature. Reviewing charts and databases, no matter how robust, does not capture many of the clinical decisions made in the assessment of a trauma patient. There may have been evidence of more concerning injuries in the OM group that wasn't recorded in the clinical notes or diagnostic imaging reports. The sample size, particularly in the OM group, was small but representative of the volume of penetrating trauma in the majority of Canadian trauma centres. The small sample size may have prevented the identification of other predictive factors for the failure of CM, such as mechanism or number of injuries. The sample size also contributed to decreased precision in the statistical analysis, as can be seen by the wide CIs of the odds ratios.

The duration of close clinical monitoring in patients receiving CM has been considered in previous studies, many of which concluded that if peritoneal signs are not present on examination after 12 h of observation, there is very low likelihood of intraperitoneal injury.<sup>18,19</sup> In a series of 68 patients ultimately requiring laparotomy during CM, Alzamel and Cohn<sup>19</sup> found that none occurred after the 12-h mark. In the present study, however, 5 of the 9 laparotomies in the CM group occurred after the initial 12-h window. Two of these laparotomies revealed only hemoperitoneum with no repair performed, but 1 required ligation of an abdominal wall vessel after 22 h of observation, and 2 cases of small bowel enterotomies went to the OR after 15.5 and 22.1 h, respectively. This evidence may support continued observation of asymptomatic patients for up to 24 h.

### CONCLUSION

Our study has demonstrated that, when compared with routine OM, CM is safe for well-selected patients with penetrating abdominal trauma in a Canadian level 1 trauma centre. Conservative management avoids negative laparotomies, the rate of which in the present series was found to be greater than 40%, and can result in a 2-day decreased hospital LOS. Patients who have findings of free intra-abdominal fluid on initial CT scan have an increased risk of CM failing and could be considered for OM (either laparotomy or diagnostic laparoscopy) or at least an increased suspicion for intra-abdominal injury. For patients treated with CM, we recommend an observation period of 24 h, after which they can be safely discharged if there is no evidence of deterioration.

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**Competing interests:** None declared.

**Contributors:** S. Bennett and J. Lampron designed the study. All authors acquired the data, which S. Bennett, A. Amath and J. Lampron analyzed. S. Bennett wrote the article, which all authors reviewed and approved for publication.

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