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e-ISSN: 3048-9814 (Online)
Vol. 2 No. 5 (2025)
July 2025 Issue

INDIAN JOURNAL OF INNOVATIVE CLINICAL RESEARCH

Received 16 May 2025
Revised 15 June 2025
Accepted 19 July 2025

REVIEW ARTICLE

A COMPREHENSIVE REVIEW ON NON-OPERATIVE MANAGEMENT OF SOLID ORGAN INJURIES: SUCCESSES AND PITFALLS IN SPLENIC AND LIVER TRAUMA

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Abstract

Introduction: Non-Operative Management (NOM) has become the standard approach for managing blunt solid organ injuries, particularly in hemodynamically stable patients. This review focuses on the application of NOM in hepatic and splenic trauma, highlighting its clinical efficacy, evolving practices, and the implications for surgical training.

Methods: A comprehensive review of the literature was conducted to evaluate the outcomes, selection criteria, imaging practices, adjunct procedures, and educational significance of NOM in the management of blunt liver and spleen injuries.

Results: The literature reveals high success rates for NOM, with blunt liver trauma showing nearly 100% success and splenic injuries demonstrating rates between 94.7% and 96.4%. Clinical stability is the primary criterion for selecting patients. Early CT imaging plays a crucial role in assessing injury severity, and splenic artery embolization emerges as a highly effective adjunct in high-grade splenic injuries, achieving success rates above 98%. Notable complications include delayed splenic rupture and injuries from associated trauma.

Conclusion: Strict adherence to selection protocols based on hemodynamic stability, accurate imaging, and organized follow-up significantly enhances the success of NOM. This approach not only promotes organ preservation and reduces morbidity and costs but also serves as a valuable training opportunity for surgical residents when supported by standardized guidelines and multidisciplinary responsiveness.

Keywords: Non-operative management, splenic trauma, hepatic trauma, blunt abdominal trauma, splenic artery embolization, trauma surgery

e-ISSN: 3048-9814 (Online)
Vol. 2 No. 5 (2025)
July 2025 Issue

BACKGROUND/INTRODUCTION

In the past several decades, non-operative management (NOM) has become the gold standard for treating blunt solid organ injuries, especially those involving the spleen and liver. There has been a monumental shift from earlier surgical treatments to more conservative and less invasive NOM because of improvements in imaging, the capabilities of intensive care units, and the overall better understanding of the injury-pattern-based physiologic responses in patients. For patients who are hemodynamically stable or who can be made stable, NOM is safe, effective, and, at the same time, preserves organ function in addition to reducing postoperative morbidity and overall healthcare expenditures [1].

This review analyzes the benefits and challenges of implementing NOM for splenic and hepatic injuries. It is intended for third-year junior residents to dissect the findings, grappling with the steps taken and obstacles faced in contemporary non-operative managed care pathways, situating them within the recent consensus guidelines and literature evaluative debates.

RESULTS

Success Rates and Outcomes

A cornerstone of the argument in favor of NOM is its high success rate. Multiple studies documented in the literature have established that non-operative strategies can yield excellent outcomes when applied in selected patients. For instance, one retrospective study reported an overall NOM success rate of approximately 96.4% in patients with blunt hepatic and splenic trauma, with liver trauma patients achieving 100% success and splenic injuries reporting success rates of 94.7%9. Similarly, current data from consensus documents suggest that when NOM is applied appropriately, success rates can reach up to 95%12.

The following table compares the reported success rates from several studies:

Table 1: Comparison of NOM Success Rates in Liver and Splenic Injuries

Organ Injury Type	Reported Success Rate	Source Description
Blunt liver trauma	100%	Ruscelli et al. (chunk 213)

e-ISSN: 3048-9814 (Online)
Vol. 2 No. 5 (2025)
July 2025 Issue

Blunt splenic trauma	94.7% – 96.4%	Ruscelli et al. (chunks 23, 24, 213)
Overall NOM	Up to 95%	Follow-up strategies consensus (chunk 110)

These high success rates underscore the efficacy of NOM and justify its widespread acceptance. The outcomes are not only measured in terms of survival but also include parameters such as organ salvage, reduction in transfusion requirements, and minimized complications compared with traditional surgical approaches17.

Moreover, studies have demonstrated a significant reduction in hospital costs as well as postoperative complications like non-therapeutic laparotomies or infectious issues following surgical interventions. This comprehensive benefit profile has cemented NOM as the standard of care for patients who are hemodynamically stable917. The robust performance of NOM is further bolstered by the integration of modern imaging modalities – particularly computed tomography (CT) – which allow for precise injury grading and facilitate patient monitoring during the non-operative approach9.

Patient Selection and Diagnostic Protocols

Hemodynamic Stability as the Primary Selection Criterion

Central to the successful implementation of NOM is the careful selection of patients based on clinical criteria. Hemodynamic stability is the most critical determinant for considering a non-operative approach. Patients who are stable or responsive to fluid resuscitation are ideal candidates for NOM9. Clinical studies indicate that the presence or absence of hemodynamic instability is the single most important factor influencing the decision-making process20. For instance, hemodynamically unstable patients, or those showing signs of peritonitis, are more likely to be directed toward operative management2021.

Role of Diagnostic Imaging

Diagnostic imaging, particularly CT scanning, is pivotal in the evaluation and management of blunt abdominal trauma. An early CT scan performed upon patient admission allows for a detailed assessment of liver and splenic lesions, evaluating the presence of contrast extravasation, hematomas, or other signs indicating active bleeding9. The early integration of CT imaging into trauma management protocols has been shown to improve survival rates and prognosis920.

In practice, patients undergo a total-body CT scan soon after initial stabilization. This detailed radiologic evaluation helps classify injuries according to

e-ISSN: 3048-9814 (Online)
Vol. 2 No. 5 (2025)
July 2025 Issue

established scales, such as the American Association for the Surgery of Trauma (AAST) Organ Injury Scale. The imaging results not only provide a baseline for treatment planning but also serve as an essential tool in monitoring the progress of NOM9.

Protocols and Clinical Pathways

Most high-volume trauma centers have developed specific institutional protocols to standardize the application of NOM. These protocols typically involve:

- Immediate and continuous monitoring of vital signs
- Regular serial examinations to assess abdominal tenderness or changes in the patient's clinical status
- Repeated imaging when necessary, particularly if there is a decline in hemodynamic stability
- A low threshold for transitioning to operative management if any signs of deterioration are observed

These protocols are designed to balance the dual objectives of minimizing unnecessary surgical interventions while ensuring that no critical changes in the patient's condition are missed20.

Visualization: Patient Selection Process Flowchart

Below is a Mermaid flowchart that illustrates the decision-making process for selecting patients for NOM:

e-ISSN: 3048-9814 (Online)
Vol. 2 No. 5 (2025)
July 2025 Issue

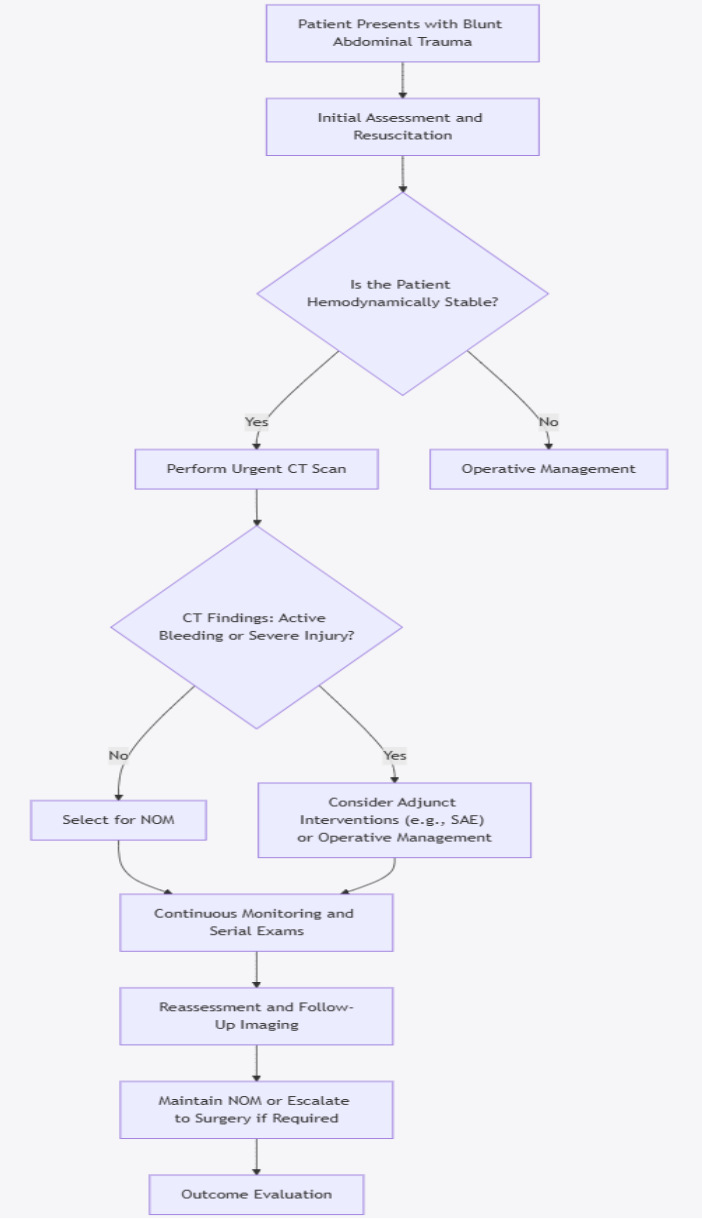

Figure 1: Decision Flowchart for Patient Selection in Non-Operative Management of Blunt Solid Organ Injuries

This flowchart demonstrates the importance of hemodynamic stability, imaging findings, and regular clinical re-evaluation in the management pathway, ensuring patient safety and optimal outcomes.

Role of Adjunctive Techniques: Splenic Artery Embolization

Splenic artery embolization (SAE) has become an important adjunct in the non-operative management of splenic injuries. When indicated, SAE has been associated with improved splenic salvage rates, particularly in injuries classified as intermediate or high grade.

Efficacy of SAE

The integration of SAE into NOM protocols can significantly decrease the rate of operative interventions. One study reported a clinical success rate of 97% following SAE, with only a small percentage of patients requiring subsequent splenectomy due to recurrent

e-ISSN: 3048-9814 (Online)
Vol. 2 No. 5 (2025)
July 2025 Issue

bleeding or pseudoaneurysm formation3. These results have further enhanced the reputation of NOM approaches, making them safer and more appealing in the modern era.

Some studies have compared observation alone versus the addition of SAE, using propensity score matching to control for treatment biases. Notably, while SAE is generally associated with higher salvage rates—approaching 98% in some reports—these analyses suggest that, after correcting for confounders, there may be no significant difference in success between observation and embolization in selected cases1. This finding emphasizes the need for individualized decision-making and reassessment of the role of SAE based on patient-specific factors.

Indications and Contraindications

SAE is particularly indicated in cases where CT imaging reveals contrast extravasation or when patients are classified as having an AAST grade III or higher injury. However, its use should be balanced against the risks associated with the procedure itself, including vascular complications and the potential for infection. In some instances, minor injuries that do not exhibit active bleeding may not require embolic intervention12.

Visualization: Comparison of NOM Techniques and Outcomes

The table below provides a side-by-side comparison of the outcomes of NOM with observation alone versus NOM with SAE:

Table 2: Comparative Outcomes of Observation Versus SAE in NOM for Blunt Splenic Trauma

Parameter	Observation Alone	SAE Adjunct
Success Rate	Approximately 92%1	Up to 98%1
Splenic Salvage Rate	High, but variable	Over 90% even in severe cases 12
Need for Re-intervention	Low (readmission in approx. 2%)1	Minimal, with low complication rates 3

e-ISSN: 3048-9814 (Online)
Vol. 2 No. 5 (2025)
July 2025 Issue

Procedure-related Complications	Minimal	Slight risk of embolization-related issues

Decision-Making Considerations for SAE

The decision to incorporate SAE involves a careful evaluation of injury severity, presence of active bleeding, patient comorbidities, and the potential risks of the procedure. While the overarching guideline supports NOM for hemodynamically stable patients, the addition of SAE can be particularly advantageous in high-grade injuries or in patients with complex injury patterns15.

Complications and Limitations of NOM

Despite the high success rates associated with NOM, several potential complications and pitfalls deserve attention. These complications may necessitate a change in management strategy and can adversely affect outcomes if not promptly identified and managed.

Delayed Splenic Rupture

Delayed splenic rupture (DSR) remains one of the most concerning complications of NOM. Although infrequent, DSR can occur several days to even months after the initial trauma, sometimes after an apparently normal admission CT scan816. The occurrence of DSR emphasizes the need for vigilant monitoring during the post-injury period. Clinicians should be aware that although rare, the risk of sudden deterioration exists, particularly in patients with low-grade rib fractures or other risk factors816.

Impact of Concomitant Injuries

The presence of concomitant injuries has been repeatedly identified as a predictor of NOM failure. Studies have indicated that complications and failure of non-operative therapy are more likely in patients sustaining additional injuries, such as a femur fracture or other significant trauma14. These findings suggest that even if solid organ injuries appear manageable, the overall trauma burden may predispose patients to a higher risk of NOM failure.

Other Complications

Other complications associated with NOM include the formation of hematomas, pseudocysts, and rarely, splenic abscesses. A study reported that complications such as hematomas had an incidence of approximately 14.47%, while pseudocysts were detected in 3.94% of patients, and splenic abscess and pseudoaneurysm were even less frequent at around 1.31%412. Although these events are relatively uncommon, they underscore the need for effective follow-up and timely intervention if complications develop.

Limitations in Monitoring and Diagnostic Protocols

Another limitation inherent to NOM is the lack of consensus regarding the optimal frequency and duration of monitoring. While many institutions rely on serial physical examinations and repeated imaging, protocols vary widely. Some guidelines indicate that repeat CT

e-ISSN: 3048-9814 (Online)
Vol. 2 No. 5 (2025)
July 2025 Issue

scans performed after more than 10 days post-injury do not significantly influence treatment decisions20. This variability in monitoring protocols highlights an area where further research and standardization are needed.

Visualization: Common Complications Encountered in NOM

Below is a flow diagram that summarizes the potential complications associated with NOM and their subsequent management implications:

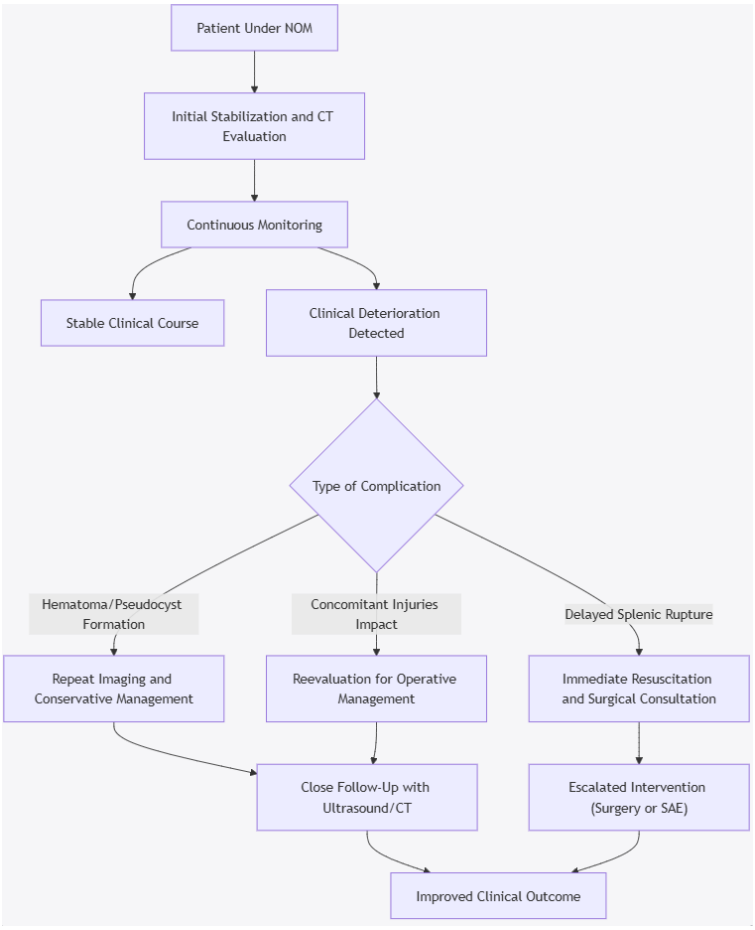

Figure 2: Flowchart Illustrating Potential Complications in the Non-Operative Management of Splenic and Hepatic Injuries

Follow-up and Monitoring Strategies

Monitoring and follow-up protocols are essential components of the NOM pathway. They serve to detect delayed hemorrhage, emerging complications, and the need for any change in management strategy as the patient progresses through the recovery period.

Importance of Early and Serial Imaging

Early imaging is crucial for the initial assessment of injury severity, while serial imaging plays a critical role in the detection of evolving complications. Although some studies suggest that repeated CT scans after 10 days have limited influence on management, early detection of changes within the first week is vital20. As such, many institutions favor an approach that employs

e-ISSN: 3048-9814 (Online)
Vol. 2 No. 5 (2025)
July 2025 Issue

repeat CT or ultrasound evaluations within the first 4 to 12 weeks post-trauma.

Role of Ultrasound in Follow-Up

Ultrasound is frequently the first-line modality used for follow-up examinations. It is particularly valuable due to its availability, lack of ionizing radiation, and ability to detect complications such as hematomas, pseudocysts, and abscesses. In pediatric patients—as well as in adult populations—the implementation of a standardized ultrasound follow-up protocol has been shown to facilitate early detection of complications and prompt re-intervention when necessary4.

Monitoring of Vital Signs and Laboratory Parameters

Apart from imaging, continuous monitoring of vital signs (blood pressure, heart rate, respiratory rate, and oxygen saturation) remains essential. Additionally, periodic laboratory tests, especially serial hemoglobin measurements, are recommended to detect subtle signs of ongoing bleeding that may initially be clinically silent. The combination of physical examinations with these laboratory and imaging assessments provides a safety net in the NOM pathway20.

Defining a Standardized Follow-up Protocol

While many centers have developed their own NOM protocols, there remains considerable variation in the intensity and duration of monitoring. A standardized protocol typically includes the following steps:

- Initial assessment with CT imaging immediately after stabilization.
- Serial ultrasound examinations, particularly in the first four weeks after injury.
- Periodic laboratory evaluations to monitor hemoglobin levels and other vital parameters.
- A scheduled re-assessment at 4–12 weeks post-injury to ensure complete resolution of injuries and early detection of any delayed complications.

The importance of these measures is further highlighted by studies that report reduced complication rates when structured follow-up protocols are implemented compared to less regimented approaches45.

Visualization: Follow-Up Protocol Timeline

The timeline below summarizes a proposed follow-up protocol for patients undergoing NOM for blunt solid organ injuries:

Table 3: Standardized Follow-Up Protocol for NOM Patients

e-ISSN: 3048-9814 (Online)
Vol. 2 No. 5 (2025)
July 2025 Issue

Time Frame	Recommended Follow-Up Actions	Expected Outcomes
Day 0 – Initial Visit	CT imaging, vital sign stabilization, laboratory tests	Establish baseline injury severity
Day 1 – 7	Serial physical examinations, continuous monitoring	Early detection of any subtle changes
Week 1 – 4	Follow-up ultrasound examinations, repeat lab tests	Detection of hematomas, pseudocysts, or delayed bleeding
Week 4 – 12	Additional CT or ultrasound if indicated	Confirmation of injury resolution or early complication management
Beyond 12 Weeks	Clinical follow-up and resolution confirmation	Ensure full recovery and address any residual complications

Guidelines, Consensus, and Future Directions

Consensus and Guideline Recommendations

The evolution of NOM in the management of blunt splenic and hepatic injuries is supported by a wealth of guidelines and consensus documents. The World Society of Emergency Surgery (WSES) guidelines, for instance, advocate for the initial use of NOM in hemodynamically stable patients regardless of injury grade21. These recommendations are based on a significant body of evidence that supports the safety and effectiveness of NOM when proper selection criteria and monitoring protocols are enforced.

Similarly, guidelines from the Eastern Association for the Surgery of Trauma (EAST) indicate that NOM should be employed in patients with blunt liver and splenic injuries, recommending adjunct interventions such as SAE when appropriate20. These guidelines have played a critical role in shifting clinical practice toward a more conservative approach, emphasizing individual patient factors rather than relying solely on the anatomical grading of injuries.

Areas for Future Research

Despite substantial progress, several critical questions remain unanswered. Future research directions include:

- **Optimization of Monitoring Protocols:** Refining the frequency and modalities of follow-up imaging to balance early detection of complications with resource utilization.

e-ISSN: 3048-9814 (Online)
Vol. 2 No. 5 (2025)
July 2025 Issue

- **Risk Stratification Models:** Developing robust predictive models, perhaps aided by machine learning, to identify patients at higher risk of NOM failure.
- **Role of Adjunctive Therapies:** Further investigating the comparative efficacy of observation versus SAE, especially in high-risk patients with concomitant injuries.
- **Long-Term Outcomes:** More comprehensive analyses of long-term outcomes, including immunological consequences following splenic preservation, are essential for validating the benefits of NOM.

Emerging Technologies and Techniques

Advances in technology are also set to further refine NOM. Recent developments in interventional radiology, improved CT imaging resolution, and the use of artificial intelligence to interpret imaging findings are expected to enhance the accuracy of initial assessments and early detection of complications. Such innovations may also lead to personalized treatment protocols that consider patient-specific risk factors in real time.

Visualization: Key Research Focus Areas

Below is a diagram highlighting the key areas for future research in NOM:

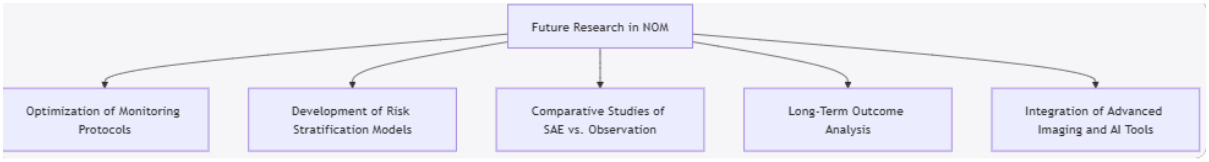

Figure 3: Diagram Highlighting Future Research Priorities in Non-Operative Management of Solid Organ Injuries

CONCLUSION

Non-operative management represents a significant advancement in the treatment of blunt hepatic and splenic injuries. High success rates—ranging from approximately 94.7% to 100% for liver injuries and around 95% for splenic traumas—demonstrate that, in selected patients, NOM is both safe and effective912. The critical emphasis on hemodynamic stability, coupled with the strategic use of diagnostic imaging and the possible integration of adjunctive interventions such as splenic artery embolization, has revolutionized trauma care.

LIMITATION

This review is limited by variability in institutional protocols and a lack of uniform criteria across the literature for defining NOM success and failure.

RECOMMENDATION

Future research should focus on standardizing NOM protocols and developing predictive tools for early identification of patients at risk for complications.

ACKNOWLEDGEMENT

The author acknowledges the Department of General Surgery at Katihar Medical College for academic support and access to clinical data.

CONFLICT OF INTEREST

e-ISSN: 3048-9814 (Online)
Vol. 2 No. 5 (2025)
July 2025 Issue

The author declares no conflict of interest related to this study.

LIST OF ABBREVIATION

NOM – Non-Operative Management

CT – Computed Tomography

SAE – Splenic Artery Embolization

DSR – Delayed Splenic Rupture

AAST – American Association for the Surgery of Trauma.

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