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BLADDER INJURY CORRECTION FOLLOWING CESAREAN SECTION: SURGICAL APPROACHES AND OUTCOMES – A LITERATURE REVIEW

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Abstract: Introduction: Bladder injury is an uncommon but clinically relevant complication of cesarean section. Although its incidence is relatively low, such injuries are associated with increased maternal morbidity, prolonged hospital stay, and long-term sequelae, including fistula formation and urinary dysfunction. The global increase in cesarean section rates and the growing prevalence of placenta accreta spectrum disorders underscore the importance of prevention, early diagnosis, and effective surgical management. Objective: This article aims to review the current literature on the epidemiology, risk factors, diagnosis, surgical repair techniques, postoperative management, and outcomes of bladder injuries during cesarean section, with an emphasis on areas of consensus, controversy, and gaps in knowledge. Methods: A narrative review of the literature was performed using the PubMed, Embase, Scopus, and Cochrane Library databases. Studies published in English up to March 2025 that addressed diagnosis, surgical correction, or outcomes of bladder injury during cesarean sections were included. Original articles, retrospective series, systematic reviews, and relevant randomized clinical trials were analyzed, excluding isolated case reports and non-obstetric bladder injuries. Results: Twelve key studies were identified and analyzed. Previous cesarean sections, adhesions, and placenta accreta spectrum were the main associated risk factors. Intraoperative recognition, aided by cystoscopy or dye tests, is the main determinant of a good prognosis. Primary closure with absorbable sutures remains the standard technique, with adjuvant measures, such as omentum interposition or ureteral catheterization, reserved for complex cases. Postoperative management usually involves 7 to

14 days of bladder drainage, with selective use of imaging tests before catheter removal. When the injury is diagnosed and repaired intraoperatively, maternal outcomes are excellent, while late diagnosis significantly increases morbidity and the risk of fistula. Conclusion: Bladder injury during cesarean section, although rare, has a substantial impact on maternal health. Early diagnosis and immediate repair are essential for good outcomes. Despite advances, there are still controversies regarding the technical details of closure, the ideal duration of catheterization, and the role of minimally invasive approaches. Multicenter studies and standardized guidelines are needed to standardize management and improve patient-centered care.

Keywords: Cesarean section; bladder injury; urological complications; surgical repair; maternal outcomes; spectrum of placenta accreta.

Introduction

Bladder injury is one of the most common urological complications associated with obstetric surgery, particularly during cesarean section. Although its overall incidence is relatively low—ranging from 0.1% to 0.9% of cesarean deliveries—it represents a significant source of maternal morbidity, prolonged hospitalization, and potential long-term sequelae such as fistula formation, recurrent urinary tract infections, or voiding dysfunction. The increasing global rate of cesarean sections has further underscored the importance of recognizing, preventing, and managing such injuries in contemporary obstetric practice.

The majority of bladder injuries occur in the setting of repeat cesarean sections, largely due to dense adhesions between the

lower uterine segment and bladder dome. Other risk factors include emergency procedures, distorted pelvic anatomy from placenta accreta spectrum, prior pelvic surgery, and conditions that complicate surgical dissection. Failure to identify the injury intraoperatively can lead to delayed diagnosis, which significantly worsens prognosis and often requires more complex surgical interventions.

Over the past decades, various surgical strategies for bladder injury correction during cesarean section have been described. Primary closure with absorbable sutures remains the most widely accepted method, but controversies persist regarding technical details such as single- versus double-layer repair, the role of omental interposition, and optimal duration of postoperative catheterization. More recently, minimally invasive techniques, including laparoscopic and robotic approaches, have been reported in selected cases, although their role remains limited and largely anecdotal in the obstetric context.

Despite the clinical importance of bladder injury during cesarean delivery, there is a lack of consensus on the best management practices, and high-quality evidence remains scarce. Most available studies are retrospective series, case reports, or expert opinions, leading to significant heterogeneity in reported outcomes. Therefore, a comprehensive review of the literature is warranted to synthesize the current evidence, highlight areas of agreement and debate, and identify knowledge gaps that require further research.

The present article aims to review the epidemiology, risk factors, intraoperative recognition, surgical approaches, and maternal outcomes related to bladder injury

correction following cesarean section, providing obstetricians and surgeons with a structured overview of current evidence and practical considerations.

Objectives

The objective of this review is to synthesize the current literature on bladder injury occurring during cesarean section, with particular emphasis on the surgical approaches employed for correction and their associated outcomes. This review seeks to describe the epidemiology, risk factors, and mechanisms underlying these injuries, while also summarizing diagnostic strategies that facilitate early recognition and timely management. In addition, it aims to analyze the different surgical repair techniques, including technical variations and adjunctive measures, and to evaluate both short- and long-term maternal outcomes following correction. Finally, the review intends to highlight areas of controversy and identify gaps in the available evidence that warrant further investigation, thereby providing clinicians with an evidence-based overview to guide decision-making and improve maternal care.

Methods

This review was conducted as a narrative synthesis of the available literature addressing bladder injury during cesarean section and its surgical correction. A comprehensive search was performed in the PubMed, Embase, Scopus, and Cochrane Library databases to identify relevant studies published in English up to March 2025. The search strategy combined keywords and Medical Subject Headings (MeSH) terms, including

“cesarean section”, “bladder injury”, “urinary tract injury”, “surgical repair”, and “maternal outcomes”.

Studies were eligible for inclusion if they reported on the diagnosis, surgical management, or outcomes of bladder injury sustained during cesarean delivery. Original research articles, retrospective and prospective cohort studies, systematic reviews, and significant case series were included. Exclusion criteria comprised non-English language publications, isolated case reports without detailed outcome data, conference abstracts lacking full manuscripts, and studies focusing exclusively on gynecologic or non-obstetric bladder injuries.

The titles and abstracts of retrieved articles were screened for relevance, and the full texts of potentially eligible studies were reviewed. Data were extracted and synthesized narratively, with emphasis on epidemiology, risk factors, diagnostic approaches, surgical techniques, postoperative management, and maternal outcomes. Given the heterogeneity of study designs and outcome measures, no formal meta-analysis was performed.

Review

Epidemiology and Risk Factors

Bladder injury during cesarean section, though relatively rare, remains one of the most significant urological complications encountered in obstetric surgery. Reported incidences vary between 0.1% and 0.9% of all cesarean deliveries, depending on study design and population, but the true frequency may be underestimated due to delayed recognition in some cases.^{8,9} Despite its low incidence, the clinical impact is

considerable, as these injuries are associated with increased operative times, higher rates of infection, fistula formation, prolonged catheterization, and psychological stress for the patient.^{9,12} The risk is particularly pronounced in women undergoing repeat cesarean sections, in whom adhesions between the lower uterine segment and the bladder can obscure dissection planes and predispose to inadvertent cystotomy.^{7,8} Adhesion-related distortion of anatomy is considered one of the strongest predictors of intraoperative bladder trauma, and the likelihood of adhesions rises progressively with each subsequent cesarean.^{7,8}

Several maternal and obstetric factors further increase susceptibility. Case-control data have demonstrated that emergency cesareans, attempted vaginal birth after cesarean (VBAC), labor prior to surgery, and uterine rupture are all independently associated with higher risk of bladder injury.^{7,8} Placenta accreta spectrum (PAS) is another major contributor, as abnormal placental invasion into the vesicouterine space creates dense neovascularization and scarring, rendering dissection technically hazardous.^{1,5} In women with severe PAS (incretia or percreta), preoperative MRI features such as vesicouterine hypervascularity, absence of the chemical shift line, and uterine-placental bulging have been shown to independently predict bladder injury at the time of cesarean delivery.^{1,5} These findings highlight the importance of accurate antenatal imaging not only for planning delivery but also for anticipating the need for multidisciplinary surgical support.

Other conditions, such as prior pelvic surgery or the presence of large uterine myomas, may also increase surgical difficulty. Interestingly, although cesarean myomectomy

has traditionally been avoided due to perceived risk of hemorrhage and visceral injury, recent data suggest that bladder injury rates are not significantly different compared with cesarean section alone, even when large myomas are present.^{3,9} Finally, aggregate systematic reviews confirm that recognition of these risk factors and adequate preoperative preparation, particularly in referral centers for complex obstetric cases, are essential steps to reduce the incidence and severity of bladder injuries.^{9,10}

Diagnosis and Intraoperative Recognition

The timely recognition of bladder injury during cesarean delivery is crucial, as immediate repair yields superior outcomes compared with delayed diagnosis.^{6,12} Most injuries occur during the initial peritoneal entry or while creating and dissecting the bladder flap, particularly when adhesions tether the bladder dome to the uterine wall.^{8,10} Surgeons should maintain a high index of suspicion in women with multiple prior cesareans or known PAS, where distorted anatomy increases the likelihood of inadvertent trauma.^{1,5} Classic intraoperative signs include the unexpected visualization of the Foley catheter within the surgical field, the presence of urine extravasation, macroscopic hematuria, or direct identification of a cystotomy.^{6,8} Because these findings may be subtle, careful inspection of the vesicouterine space is warranted whenever dissection proves unusually difficult or when adhesions are extensive.

Adjunctive diagnostic techniques are valuable in confirming or excluding injury. Intraoperative cystoscopy, with direct visualization of both ureteric orifices and efflux of indigo carmine-stained urine, is consi-

dered a reliable method to rule out ureteral involvement.^{6,10} Retrograde filling of the bladder with methylene blue or saline may also delineate the extent of a cystotomy.^{6,10} Randomized controlled evidence has further explored preventive strategies that simultaneously aid recognition: for example, cysto-inflation, in which the bladder is retro-filled before vesicouterine dissection, enhances visualization of bladder margins and has been shown to reduce inadvertent injury in difficult repeat cesareans.¹¹ Conversely, routine creation of the bladder flap has not been demonstrated to prevent bladder injury; in fact, randomized data indicate that omission of this step shortens incision-to-delivery time without increasing urological complications.^{4,8} These findings question the long-standing practice of routinely dissecting the bladder flap, particularly in women at low risk for adhesions.

Early intraoperative detection is paramount, as immediate repair is associated with shorter hospital stays, lower rates of fistula formation, and better long-term urinary function compared with injuries diagnosed postoperatively.^{6,12} Collectively, these data emphasize that intraoperative vigilance, aided by selective use of cystoscopy or dye studies, remains the cornerstone of safe obstetric surgical practice when bladder injury is a possibility.

Surgical Approaches to Repair

When bladder injury is identified during cesarean delivery, the cornerstone of management is immediate surgical repair, ideally performed at the time of the index operation. prompt recognition and primary closure generally ensure excellent outcomes, whereas delayed diagnosis predisposes to urinary fistula, infection, and chronic voi-

ding dysfunction.^{6,12} most injuries involve the dome of the bladder, which is accessible through the existing hysterotomy incision and can be repaired without requiring advanced urological reconstruction.^{6,8}

Primary Closure Techniques: The standard approach for cystotomy repair is a layered closure with absorbable sutures. traditionally, a two-layer closure has been advocated: the first approximates the bladder mucosa and muscularis, and the second reinforces the muscularis and serosa to provide a watertight seal.^{6,10} surgeons often prefer polyglactin (vicryl) or poligle-caprone sutures, which maintain tensile strength long enough to support healing yet avoid long-term foreign-body reaction.^{6,8} experimental and clinical data have shown that when careful mucosal apposition is achieved, a single-layer closure may be sufficient in small injuries, but most obstetric and urological surgeons continue to favor the two-layer technique to minimize leakage risk.^{8,10} intraoperative retrofilling with methylene blue or sterile saline after repair is recommended to test the integrity of the closure before proceeding.^{6,10}

Adjunctive Measures and Reinforcement: In more extensive injuries, especially those near the trigone or with devascularized tissue, reinforcement with an omental flap can be considered. the omentum provides vascular supply and reduces the risk of fistula formation, and has been successfully employed in gynecologic oncology and obstetric settings.^{2,5} when PAS is present, injury sites are often irregular and friable due to abnormal neovascularization, making multilayer closure plus omental interposition particularly valuable.^{1,5} in cases with concomitant ureteric injury or suspicion of

involvement, stenting of the ureter is indicated to maintain patency during healing.^{6,12}

Timing of Repair: The overwhelming consensus in the literature is that immediate repair during cesarean is associated with superior outcomes compared to delayed correction.^{6,12} injuries missed intraoperatively may present days later with urinary ascites, peritonitis, or vesicouterine fistula, conditions that necessitate reoperation under more complex and less favorable circumstances.^{8,10} retrospective series demonstrate that women who underwent primary repair during the cesarean itself had shorter catheterization times, fewer infections, and lower rates of fistula than those in whom the diagnosis was delayed.^{6,12}

Minimally Invasive and Alternative Approaches: Although open repair through the cesarean incision remains the gold standard, minimally invasive approaches have been described in select cases. laparoscopic or robotic repair may be feasible when bladder injuries are diagnosed postoperatively or when secondary surgical intervention is required.^{9,12} these techniques allow meticulous intracorporeal suturing and may reduce postoperative pain and recovery time. however, they require advanced expertise and are rarely applicable in the acute obstetric setting, where the patient's stability and operative urgency dictate management.^{8,9}

Interestingly, preventive maneuvers overlap with reparative strategies. for example, cysto-inflation—shown in randomized trials to improve visualization of the bladder dome in high-risk cesareans—also facilitates precise repair by delineating tissue planes and ensuring complete suture apposition.¹¹ similarly, omission of the bladder flap, once thought to predispose to injury, has been demonstrated in randomized trials not to

increase the risk and may simplify surgical repair if trauma does occur.^{4,8}

Suture Material and Technical Considerations: While absorbable sutures are the mainstay, there is debate regarding whether interrupted or continuous closure is superior. some authors advocate continuous sutures for speed and even distribution of tension, whereas others prefer interrupted stitches to avoid purse-stringing and allow selective reinforcement in fragile areas.^{8,10} the choice often depends on the size and location of the defect, as well as the surgeon's preference. regardless of technique, ensuring a watertight closure tested by retrofilling is universally emphasized.^{6,10} in addition, prolonged operative time should be anticipated in complex injuries, particularly in PAS cases, where dense adhesions, bleeding, and distorted anatomy complicate both the dissection and the closure.^{1,5}

Multidisciplinary Involvement: Another key aspect is the role of multidisciplinary collaboration. in complex repeat cesareans and placenta accreta spectrum cases, the assistance of urologists can be crucial, particularly when injuries extend to the trigone or involve the ureters.^{5,6} planned deliveries in tertiary centers with access to obstetric, urological, and anesthetic expertise have been shown to lower maternal morbidity, underscoring the importance of early referral and surgical planning.^{1,5,9}

Postoperative Management

Optimal postoperative care following bladder repair during cesarean delivery is critical to ensure proper healing and to minimize the risk of complications such as urinary fistula, infection, and voiding dysfunction.^{6,12} The cornerstone of management is

bladder drainage with a transurethral Foley catheter, which reduces intravesical pressure, allows continuous decompression of the bladder wall, and facilitates healing of the suture line.^{6,10} The recommended duration of catheterization varies across studies, typically ranging from 7 to 14 days, but some authors advocate up to 21 days for extensive or complex injuries, especially when the trigone or ureteric orifices are close to the repair site.^{6,8} Comparative series suggest that premature removal of the catheter increases the risk of leakage and vesicovaginal or vesicouterine fistula, whereas extended catheterization beyond three weeks provides no additional benefit and is associated with higher rates of urinary tract infection (UTI).^{9,12}

Antibiotic prophylaxis during catheterization remains a subject of debate. While some guidelines recommend short-term antibiotics to reduce the incidence of bacteriuria, others argue that judicious catheter care and early mobilization are sufficient, reserving antibiotics for symptomatic infection.^{6,10} Several observational studies note that asymptomatic bacteriuria is common in this setting, but routine treatment does not improve outcomes and may contribute to antimicrobial resistance.^{10,12} Instead, emphasis is placed on careful monitoring, maintaining closed drainage systems, and minimizing unnecessary manipulation of the catheter.

Adjunctive imaging is often recommended prior to catheter removal, especially after repair of larger injuries or those with uncertain integrity. A cystogram or retrograde cystography with contrast can confirm healing and exclude leakage before the patient resumes spontaneous voiding.^{6,12} In low-risk cases, some institutions omit routi-

ne imaging and instead rely on clinical monitoring, reporting comparable safety with shorter hospital stays.^{9,10} In cases complicated by PAS or where repair involved reinforcement with an omental flap, postoperative imaging is generally advised, given the friable nature of the tissue and higher risk of dehiscence.^{1,5}

Beyond bladder-specific care, general postoperative measures play a role in optimizing recovery. Early mobilization, adequate hydration, and pain control reduce risks of thromboembolism and facilitate urinary drainage.^{8,10} Ureteral stents, when placed for suspected or confirmed ureteric involvement, typically remain in situ for 4–6 weeks, with subsequent cystoscopic removal after follow-up imaging confirms patency.^{6,12} In centers managing high volumes of complex PAS cases, structured follow-up protocols include both urogynecologic and radiologic assessment, which have been associated with improved detection of late complications such as strictures or persistent fistulas.^{1,5,9}

Long-term outcomes after appropriate postoperative management are generally excellent. Prospective and retrospective data suggest that most women regain normal bladder function with low rates of recurrent UTIs or fistula formation when repairs are performed promptly and followed by adequate drainage.^{6,12} However, women with delayed diagnosis or complex injuries requiring reoperation face higher risks of chronic sequelae, including incontinence and pelvic pain.^{9,12} Consequently, individualized postoperative protocols, tailored to the complexity of the injury and the patient's comorbidities, are widely recommended as the optimal strategy for ensuring favorable outcomes.

Outcomes

The prognosis following bladder injury repair during cesarean delivery is generally favorable when the injury is recognized intraoperatively and corrected immediately. Early repair is consistently associated with high success rates, low morbidity, and minimal long-term sequelae.^{6,12} In such cases, most women regain normal bladder function after a short period of catheterization, and complications such as vesicovaginal or vesicouterine fistula are rare.^{6,8} Retrospective data indicate that when diagnosis is delayed until the postoperative period, outcomes are significantly worse, with higher rates of infection, peritonitis, prolonged hospitalization, and the need for secondary surgery.^{6,9}

Short-term outcomes are primarily determined by the size and location of the injury, the technical quality of the repair, and the adequacy of bladder drainage.^{8,10} Small dome injuries repaired with a two-layer closure and 7–14 days of catheterization heal reliably, while more complex injuries near the trigone or involving the ureteric orifices carry greater risk for leakage or recurrent complications.^{6,12} The use of adjuncts such as omental flaps or ureteric stenting in complex cases has been shown to improve primary healing rates, although data remain limited to case series and expert opinion.^{2,5}

Long-term maternal outcomes vary according to timing of recognition and complexity of the injury. Women repaired intraoperatively typically report normal voiding function, low rates of recurrent urinary tract infection, and preservation of quality of life.^{6,12} In contrast, those requiring reoperation for delayed diagnosis or fistula often experience more protracted recovery and higher rates of residual urinary dysfunc-

tion.^{9,12} Safrai et al. reported that urinary tract injuries diagnosed and managed at the time of cesarean delivery had minimal long-term sequelae, whereas delayed recognition was associated with persistent urinary complaints, including urgency, frequency, and incontinence in a subset of patients.¹² Similarly, data from large systematic reviews confirm that prompt intraoperative repair is the single most important prognostic factor for favorable long-term outcomes.^{9,10}

Beyond functional sequelae, bladder injury during cesarean delivery has important psychosocial and economic implications. Women requiring reoperations or prolonged catheterization often face significant emotional distress, disruption of maternal–newborn bonding, and increased healthcare costs due to extended hospitalization and follow-up interventions.^{8,10} These indirect outcomes, though less frequently measured, are highly relevant to patient well-being and underscore the importance of preventive strategies and multidisciplinary intraoperative vigilance.

Importantly, maternal survival is rarely compromised by bladder injury itself, but morbidity may be compounded in the presence of placenta accreta spectrum, where injuries often occur in the context of massive hemorrhage and technically complex cesarean hysterectomy.^{1,5} In such scenarios, bladder injury represents not an isolated complication but part of a constellation of surgical and anesthetic challenges that can substantially worsen outcomes.^{1,5,9} For these women, referral to tertiary centers with experienced multidisciplinary teams has been shown to mitigate risks and optimize survival and functional outcomes.^{1,5}

Taken together, the evidence suggests that while bladder injury during cesarean

delivery remains a serious complication, outcomes are highly dependent on intraoperative recognition, immediate repair, and appropriate postoperative management.^{6,12} When these elements are in place, the majority of women experience full recovery and minimal long-term sequelae, reinforcing the value of vigilance, surgical expertise, and structured follow-up in optimizing patient outcomes.

Discussion

Bladder injury during cesarean delivery, though infrequent, represents a complication with disproportionate clinical and psychosocial impact. Our review highlights a consistent set of risk factors, diagnostic strategies, surgical techniques, and postoperative care principles that together shape outcomes. By synthesizing data from observational studies, randomized trials, and systematic reviews, several key themes emerge.

Epidemiology and Risk Stratification

The available evidence demonstrates strong agreement that prior cesarean section is the single most important predictor of bladder injury.^{7,8} Each subsequent cesarean amplifies adhesion formation at the vesicouterine interface, complicating dissection and increasing the likelihood of cystotomy.^{7,8} Placenta accreta spectrum (PAS) is another major driver of risk, and both observational and imaging-based studies confirm that MRI and ultrasound features can predict surgical complexity and injury likelihood.^{1,5} However, although imaging is highly specific, its sensitivity remains limited, and the generalizability of these findings is restricted to tertiary centers with advanced radiologi-

cal expertise.^{1,5} This underscores the need for standardized imaging protocols and broader validation in diverse populations.

Intraoperative Diagnosis

The literature converges on the principle that early intraoperative recognition is the strongest determinant of favorable prognosis.^{6,12} Classic signs such as urine extravasation and catheter visualization remain relevant, but adjunctive cystoscopic or dye-based confirmation adds diagnostic certainty.^{6,10} Randomized evidence suggests that selective maneuvers like cysto-inflation improve visualization in high-risk cases, while routine creation of a bladder flap offers no protective benefit and may prolong dissection unnecessarily.^{11,4} These findings challenge long-standing dogma and support a more tailored approach, reserving additional steps for women at demonstrably higher risk.

Surgical Management

Consensus exists that immediate repair with absorbable sutures provides excellent outcomes in most dome injuries.^{6,10} The debate continues, however, regarding single versus double-layer closure.^{8,10} While some authors demonstrate equivalent healing with one-layer closure in small injuries, the two-layer technique remains preferred in obstetric practice due to perceived greater security, particularly in friable or vascular tissue.^{6,10} Adjunctive measures such as omental interposition and ureteral stenting are widely employed in complex injuries, but high-quality comparative data are lacking.^{2,5} Minimally invasive approaches (laparoscopic/robotic) are technically feasible in delayed diagnoses or planned reopera-

tions, yet their application in acute obstetrics is limited by urgency, bleeding risk, and need for immediate repair.^{9,12}

Postoperative Management

Postoperative strategies illustrate another area of variability. although bladder catheterization is universally recommended, the ideal duration remains uncertain.^{6,10} most series support 7–14 days, but some advocate up to 21 days in complex repairs.^{6,8} systematic reviews suggest prolonged drainage beyond this point does not reduce leakage and instead increases urinary tract infections.^{9,12} similarly, practices around routine postoperative imaging vary: while many centers perform cystography before catheter removal, others reserve it for high-risk repairs, reporting equivalent safety with fewer costs.^{9,10} this lack of standardization highlights the pressing need for prospective comparative studies to refine best practice guidelines.

Outcomes

When bladder injuries are repaired intraoperatively, outcomes are overwhelmingly favorable, with low rates of fistula, recurrent infection, or long-term voiding dysfunction.^{6,12} conversely, delayed recognition is consistently associated with worse morbidity, including increased reoperation rates, prolonged hospital stay, and persistent urinary symptoms.^{9,12} psychosocial outcomes are less studied but are highly relevant; prolonged catheterization and fistula repair disrupt postpartum recovery, maternal–infant bonding, and quality of life.^{8,10} future studies should incorporate patient-reported outcomes and quality-of-life measures to capture the broader impact of these injuries.

Controversies and Gaps

Despite growing literature, significant controversies remain unresolved. the optimal technical approach—single versus double-layer closure, continuous versus interrupted suturing—lacks high-level evidence.^{8,10} similarly, recommendations regarding catheter duration, the role of prophylactic antibiotics, and the necessity of routine postoperative cystography differ markedly across institutions.^{9,12} the emergence of minimally invasive repair techniques raises additional questions about feasibility and long-term outcomes, but their role in acute obstetric practice is unclear.^{9,12} most published studies are retrospective, single-center, and underpowered to detect rare but clinically important complications. moreover, the vast majority originate from high-income countries, whereas data from low- and middle-income settings—where surgical resources and multidisciplinary support may be limited—are sparse.^{2,9}

Future Directions

Addressing these gaps requires well-designed multicenter prospective registries and, where feasible, randomized controlled trials. priority areas include the comparative effectiveness of single- versus double-layer closure, the optimal duration of catheterization, and standardized criteria for postoperative imaging. the development of consensus guidelines through professional societies may help harmonize practice and improve outcomes across diverse settings. equally important is the inclusion of patient-centered endpoints such as quality of life, sexual function, and psychological well-being, which are often underrepresented in the literature.^{9,10}

Conclusion

Bladder injury during cesarean delivery remains an uncommon but clinically significant complication, with implications that extend beyond immediate surgical morbidity to long-term maternal well-being. Recognition of risk factors—particularly prior cesarean section, adhesions, and placenta accreta spectrum—is central to prevention and surgical planning. Intraoperative vigilance and prompt diagnosis are the most decisive determinants of outcome, as immediate repair consistently yields superior results compared with delayed recognition. Standard surgical management relies on primary closure with absorbable sutures, often in two layers, with adjunctive measures such as omental interposition or ureteral stenting reserved for complex cases. Postoperative care, especially the duration of bladder catheterization and the role of routine imaging, remains variable across institutions, reflecting a lack of consensus and the need for high-quality evidence.

Overall, when bladder injuries are identified and managed intraoperatively, outcomes are highly favorable, with restoration of normal bladder function and minimal long-term sequelae in most patients. However, persisting controversies regarding technical details, postoperative protocols, and the applicability of minimally invasive approaches underscore the importance of further research. Multicenter prospective studies and consensus guidelines are urgently needed to harmonize practice, reduce variability in care, and improve patient-centered outcomes worldwide.

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