

Case Report

Indocyanine Green-Guided Robotic Bladder Neck Reconstruction with Hybrid Buccal Mucosal Graft and Bladder Mucosal Augmentation for Recurrent Bladder Neck Contracture Following Laser TURP

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Background: Bladder neck contracture after TURP

Bladder Neck Contracture (BNC) is a recognised late complication of Transurethral Resection of the Prostate (TURP) and its laser-based variants, with reported incidence ranging from 0.3% to 9.7% depending on the technique employed and the energy modality utilised. The pathophysiological basis lies in ischaemic fibrosis at the bladder neck, compounded by thermal injury, postoperative extravasation, and the inflammatory sequelae of repeated instrumentation.

Initial management conventionally involves endoscopic Bladder Neck Incision (BNI), with acceptable short-term success rates in primary contractures. However, recurrent BNC following two or more endoscopic interventions presents a formidable reconstructive challenge. Progressive fibrosis, obliteration of tissue planes, and compromised vascularity of residual tissue substantially reduce the efficacy of further endoscopic manoeuvres and increase the risk of recurrence after any repair.

Open and robotic reconstructive surgery — including Y-V plasty, posterior urethral reconstruction, and augmented anastomotic techniques — have been described for refractory cases. Nevertheless, the optimal method for addressing circumferential fibrosis with impaired local tissue perfusion remains incompletely defined in the published literature.

- Incidence of BNC Post-TURP

0.3% – 9.7% across surgical modalities

- Primary BNI Success

Acceptable short-term outcomes; recurrence common in refractory cases

- Recurrent BNC Challenge

Progressive fibrosis, poor vascularity, failed endoscopic salvage

Why recurrent BNC is particularly difficult to manage

Each successive endoscopic incision into a bladder neck contracture introduces additional thermal or mechanical injury to an already compromised tissue bed.

The resultant fibroblastic response, mediated by transforming growth factor-beta signalling pathways, produces dense collagenous scar that replaces the pliable mucosal and submucosal architecture of the normal bladder neck.

Over time, this cumulative injury creates an annular stenosis characterised not merely by luminal narrowing but by hypoperfused, avascular fibrosis that resists healing after any mucosal repair.

➤ Failed endoscopic cycles

Repeated BNI creates progressive ischaemic fibrosis at the bladder neck, diminishing residual tissue vascularity with each intervention.

➤ Impaired tissue perfusion

Poorly vascularised scar cannot support mucosal healing, significantly increasing the risk of anastomotic breakdown and contracture recurrence.

➤ Reconstructive complexity

Obliterated tissue planes and circumferential fibrosis demand an intraoperative strategy capable of distinguishing viable from non-viable tissue in real time.

➤ Graft failure risk

Standard augmentation grafts placed on an ischaemic bed are at high risk of necrosis, secondary contracture, and poor functional outcome.

Patient clinical timeline

A 73-year-old male presented with progressive lower urinary tract symptoms, recurrent urinary retention, and significantly impaired uroflowmetry parameters following a prior history of laser TURP and two subsequent endoscopic bladder neck incisions. The clinical trajectory below summarises the key interventional milestones preceding definitive robotic reconstruction.

1. Laser TURP

Initial surgical management of benign prostatic obstruction. Holmium laser enucleation performed at index centre.

2. First BNI

Endoscopic bladder neck incision performed for early postoperative BNC. Temporary symptomatic improvement documented.

3. Second BNI

Recurrent contracture managed with repeat endoscopic incision. Recurrence at 4 months post-procedure confirmed on cystoscopy.

4. Preoperative assessment

Qmax 8 mL/s, PVR 140 mL. Cystoscopy demonstrated dense annular fibrosis with near-complete obliteration of the bladder neck lumen.

5. Robotic ICG-guided reconstruction

Fluorescence-guided annular excision with hybrid posterior BMG augmentation and anterior bladder mucosal advancement performed.

Preoperative evaluation: Uroflowmetry and cystoscopy

Preoperative uroflowmetry parameters

Maximum flow rate (Qmax): 8 mL/s - severely impaired, consistent with significant bladder outlet obstruction.

Postvoid residual (PVR): 140 mL - indicative of incomplete bladder emptying and detrusor compensation.

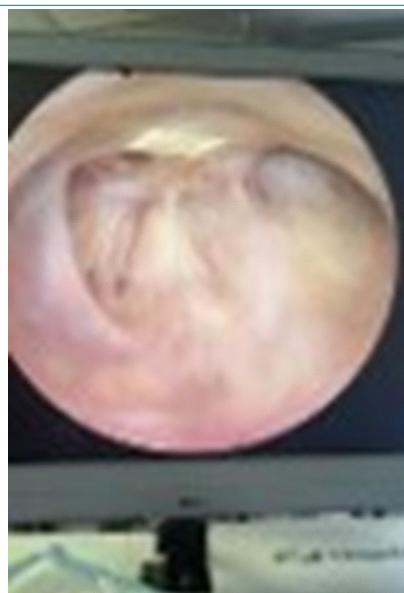


Figure 1: Preoperative cystoscopy: dense annular fibrosis at the bladder neck with near-complete luminal obliteration.

Voided volume: Reduced, with prolonged flow time and a plateau-shaped trace on flowmetry, consistent with fixed outlet obstruction rather than detrusor dysfunction.

Voiding pattern: Obstructed pattern on pressure-flow study with no evidence of detrusor underactivity, confirming anatomical rather than neurogenic aetiology.

Preoperative cystoscopic findings

Rigid and flexible cystoscopy demonstrated dense circumferential fibrosis at the bladder neck, with near-total luminal obliteration at the vesico-urethral junction. The mucosal architecture was effaced, replaced by pale, avascular fibrous tissue extending over approximately 1.5 cm in length. No residual posterior lip mucosa was identifiable as a suitable native reconstruction substrate. The bladder body and ureteric orifices were normal. There was no evidence of bladder calculi or trabeculation disproportionate to the degree of outlet obstruction, suggesting preserved detrusor reserve.

Intraoperative ICG fluorescence imaging: Identification of fibrosis

Intravenous Indocyanine Green (ICG) was administered at a dose of 7.5 mg following robotic port placement and initial dissection. Near-Infrared Fluorescence (NIRF) imaging was activated using the da Vinci Firefly® system. Within 60–90 seconds of intravenous injection, differential perfusion patterns became clearly discernible between the well-vascularised bladder wall and the hypoperfused annular fibrotic stenotic segment at the bladder neck.

Fluorescence findings

The fibrotic stenotic ring demonstrated markedly reduced or absent fluorescence signal on NIRF imaging, in stark contrast to the surrounding well-perfused detrusor muscle and adjacent perivesical tissue. This differential perfusion pattern enabled real-time, intraoperative delineation of the scar boundary — a distinction not reliably achievable with white-light visualisation alone.



Figure 2: ICG fluorescence demonstrating hypoperfused annular fibrosis (absent signal) versus well-perfused bladder wall (bright fluorescence).



Figure 3: White-light view confirming extent of fibrotic annular stenosis.

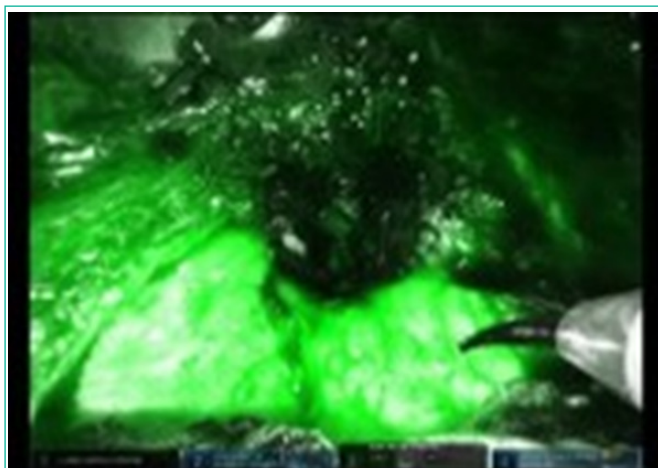


Figure 4: Completion of fluorescence-guided circumferential annular excision.

ICG imaging was used iteratively during circumferential excision: fluorescence was reassessed at each stage of resection to confirm that the remaining tissue margins demonstrated adequate perfusion before reconstruction was commenced.

Clinical significance of ICG mapping

This application of ICG extends beyond its established role in vascular assessment. In this case, fluorescence imaging served as an

intraoperative decision-making tool, directly informing the extent of scar excision and reducing reliance on subjective tactile or visual assessment of tissue viability — which is inherently unreliable in the context of recurrent fibrosis.

White-light confirmation and annular excision

White-Light operative confirmation

Following NIRF-guided mapping, white-light cystoscopic correlation was performed to confirm the anatomical extent of the fibrotic annulus. The pale, avascular tissue identified on fluorescence imaging corresponded precisely with the hypopigmented, non-bleeding zone visible on standard white-light robotic imaging — providing dual-modality confirmation of the scar boundary prior to excision.

Circumferential annular excision

Fluorescence-guided circumferential excision of the stenotic ring was performed using monopolar scissors, with careful preservation of the posterior urethral sphincteric mechanism and bilateral neurovascular bundles. Excision was carried to a depth and circumferential extent determined entirely by the return of fluorescence signal at the resection margin, ensuring that all poorly perfused fibrous tissue was removed prior to reconstruction.

This iterative fluorescence-guided approach represented a significant departure residual avascular tissue at the anastomotic margin — a key determinant of recurrence risk in prior series.

Hybrid mucosal reconstruction: Posterior BMG and anterior advancement

Following completion of fluorescence-guided annular excision, a hybrid two-component mucosal reconstruction was performed to restore circumferential continuity of the bladder neck without tension or reliance on a single graft type. This approach was selected to maximise the epithelial surface area while leveraging the distinct biological properties of each tissue source.

Posterior: Buccal mucosal graft augmentation

A buccal mucosal graft was harvested from the right cheek under standard technique. The graft was defatted, fenestrated, and secured to the posterior bladder neck defect in an onlay configuration over a well-vascularised detrusor bed exposed by the prior excision. BMG provides a robust, hairless epithelial surface with high water content and low contracture rate — properties well-established in urethroplasty literature and extrapolated here to bladder neck reconstruction.

Anterior: Bladder mucosal advancement

Anterior reconstruction was achieved by advancing a tongue of well-vascularised native bladder mucosa distally to meet the posterior BMG, completing circumferential mucosal continuity. This advancement avoided the need for a second graft and capitalised on the reliable vascularity of the native detrusor-mucosa unit confirmed by intraoperative ICG imaging. The suture line was constructed in an interrupted fashion over a 20Fr urethral catheter to calibrate luminal diameter.

Postoperative outcomes: Radiological and functional assessment

Retrograde urethrography

Retrograde Urethrography (RGU) performed at six weeks postoperatively demonstrated a widely patent bladder neck with unobstructed contrast flow from the urethra into the bladder. The reconstructed segment showed no evidence of residual filling defect, luminal irregularity, or anastomotic narrowing. The calibre of the neobladder neck was radiologically normal, consistent with successful restoration of anatomical patency.

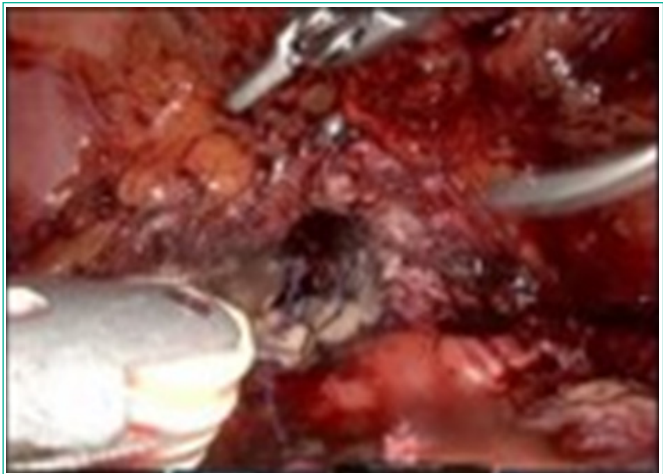


Figure 5: Posterior buccal mucosal graft placed in onlay configuration on the posterior bladder completed.



Figure 6: Neckdef hybrid reconstruction showing anterior bladder mucosal advancement and.

Uroflowmetry comparison

Parameter	Preoperative	Postoperative (3 months)
Maximum Flow Rate (Qmax)	8 mL/s	24 mL/s
Postvoid Residual (PVR)	140 mL	20 mL
Voiding Pattern	Obstructed plateau trace	Normal bell-shaped curve

Discussion: The role of ICG in reconstructive urology

The application of indocyanine green fluorescence imaging in urological surgery has expanded substantially since its initial descriptions in partial nephrectomy and renal tumour localisation. Within the reconstructive urology domain, ICG has been described for ureteral identification during complex pelvic dissection, assessment of intestinal conduit vascularity in urinary diversion, and intraoperative mapping of lymphatic channels. However, its use as a primary decision-making tool for defining the extent of scar excision in bladder neck reconstruction represents a conceptually novel application with significant potential implications for recurrence prevention. The fundamental challenge in recurrent BNC reconstruction is the reliable identification of the boundary between viable, perfused tissue capable of supporting graft integration and avascular fibrosis that will inevitably lead to recurrence if left in the reconstruction bed. Conventional white-light assessment, even with the magnification afforded by robotic systems, does not reliably discriminate between these tissue states. ICG fluorescence imaging, by contrast, provides a real-time, objective, and reproducible perfusion map that can be reassessed iteratively throughout the operative procedure.

The parallel use of BMG in bladder neck reconstruction builds upon the extensive evidence base for buccal mucosa in urethral reconstruction, where its durability, low contracture rate, and resistance to wet environments have been well-characterised. Anterior bladder mucosal advancement as a complementary technique leverages native, fluorescence-confirmed well-perfused tissue and avoids the morbidity associated with circumferential grafting, representing a pragmatic and biologically sound approach.

ICG in partial nephrectomy

Tumour demarcation and ischaemia assessment during clamping — established evidence base [9].

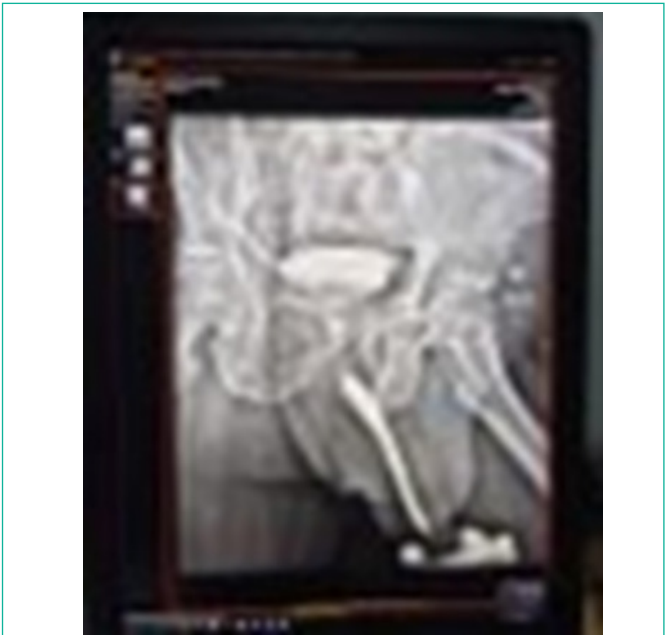


Figure 7: Postoperative retrograde urethrogram confirming patent bladder neck reconstruction

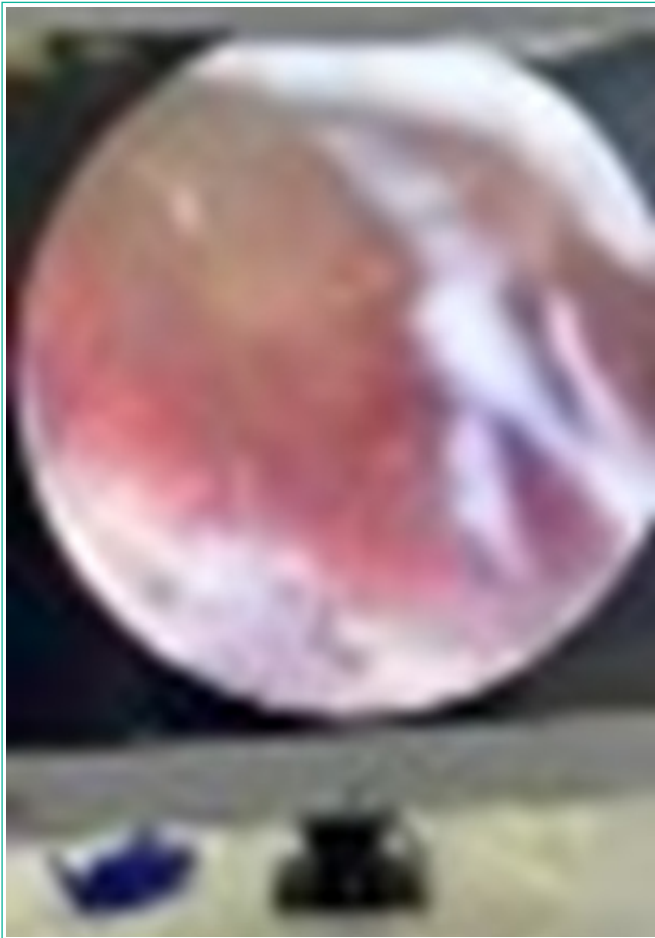


Figure 8: Postoperative cystoscopy demonstrating patent, well-epithelialised reconstructed bladder neck at 3W.

ICG in Ureteral identification

Real-time fluorescence ureteral mapping in complex pelvic and retroperitoneal dissection

ICG in BNC reconstruction

Novel: Perfusion-guided scar excision margin determination — current case

Novelty and learning points

What makes this case unique:

Novel intraoperative ICG application

ICG fluorescence imaging was employed not merely for vascularity assessment post-reconstruction but as an **intraoperative decision-making instrument** to map the annular fibrosis boundary and define precise scar excision limits in real time.

Fluorescence-guided annular excision

Near-infrared imaging demonstrated differential perfusion between viable tissue and the hypoperfused fibrotic segment, enabling circumferential excision until well-perfused margins were confirmed at every quadrant — an iterative, objective approach.

Hybrid mucosal reconstruction

Combining **posterior buccal mucosal graft augmentation** with **anterior bladder mucosal advancement** restored circumferential mucosal continuity, avoided circumferential grafting morbidity, and leveraged the distinct biological properties of each tissue source.

Objective multi-domain functional success

Outcome confirmation across anatomical (cystoscopy), radiological (RGU), and functional (uroflowmetry, PVR) domains — Qmax improved from 8 to 24 mL/s; PVR reduced from 140 to 20 mL.

Key learning points

1. Progressive fibrosis with repeated endoscopy

Repeated endoscopic incision of bladder neck contractures may lead to progressive fibrosis and reduced tissue vascularity, making definitive reconstruction increasingly challenging with each failed intervention. Surgeons should consider early referral for reconstructive evaluation after the second failed BNI.

2. ICG as a tissue discrimination tool

Intravenous ICG fluorescence imaging may assist surgeons in objectively distinguishing viable, well-perfused tissue from poorly perfused fibrosis during robotic reconstruction — a distinction not reliably achievable with white-light assessment alone.

3. Fluorescence-guided margins reduce recurrence risk

Fluorescence-guided identification of healthy tissue margins at the excision boundary may reduce the risk of inadequate scar excision, which is a primary driver of contracture recurrence in the reconstructive urology literature.

4. BMG provides a durable epithelial surface

Posterior buccal mucosal graft augmentation provides a well-vascularised, hairless epithelial surface with high water content and documented resistance to secondary contracture, making it a reliable substrate for bladder neck reconstruction in a compromised tissue bed.

5. Anterior advancement complements posterior BMG

Anterior bladder mucosal advancement complements posterior graft augmentation and allows restoration of circumferential mucosal continuity without the need for circumferential grafting, thereby reducing operative complexity and donor site morbidity.

6. Robotic platform enables precision reconstruction

Robotic surgery provides excellent visualisation, three-dimensional magnification, and instrument dexterity for complex lower urinary tract reconstruction, facilitating precise graft placement, meticulous haemostasis, and secure multi-quadrant suturing.

Conclusions and future directions

To our knowledge, this represents one of the first reported cases describing the use of intravenous indocyanine green fluorescence imaging to guide annular excision of recurrent bladder neck fibrosis during robotic reconstruction combined with hybrid posterior

buccal mucosal graft augmentation and anterior bladder mucosal advancement.

Take-home message

In patients with recurrent bladder neck contracture after failed endoscopic treatment, robotic reconstruction aided by fluorescence-guided scar identification and hybrid mucosal augmentation may offer an effective reconstructive solution with encouraging early functional and radiological outcomes. The Qmax improvement from 8 mL/s to 24 mL/s and reduction in PVR from 140 mL to 20 mL at three months represent clinically significant objective gains in a patient population where re-do reconstruction carries substantial risk.

Future applications

Prospective validation of ICG-guided scar excision in larger cohorts of patients with refractory BNC is warranted. Standardisation of fluorescence thresholds for defining adequate tissue perfusion at the excision margin, integration of ICG guidance into urethroplasty for complex posterior urethral stenosis, and assessment of long-term patency rates in hybrid mucosal reconstruction represent priority areas for future investigation.

- ICG threshold standardisation

Define quantitative fluorescence cut-offs for viable vs. non-viable tissue in BNC surgery

- Multicentre series

Prospective registry of ICG-guided lower urinary tract reconstruction cases across reconstructive urology centres

- Long-term patency data

Five-year cystoscopic and uroflowmetric follow-up to assess durability of hybrid reconstruction

- Extension to posterior urethral stenosis

Evaluate ICG-guided excision in complex posterior urethral stenosis and obliterative BNC

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