

# Endoscopic Combined IntraRenal Surgery (ECIRS)



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**Abstract** Endoscopic combined intrarenal surgery (ECIRS) is the simultaneous antegrade and retrograde approach to treating complex renal stone diseases by combining percutaneous nephrolithotomy (PCNL) with retrograde intrarenal surgery (RIRS). ECIRS has become popular over the last decade with the introduction of modified supine PCNL, as PCNL in this position makes retrograde approach to the kidney easily accessible without the need to reposition the patient. The goal of performing ECIRS is to achieve stone-free status for the operated renal unit in a one-stage surgery while minimizing the required percutaneous access to a single tract by taking advantage of the best of both PCNL and RIRS armamentarium.

**Keywords** Endoscopic Combined IntraRenal Surgery (ECIRS) · Kidney stone surgery · Endoscopic surgery · Minimally invasive surgery · Urolithiasis · Nephrolithiasis · Kidney stones · Stone removal · Renal calculi · Renal anatomy · Endourology · Flexible ureteroscopy · Percutaneous nephrolithotomy (PCNL) · Miniaturized percutaneous nephrolithotomy (mini-PCNL) · Retrograde intrarenal surgery (RIRS) · Holmium laser lithotripsy · Stone fragmentation · Renal access · Fluoroscopy · Postoperative care

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## 1 Introduction

Endoscopic combined intrarenal surgery (ECIRS) is the simultaneous antegrade and retrograde approach to treating complex renal stone diseases by combining percutaneous nephrolithotomy (PCNL) with retrograde intrarenal surgery (RIRS).

ECIRS has become popular over the last decade with the introduction of modified supine PCNL, as PCNL in this position makes retrograde approach to the kidney easily accessible without the need to reposition the patient.

After Valdivia-Urĭa first demonstrated that PCNL can be done safely in the supine position with a 3L-saline bag under the flank in 1987 (Valdivia Uria et al. 1998), different variations in positioning have been reported in the literature—lateral, complete supine and modified supine positions (Kerbl et al. 1994; Falahatkar et al. 2008; Papatsoris et al. 2008; Bach et al. 2012). Yet none of these managed to replace the conventional prone positioning for PCNL until in 2001, when Professor Gaspar Ibarluzea from the Galdakao hospital shared his innovative concept of incorporating a modified lithotomy position to the supine Valdivia position (Ibarluzea González et al. 2001; Ibarluzea et al. 2007). This position is now known as Galdakao-modified supine Valdivia (GMSV) position and has led to supine PCNL gaining worldwide acceptance in the last decade as more urologists adopt this technique.

The term ECIRS was coined in 2008 by Scoffone et al. in the first report of the safety and efficacy of this combined approach (Scoffone et al. 2008). In their prospective study between 2004 and 2007, 127 patients underwent ECIRS, in which both PCNL and RIRS were simultaneously performed in the GMSV position, to treat large and/or complex urolithiasis. They reported high stone-free rates of 81.9% after the initial surgery and the mean operative time of  $70 \pm 28$  min, including the time taken for positioning. Their reported complication rate of 38.6% for ECIRS was comparable to PCNL complication rates in the literature. Hence, they demonstrated that ECIRS could be performed efficiently and safely without the additional risk of complications from the combination of the two operations.

The goal of performing ECIRS is to achieve stone-free status for the operated renal unit in a one-stage surgery while minimizing the required percutaneous access to a single tract by taking advantage of the best of both PCNL and RIRS armamentarium.

ECIRS is particularly advantageous over PCNL or RIRS as monotherapy in treating complex renal stones such as staghorn or stones in multicalyceal locations. In these challenging cases, PCNL as a single modality may lead to increased risk of renal parenchymal injury and resultant bleeding, either from the excessive swing of the nephroscope via a single access tract or from making multiple access tracts, in attempting to treat the stones located in difficult-to-reach calyces. On the other hand, RIRS alone on its own would result in high intrarenal pressures with resultant risk of sepsis, not to mention, prolonged operative time and its associated consequences.

In contrast, the dual approach enables a more effective lithotripsy, reduces operative time and increases surgical success for stone free rates while minimizing complications (Cracco et al. 2011, 2020; Hamamoto et al. 2014b; Nuño de la Rosa et al. 2014). In cases of large stones, simultaneous lithotripsy via antegrade and retrograde routes will fragment the stones more efficiently and reduce operative time. When there are multicalyceal stones and the antegrade access via the percutaneous tract is unable to access the affected calyces (particularly if the stone is located in a calyx parallel to that of the access tract), retrograde flexible ureteroscope may be deployed to treat the stone, hence reducing the number of PCNL tracts or the need for staged surgery by improving stone clearance in a single operation.

Another example where ECIRS is indicated is in cases of ureteric strictures where retrograde access may be difficult or impossible—simultaneous antegrade and retrograde endoscopic assessment will delineate the extent of the disease accurately. The stricture may be treated by the antegrade approach if deemed suitable or planned for alternative appropriate intervention (Miyai et al. 2021; Scarpa et al. 1997). Similarly, in cases of reconstructed urinary systems such as ileal conduits, where retrograde approach may be complicated due to anastomotic stricture or obscure ureteric orifice, initial antegrade approach will allow the passage of wire down the ureter to identify the ureteric orifice for retrograde approach and thus, enabling assessment and potential treatment of the underlying pathology.

## 2 Patient Positioning

The same debate for patient positioning in PCNL exists for ECIRS. The choice of modified supine/lithotomy position versus prone position depends mostly on the familiarity of the approach by the surgeons.

### 2.1 *Galdakao-Modified Supine Valdivia (GMSV) Position and Giusti's Position*

These positions are commonly adopted for ECIRS due to their ease of positioning the patient without the need to turn the patient prone and because of the familiarity of urologists in doing RIRS in the lithotomy position rather than prone. Furthermore, there is an increasing shift from prone PCNL to supine PCNL with the use of ultrasound-guidance for access puncture over the last decade.

The details for these positions are discussed in the previous chapter on Supine PCNL.

## 2.2 *Prone Split Leg Position*

For urologists who are keen to maintain the prone approach for PCNL, ECIRS has also been reported to be successfully performed with the patient prone on an operating table that allows the legs to be placed in a split position in order to enable a second surgeon to perform retrograde ureterorenoscopy (Hamamoto et al. 2014a; Wang et al. 2022).

In this position, the ureteric orifice is first cannulated with the use of flexible cystoscopy and subsequent retrograde access is attained with flexible ureteroscopy. Antegrade access is established by traditional prone PCNL technique.

Those that advocate the prone position reported the advantages to be that of the availability of a wider surgical field for percutaneous access, an easier access to the upper pole calyces, less mobility of the kidney and shorter distance into the collecting system particularly in obese patients. Prone split leg position also enables the team to perform bilateral surgery without the need to reposition the patient (Hamamoto et al. 2014a; Wang et al. 2022; Duty et al. 2012).

Literature reports that there are no significant differences in outcomes in terms of stone-free rates and complications for the GMSV versus prone split leg position for ECIRS (Abouelgreed et al. 2022; Cracco and Scoffone 2020), though ECIRS became popular in the GMSV position and many have adopted this position in practice.

This is because ECIRS in GMSV position offer many anaesthesiologic advantages over prone positioning including easier access to the airway, less risk of endotracheal tube kinking or dislodgement, and improved cardiovascular and respiratory indexes (Ibarluzea et al. 2007; Khoshrang et al. 2012; Cracco and Scoffone 2011). It is also easier to position the patient in GMSV position as there is no need to turn over an anaesthetized patient, thus, decreasing need for manpower and lessening theatre occupancy time. More importantly, this avoids possible pressure injuries associated with the prone position, that can potentially lead to neurological or visual deficits. This is especially important in the challenging obese patients.

However, some disadvantages exist with modified supine positions. One of these is the limited access for puncture especially for the upper pole calyx where it may be associated with an increased risk of visceral injury. This risk may be decreased by the wide availability of pre-operative anatomical assessment with CT scans and the use of ultrasound to guide the needle puncture to ensure there is no intervening organ along the tract to the kidney. Hence, upper pole puncture is not necessarily excluded for ECIRS and may still be performed in selected cases. Furthermore, it is reported that access through lower pole in the supine position has a wider angle for manipulation to reach the upper pole (Proietti et al. 2019; Sofer et al. 2016). For cases where upper pole is not accessible through the percutaneous tract, this is precisely the indication for a combined approach surgery anyway.

Another critique for GMSV position is the difficulty with establishing antegrade access due to the increased mobility of the kidney in the supine position which makes percutaneous puncture and especially dilatation difficult, particularly so for patients of a thinner body habitus. In these cases, passing the guidewire down the ureter and out through the external urethral meatus in a through-and-through fashion (the “kebab” patient) can aid in stabilizing the kidney (Cracco and Scoffone 2020).

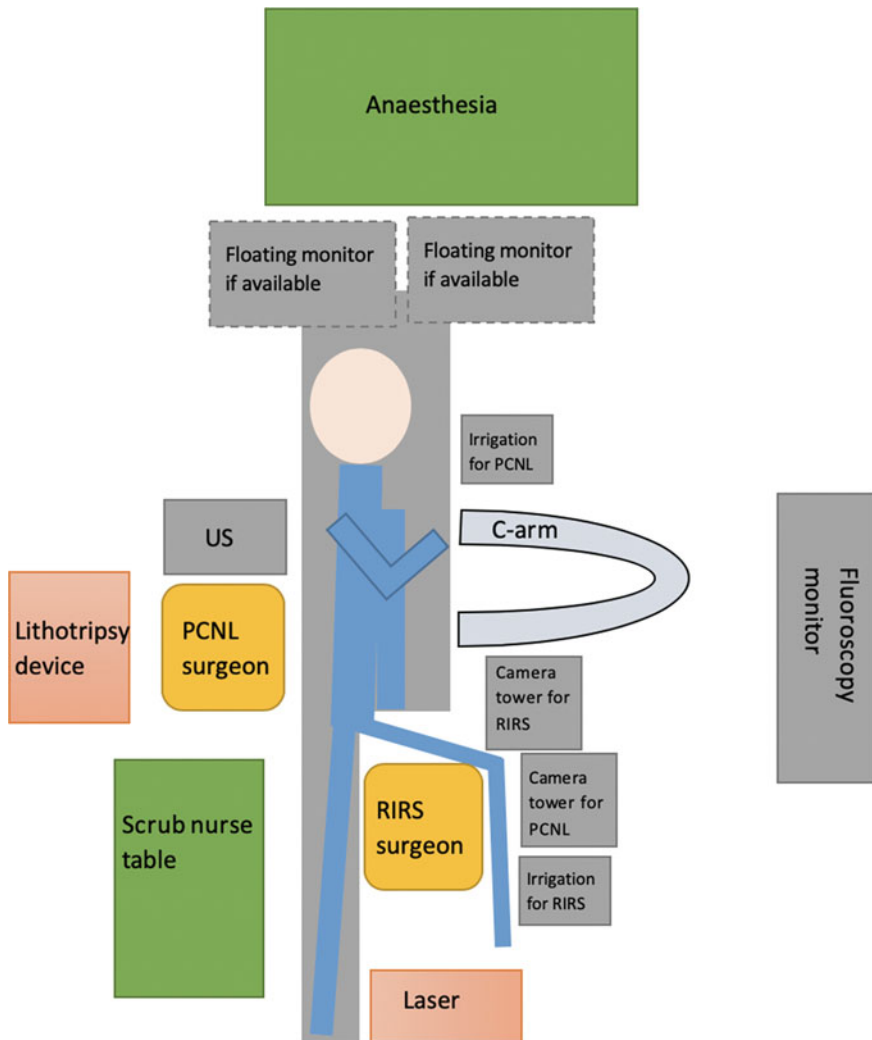
Lastly, in the GMSV position, as the antegrade access drains the irrigation fluid by gravity, it may be difficult to keep the calyces distended. However, with dual-access flow, endovision can be maintained well. In fact, keeping calyces less distended is advantageous in reducing intrarenal pressure, fluid reabsorption and its resultant risk of sepsis. The downward or horizontal position of the sheath also allows stone fragments to be flushed out (Nicklas et al. 2015), making fragment evacuation more efficient.

### 3 Equipment Positioning

Whether the surgeons prefer the GMSV or the prone split leg position, one of the main challenges for ECIRS is the arrangement of equipment in the confined space of the operating theatre. In ECIRS, two surgeries are being performed concurrently and therefore, two sets of equipment are needed including the bulky endoscopic video systems and lithotripsy machines. Also, fluoroscopy must be well-coordinated between the urologists and its imaging screen positioned to be easily seen by both the antegrade and retrograde teams.

Figure 1 suggests an example of how the equipment may be arranged in a theatre with two camera tower stacks—one for PCNL and one for RIRS. More commonly, not every hospital has the luxury of two sets of endoscopy camera towers for both the antegrade and retrograde surgeons. In these cases, the retrograde surgeon uses the camera system first for cystoscopy and semi-rigid ureteroscopy. Subsequently, the surgeon may switch to a disposable flexible ureteroscope as the disposable ureteroscopes come with their own monitor so that RIRS may be performed concurrently with the antegrade approach which will use the in-house endoscopic camera system.

Equipment positioning can be individualized based on the resources available. For example, if there are floating monitor screens available in the operating theatre, it will be better ergonomically for the surgeons to have the fluoroscopic imaging or the endoscopic video projected to these screens.



**Fig. 1** Arrangement of ECIRS equipment in OR

## 4 Operative Steps

As with all surgeries, review of available radiological imaging is important for surgical planning by assessing the stone load and location as well as taking note of the presence of any aberrant anatomy such as retrorenal colon, liver ptosis, organomegaly or malrotated kidney.

After the patient is anaesthetized and prophylactic intravenous antibiotics are given, the patient is commonly placed in GMSV position with the equipment arranged

as previously discussed. The surgeon then draws reference lines on the patient—the posterior axillary line, the iliac crest and the border of 12th rib—to mark the boundaries of the operative field.

The operative sites are cleaned and draped. One urologist starts off with cystoscopy and a safety guidewire is placed in the ureter on the side of the surgery. Ureteroscopy is then performed to assess for any abnormality of the lower tract and also for the presence of any ureteric stone or strictures and to gauge the caliber of the ureter to size for access with flexible ureteroscope.

Next, flexible ureteroscope is introduced in the retrograde fashion to survey the dynamic anatomy of the collecting system and the stone load and characteristics. This preliminary retrograde assessment is an important step as it provides the urologists with much valuable additional information but at the same time, is not time-consuming and poses little risk to the patient or the equipment. After the retrograde assessment, the surgeon also has the choice to not proceed with PCNL and may decide to perform only RIRS if the anatomy and stone burden are favourable.

If, however, the decision is made to proceed with ECIRS, a ureteric catheter is placed after withdrawal of the flexible ureteroscope for placement of contrast in the collecting system. A second urologist gains percutaneous access to the calyx of choice as per standard steps for PCNL. More urologists are now moving towards the use of ultrasound to gain access to the kidney, though fluoroscopy still plays an important role in establishing access. Ultrasound can aid to visualize surrounding organs during the puncture and avoid inadvertent injuries.

In suitable cases, instead of exchanging the flexible ureteroscopy to ureteric catheter, puncture may also be aided by flexible ureteroscopy under direct endoscopic vision. One of the pioneer teams of ECIRS from Cottolengo Hospital of Torino described their Turin Technique with this endovision-check percutaneous renal puncture for ECIRS (Cracco et al. 2022). Endovision minimizes bleeding as it checks the puncture and dilatation. It can also help to reduce the need for fluoroscopy and hence, decreasing radiation exposure for both the patient and healthcare staff.

Once the percutaneous access is established, lithotripsy is performed through the PCNL tract. Simultaneous laser lithotripsy via retrograde flexible ureteroscopy may also be performed. Ureteric access sheath may not always be necessary in cases of ECIRS, especially when combined with a standard size PCNL, as irrigation outflow through nephrostomy sheath will keep intrarenal pressures low. Also, stone fragments can be easily evacuated through the percutaneous tract, avoiding the need for multiple passage of the flexible ureteroscope up and down the ureter.

During lithotripsy, care must be taken by both surgeons not to damage the flexible ureteroscope by the antegrade lithotripsy energy device, in particular if a reusable ureteroscope is being used.

Stones in calyces that are not visible to the PCNL nephroscope can be retrieved with a basket via retrograde flexible ureteroscope and passed out through the antegrade tract (pass the ball technique Cracco and Scoffone 2020) or repositioned for fragmentation in the part of the collecting system favourable to the PCNL access. Alternatively, the stones may be fragmented in-situ by laser via flexible ureteroscopy and the fragments then passed out through the PCNL tract for easier removal.

In addition to fluoroscopy, retrograde flexible ureterorenoscopy can aid in assessing stone clearance. Once stone clearance is established, a ureteric stent can be easily placed in the retrograde fashion and exit strategy as per surgeon's judgement.

## 5 Versatility of ECIRS

There can be variations to ECIRS by downsizing the PCNL tract to mini-PCNL or ultra-mini PCNL, provided two laser machines are available for both antegrade and retrograde lithotripsy.

Hamamoto et al. demonstrated in their 10-year retrospective study that ECIRS with mini-PCNL had superior outcomes when compared to conventional PCNL monotherapy or mini-PCNL monotherapy (Hamamoto et al. 2014b). For 161 patients with average renal stone size of 35–40 mm, they found operative time to be significantly shorter in mini-ECIRS arm (mini-ECIRS: 120.5 min vs. mini-PCNL: 181.9 min versus conventional-PCNL: 134.1 min,  $P < 0.001$ ) with the best stone-free rates of 81.7% while mini-PCNL and conventional PCNL stone-free rates were 38.9% and 45.1% respectively.

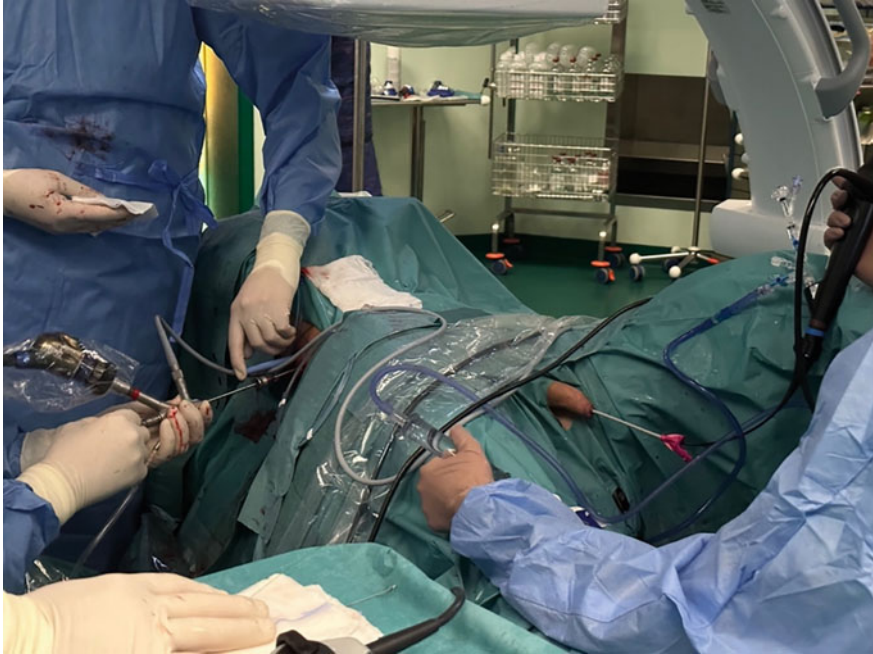
Furthermore, although the aim of ECIRS is to reduce the number of PCNL tracts, in complex cases, it is still possible to perform multiple antegrade accesses to improve stone clearance. Figure 2 shows a patient with a conventional PCNL tract and an additional mini-PCNL tract for a stone in lower pole calyx at an angle that made it impossible to pass the retrograde flexible ureteroscopy.

Regardless of choice of positioning and size of percutaneous tract, systematic review of the available ECIRS literature in 2020 by Cracco and Scoffone (Cracco and Scoffone 2020) reported stone-free rates to be  $> 80\%$  with a single percutaneous access in most cases with the overall range of 61–97%. The bigger the size of the percutaneous tract and the smaller the stone, expectedly, the higher was the stone free rate observed.

In their study, complication rates ranged from 5.8 to 44% and were associated with staghorn stones and longer operative time. Most complications classified under Clavien-Dindo grade 1 or 2 (Dindo et al. 2004). Bleeding risk was minimal regardless of the PCNL tract size. Infection and sepsis rates varied from 3 to 40%.

Notably, they found that most ECIRS were performed with single-access for PCNL, with only 1.6–10% of cases needing an additional access tract. Operative time was often found to be shorter compared to traditional PCNL monotherapy and was as fast as 70 minutes including the time taken for positioning. More importantly, ECIRS indicated a decreased need for additional procedures and was effective in achieving stone-free status even in cases of large and/or complex stones (Cracco and Scoffone 2020; Nuño de la Rosa et al. 2014).





**Fig. 2** ECIRS with standard and mini PCNL tracts

## 6 Disadvantages of ECIRS

While ECIRS has many merits, there are also some drawbacks. For a successful ECIRS, two operating teams and 2 sets of instruments are required simultaneously. This means additional manpower that may not always be available. Moreover, with the increase in the number of staff and extra equipment required, the operating theatre may be over-crowded. Well-trained and dedicated staff who are familiar with the set up and positioning of the equipment will increase efficiency.

In addition, there must also be synergy between the two urologists as well as between the surgeons and the scrub team and supporting theatre staff. Everyone should be familiar with the steps of the operation and the two surgeons need to communicate well in order to perform a successful ECIRS.

Lastly, since two operations are combined into one during ECIRS, the cost of each ECIRS will be more than that of either PCNL or RIRS alone due to additional instrument and consumables required for the combined surgery compared to PCNL or RIRS alone. However, since ECIRS reduces the need for ancillary procedures (Cracco and Scoffone 2020; Nuño de la Rosa et al. 2014), in the long run, it would be more cost effective. When patients can be rendered stone-free in a single step surgery rather than through repeated operations, there will be reduced need for operating theatre occupancy, hospitalization, repeated imaging and clinic visits, and this in turn

will decrease overall healthcare costs. Nevertheless, one should be mindful of the indications for which ECIRS will be beneficial over PCNL/RIRS monotherapy and only perform ECIRS for cases that truly warrant it, rather than performing additional RIRS for all cases of PCNL, or vice versa, just because it is conveniently achievable. Avoiding unnecessary ECIRS will also reduce the amount of material waste so that we can be more environmentally-conscious.

## 7 Conclusion

ECIRS has revolutionized the management of complex renal stones. Its advantages for anaesthesia especially in the modified supine positions, and better results for one-step stone clearance with reduced need for ancillary procedures, make ECIRS the treatment of choice in cases of heavy stone burden or complex anatomy.

The debate on the best patient-positioning for ECIRS will continue based on the country of practice and personal preferences and familiarity of the performing urologists. In future, mini-PCNL paired with RIRS may replace standard-size antegrade access (Usui et al. 2020) as improvements in laser technology afford more efficient lithotripsy and the use of high powered lasers become more prevalent.

Besides its use in treatment of complex stones, ECIRS is also increasingly utilised in the treatment of other urological conditions. ECIRS has been reported to be successfully used for the treatment of ureteric strictures, encrusted stent removal, in paediatric population, in the transplanted kidney and even in a case of squamous cell carcinoma (Miyai et al. 2021; Scarpa et al. 1997; Juliebø-Jones et al. 2021; Mitome et al. 2018; Taguchi et al. 2015; Li et al. 2018; Santillán et al. 2021).

ECIRS with the maximal advantages of both PCNL and RIRS capabilities is no doubt fast-becoming the operation of choice for complex urolithiasis. As more urologists adopt this surgery for a variety of conditions, it will continue to result in improved outcomes and increased versatility.

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