Vascular complications of PCNL
Causes, management & prevention

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PCNL is still a treatment of choice for large renal stones. Even after 35-40 years of PCNL invention, bleeding is still a single most common reason why this procedure is considered as risky & has potentiality of complications. Kidney is most vascular structure in the body receiving blood flow of approx. 1 lt per min. If bleeding starts – it can be dangerous as large amount of blood loss can occur in short time leading to hypotension & significant morbidity. Occasionally this complication can result into kidney loss. Possibility of such Vascular complications makes surgeon defensive & opt for some other alternative if possible. In several published articles, Blood transfusion rates after PCNL varies from 40% to 5%. Even in cases, where blood transfusion is required, there is significant Hb drop. Hence for PCNL to become safe, it is necessary to understand causes of bleeding during & after PCNL & take steps accordingly.

In this hand out, it is elaborated – at what stages of PCNL, bleeding can occur & how to prevent it. All these points will be shown during presentation in the form of pictures, videos.

Bleeding can occur during every stage of PCNL – during puncture, during tract dilatation, during Nephroscopy, during stone disintegration, or after PCNL – early, delayed or late.

During Puncture – Ideal puncture must be through the papillae. This is the area where, there are no significant size vessels. This is also called as peripheral puncture. If puncture occurs thro infundibulum (Oblique puncture, central puncture), it can injure significant size vessel & when tract dilatation occurs, it can result into tearing of vessels resulting into bleeding, which run flush & parallel to infundibulum. (fig. 1). It is also necessary that puncture is made by shortest possible tract. If access is made after traversing significant parenchyma – obviously there are more chances of bleeding. Hence if required, do not hesitate to make supra-costal puncture rather than approaching upper calyx thro subcostal area in which needle has to traverse significant parenchyma (fig.2). Prevention – Always ensure that puncture is accurate. Do not accept suboptimal puncture, Use of USG will help you to identify the cup of calyx & puncture accordingly. Accurate puncture – makes procedure safe.

Tract dilatation –
1) Method of tract dilatation - Sequential dilatation results in more bleeding than telescopic / balloon dilatation. Single step dilatation also prevents blood loss to significant extent. Blood during dilatation can get collected into PCS & can spoil vision when nephroscopy is started.
2) Zig-zag tract. – if puncture is not straight, then during dilatation, you can have torque on the kidney, loss of tract & improper dilatation. All can result in more bleeding.
3) Incomplete dilatation – when stone is filling whole calyx, it is not possible / advisable to go into calyx & tract dilatation remains incomplete. This can result in severe bleeding from Amplatz sheath. This is tract bleeding. To overcome this – break the stone quickly in calyx. Once space is created, push the Amplatz sheath inside the PCS
& bleeding will stop immediately. As far as amplatz sheath is in the tract bleeding will take place. This can also happen when single step dilatation method is used & tract is not fully dilated & hence sheath remains in the tract just outside PCS.

4) Size of tract – Several publications have showed that size of tract is directly proportional to bleeding. CROES data also showed that as tract size increases, bleeding complications increase. Hence all recent advances have revolved around reducing tract size. As a result several minimally invasive PCNLs are introduced like miniperc, ultraminiperc, microperc …etc If you use smaller tract – bleeding complications are less.

5) Extent of tract dilatation – generally dilatation is done only upto calyx. If forceful dilatation is done through narrow infundibulum – it can result into tear & can cause severe bleeding. Preventive step is to dilate carefully only upto a calyx especially if you are using large nephroscope.

6) Multiple tracts – multiple tracts of larger size are going to result in more bleeding complications. Prevention is by limiting no of tracts to minimum necessary. Selecting entry calyx in such a way that all stones can be removed through single tract. Liberal use of flexible nephroscope, utilization of FURS along with PCNL, & whenever absolutely necessary, make accessory tracts small with use of miniperc.

**Nephroscopy** – During nephroscopy while inspecting & removing stones, from other calyx, if there is excessive torque on kidney, then infundibulum tears it can result in torrential bleeding. This is because of damage to vessel underlying infundibulum which tears. Prevention is not to use excessive pressure to enter into other calyx. Use flexible nephroscope or use puncture wash technique to flush out calculi in main system. Or use another puncture or do staged procedure with FURS. All such option should be kept in mind.

**Stone disintegration.** – Commonest energy source used to break stones are pneumatic or ultrasound for large stones & laser for small stones. While breaking stones if excessive pressure is applied on stone or if ultrasound burr touches pelvic/infundibular wall, it can cause perforation & bleeding. Prevention is by careful breakage of stones without applying pressure.

Post PCNL bleeding. – it can occur immediately post procedure (early), after 24-48 hrs (delayed) or after 5-6 days (late)

Vascular abnormalities that can form post PCNL leading to bleeding – AV fistula, Aneurysm of artery, Psuedo aneurysm of vessel, venous tear.

Expect post op hemorrhage in following conditions

1) Upper calyx puncture
2) Staghorn stones
3) Multiple punctures
4) Renal failure
5) Large tract size
6) Culture positive
7) Inexperienced surgeon.
Early bleeding – It can occur any time after procedure. – Bleeding can be from nephrostomy tract or from per urethral catheter. Some times it presents as peri-nephric bleeding – pain in flank & swelling in renal region. If bleeding is from nephrostomy – nephrostomy should be clamped immediately to achieve tamponed. Per urethral catheter irrigation should be started to prevent clot formation in bladder. Most often it is due to straining, vomiting, shifting of position which dislodges clot & results in bleeding. With conservative management it should subside. If persistent bleeding – will need angiography.

Delayed bleeding – It can occur because of straining, coughing. Or AV malformation or venous bleeding. Conservative measures – higher antibiotics, IV fluids, Blood transfusion, USG/CT to see perinephric hematoma – if present – large amount – will need evacuation by open surgery. Persistent hematuria needs angiography.

Late bleeding mostly due to Infection. Common in infective stones, Culture sensitive antibiotics are required. Fungal infection should be suspected in appropriate cases. All persistent bleeding will need angiography.

Role of Color Doppler during bleeding – Quite often color Doppler misses small lesions. Most of the times lesion are small – either small AV fistula, or aneurysm, If positive – it is useful however –ve Doppler does not rule out any vascular malformation. Although it is handy & can be done as bed side investigation, it has limited role in acute bleeding management.

Renal Angiography – It could be conventional or CT angio. Advantages of conventional angio is – if embolization is required, it can be done on the spot. Disadvantage is the it is invasive procedure & if vessels go in spasm, small lesion can be missed. CT angio can pick up any minute abnormality. Accurately diagnoses – from where bleeding is coming. Disadvantages are – large does of contrast is required & if embolization is required, one more procedure is needed.

In Arterial bleeding, super selective embolization results in dramatic response. If bleeding is venous, angiography may be normal & usually it responds to conservative management.

In post PCNL bleeding measures should be taken immediately. Indication of doing angiography & if required embolization should not be too delayed as hypotension can lead to multi-organ failure & DIC. Understanding the causes of bleeding & prevention is key factor in successful outcome of PCNL.

Fig 1- Puncture through calyx cup & oblique puncture

Fig 2 – Short distance & long distance of puncture