Original Research Article

Role of USG guidance in percutaneous needle puncture in interventional radiology

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Abstract

Background: To study the role of USG guidance in percutaneous Needle puncture in interventional radiology **Methods:** We retrospectively analysed 2056 consecutive patients who underwent diagnostic or therapeutic intervention in division of interventional Radiology, Under department of radiology at Grant Government Medical college and Sir JJ groups of Hospital, Mumbai. There were 1130 males and 926 females Age ranging from 1 month to 86 years with mean age of 46 years. All the patient had undergone vascular or other target access including non pulsatile targets under USG guidance with single wall seldinger technique. Then patient either underwent diagnostic angiogram or interventional therapeutic procedure. Patient are assessed immediately after procedure and several days after that for any puncture site related complications **Results:** we have 100% success rate in percuatneous puncture under USG guidance. 2053 patients had access punctures at predetermined location. 3 patients had undergone access puncture at alternative sites due to technical failure. First pass success rate is 98%.Total complication rate is 1.4% all of which treated conservatively. **Conclusion:** Our study highlights the importance of image guidance comparing with historical evidence. We strongly recommend use of USG guidance for Percutaneous puncture. Future studies will optimise the technique further to maximise the benefits to the patients

Key Words: USG, Percutaneous punture, Interventional Radiology.

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Received Date: 06/11/2019 Revised Date: 14/12/2019 Accepted Date: 25/01/2020
DOI: https://doi.org/10.26611/10131426

Access this article online

Quick Response Code:

Website: www.medpulse.in

Accessed Date: 15 May 2020

INTRODUCTION

First step for any Interventional radiology procedure is accessing a vessel or a cavity or any potential space or tissue(organ)by a percutaneous needle puncture. The technique of catheter replacement of the needle over guide wire invented by Dr.Sven-ivar Seldinger involves three steps ,first step is percutaneous puncture of vessel, step two is introduction of guide wire and removal of needle. Final step is introduction of catheter over guide wire.[1] Dr.Seldinger evolved these techniques because of severe complications associated with earlier technique of angiography which included vessel cut down, large bore metal trochar over wire, introduction of polythene tube through the cannula etc. Needle puncture under image guidance is always desirable to minimise puncture related complications.[2] Fluoroscopy and CT were the earliest imaging techniques used for guidance of needle placement in interventional radiologic procedures. In the past two decades, Ultrasonography (USG)is preferred as first-line image guidance modality in interventional radiology procedures. Armed with recent technical advancement CT fluoroscopy and MR guidance have rejoined the stockpile of image guidance. But their availability is not widespread. Both USG and Radio-fluoroscopy have the advantage over CT scan as being a real-time imaging of a needle. CT fluoroscopy can image a needle in real-time, but this technique is associated with a higher radiation dose to the operator. The USG scores over fluoroscopy, CT, and CT

How to cite this article: Sharad B Ghatge, Shivraj M Ingole. Role of USG guidance in percutaneous needle puncture in interventional radiology. *MedPulse International Journal of Radiology.* May 2020; 14(2): 49-53. http://www.medpulse.in/Radio%20Diagnosis/

fluoroscopy as it doesn't have risk of ionizing radiation, USG has ability to visualize and avoid blood vessels without intravascular contrast material. It is portable and can be used as point care imaging modality. USG guidance is less expensive and easy to use than CT guidance.[3] Landmark based puncture involves puncturing the vessel or target assisted by tactile sensation including vascular pulsatality of the target or adjacent vessel depending on standardised anatomical knowledge .But Even after complete knowledge of the anatomy, normal anatomical variations can lead to non-target access or puncture site related complication and may increase morbidity and mortality of interventional procedures. In view of these background facts we decided to retrospectively analyse our patients done during October 2015 - September 2019 for puncture site related complications. During this period we had decided to use USG guidance for all the vascular accesses required in patients in our DSA laboratory.

METHODS

We retrospectively analysed 2056 consecutive patients who underwent diagnostic or therapeutic intervention in division of interventional Radiology under department of radiology at Grant Government Medical college and Sir JJ groups of Hospital, Byculla Mumbai. There were 1130 males and 926 females. Age ranging from 1 month to 86 years with mean age of 46 years. All the patient had undergone vascular access or other target access including non pulsatile targets under USG guidance with single wall seldinger technique. Then patient either underwent diagnostic angiogram or interventional therapeutic procedure. Access sheaths were removed as per our departmental protocol. In diagnostic procedure 1270 access sheaths were removed immediately and in other 786 patients who underwent therapeutic intervention ,661 sheaths were removed after 2 hours with ACT value under 160 and remaining 125 patients were who had undergone therapeutic intervention, sheaths were removed immediately after the procedure and puncture site sealed with closure devices.

Patients are assessed immediately after procedure and several days after that for any puncture site related complications. Patients clinical and Procedure details are documented including puncture site, size of Needle and sheath, image guidance details, number of passes. Post procedure assessment includes about puncture site hematoma, pseudo aneurysm formation, nerve damage, infection, thromboembolic events, remote hematoma.

Technical details of the procedure: Screening USG of the region of interest is to be done prior to procedure to assess acoustic window and to determine angle of insonation. Preparation of the field is with surface disinfectant and part draped keeping the window. The USG probe is sterilized or covered with rubber glove. We don't advocate of use needle guide in our department. We prefer a freehand approach. Local anaesthetic is administered with 23G needle and same is used to check the appropriateness of the acoustic window. Procedural needle 18 or 20G is then advanced until near wall of the vessel or cavity or outer margin of target organ. Then with gentle thrust needle is navigated into the lumen and backflow if any is checked. Appropriately sized wire is introduced which should move free into the target. Rest of the procedure is carried out as per Seldinger technique and procedure completed with adequate heparinisation. sheaths were removed after 2 hours with ACT value under 160 . 25 patients were who had undergone therapeutic intervention, sheaths were removed immediately after the procedure and puncture site sealed with closure devices.

RESULTS

We were successful in gaining the targeted access in all patients(100% success rate). 2053 patients had access punctures at predetermined location. 3 patients had undergone access puncture at alternative sites due to technical failure. First pass success rate is 98%.Total complication rate is 1.4%. all of complications were treated conservatively(see table -1 for details).Various Locations for the puncture sites and various types of vessels and organs that were accessed are detailed in table-2.

Table 1:

Complications	Number of cases (out of 2056)	Percentage occurrence	Historical Comparison(8,9,10,11)	Comments
Hematoma	24/2056	1.20%	5-23%	Resolved spontaneously
Psuedoaneuysrm	02/2056	0.10%	0.5-9%	Resolved with manual compression
Infection	02/2056	0%	<0.1%	------
Thromboembolic	04/2056	0.20%	<0.8%	Resolved with antithrombotic therapy
Compressive neuropathy	0/2056	0%	0.21-0.30%	------
Retroperitoneal hematoma	0/2056	0%	0.15-0.44%	------

Table 2:

Sr.No.	Procedure puncture site	Number of cases
1	Femoral artery	1440
2	Radial Artery	11
3	Brachial artery	3
4	IJV	206
5	Subclavian Vein	18
6	Femoral vein	59
7	Billiary Tree	36
8	Pelvicaliceal system	6
9	Carotid artery	1
10	Veins draining Dialysis AV fistula	26
11	Saphenous Vein over the ankle	250
	Total	**2056**

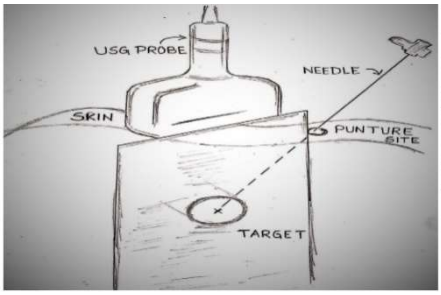

Figure 1

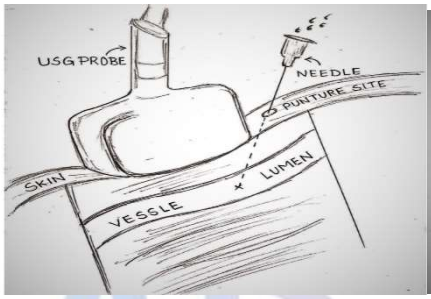

Figure 2

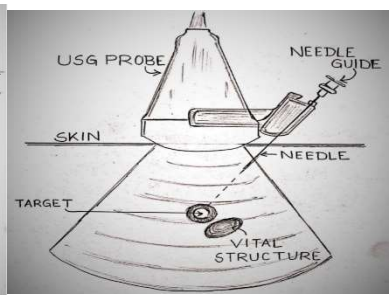

Figure 3

Figure 4

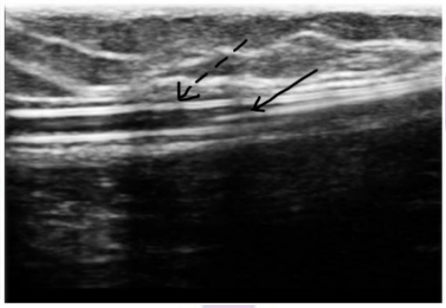

Figure 5

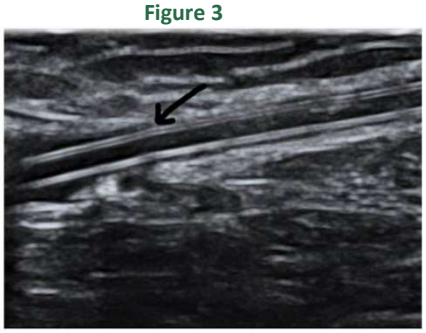

Figure 6

Figure 1: Transverse axis with free hand approach(artistic line diagram); **Figure 2:** Longitudinal axis free hand approach(artistic line diagram); **Figure 3:** USG Probe with Needle guide (artistic line diagram); **Figure 4:** Guide wire is clearly visible through Needle under USG guidance (red continuous arrow); **Figure 5:** Guide wire (Black continuous arrow) and Sheath(black broken arrow) clearly seen under USG guidance; **Figure 6:** Sheath with it's lumen (Black continuous arrow) clearly seen under USG guidance

DISCUSSION

Puncture site complications add to the morbidly- mortality of the already sick patients.USG guidance helps in minimising these complications. Interpretation of USG image and eye-hand coordination required to successfully complete the procedure [4]. USG-guided interventions requires few basic steps as good acoustic window and the shortest possible skin-to-target distance .Accordingly skin entry point is selected.. Longer skin-to-target distances are more likely to miss the target. Longer the pathway taken by the needle to reach the target more the tissues damage with corresponding increased the risk of bleeding. Patient should be comfortable and pain free as patient motions lead to longer procedure time and related complications .Good and appropriate anaesthesia is of prime importance. Two different approaches to US guidance of interventional procedures are available . Freehand Approach (FIG.1 and 2): This approach is technically more challenging and has longer learning curve. it provides greater flexibility to the operator . In this approach, the operator operates the transducer with one hand while the other hand holds the needle unattached to the transducer. The advantage of this technique is that the needle can enter the skin either distant from or very close to where the transducer is placed. For instance, it is preferable to approach a breast mass parallel to the chest wall to reduce the risk of chest wall injury, which can be achieved while maintaining the transducer on the anterior breast surface using the freehand technique.This approach also optimizes the angle of insonation. The transducer may remain outside of the

sterile field, using a more remote entry site, although needle visualization in this situation is more challenging. In acoustic obstacles like bony tissue can be easily circumnavigated with the transducer on one side of a landmark and the needle on the other side. Also, when visualizing very superficial lesions, a needle guide may not provide enough of an angle to allow the needle to enter the lesion while keeping the lesion in the field of view. Another advantage of the freehand technique is that it is possible to use needles of different gauges in the same procedure without changing the guide. However, the added versatility of the freehand approach is balanced by the need for greater technical proficiency on the part of the operator[5]. We prefer free hand approach and used same in all procedures.(FIG.1 and 2) Guided Needle Approach (FIG.3): Needle guides, which have a slot or hole that serves to direct the needle along a desired route through tissue, can be attached to an US transducer. Many US machines display a predicted path on the image, allowing the operator to access the target. Phal *et al.* used a phantom model to demonstrate that use of a needle guide is quicker than the freehand technique for less experienced operators [6] Two techniques are used for sonogmaphic guidance. The probe may be placed parallel to the long axis of the target and the needle inserted adjacent to the end or short axis of the probe so that it is under continuous visualization as it traverses the overlying tissues to the vein Alternatively, the probe may be placed perpendicular to the long axis of the vessel, visualizing the target in its short axis. The needle is placed at the centre of the probe (middle of long axis) and directed to the short axis of the vessel. The tip of the needle is not seen as it traverses the tissue between the probe and vein but only when it punctures the wall of the vessel For either approach, the needle may be directed either freehand or with an appropriate needle guide [7]. We recommend use of both long and short axes approaches as situation demands. Knowledge of the anatomy along with relations of the target has to be known thoroughly. Studying of cross sectional anatomy in sagittal ,coronal and axial planes will be of immense help during image guided interventions . Patients physical characteristic including obesity, short neck, muscle mass should taken into consideration before planning the procedure. USG guidance is mutiplanar real time imaging modality that is advantageous.

Optimisation of USG guidance technique for success:

1. Choose the best possible acoustic window, angle of insonation and frequency of probe depending upon depth and constituents of target. Angle of insonation is the angle between the axis of the ultrasound beam and the path of the needle. It also plays an important role in needle visibility. Lesser the angle lesser the visibility. Always try to have angle close to 90 degrees.
2. Larger the bore of the needle better the visualisation under USG but more the trauma to target. Echogenecity differ amongst different manufacturers. Roughening of outer surface of the needle increases echogenicity
3. Moving the needle back and forth along the longitudinal axis helps in better visualisation.
4. In cavity slight movement of the tip and needle results in microbubble formation facilitating visualisation hence smaller bore 25G can also be used .
5. Interactive feedback between operator-machine and probe plays great role in mastering the technique

Advantages of USG guidance:

1. minimally invasive
2. quicker
3. first pass success or minimum possible passes
4. can masterly avoid critical tissues or organ in the vicinity of target
5. All the steps of the Seldinger technique from insertion of the needle to sheath can be followed under vision minimising the spasm ,trauma and related complications (FIG.4 ,5 and 6).
6. Even non dilated Billiary and pelvicaliceal sytems can be accessed under image guidance which is otherwise near impossible.
7. vascular tree of Pediatric patients as small as one day old can be accessed under USG guidance.
8. complications if any will be known immediately and will be tackled in better manner than landmark based puncture techniques.
9. No ionising radiation risk .10)Widely available and cheaper

Drawbacks: Some of the obstacles encountered are non visibility of needle, Non penetration of Ultrasound through bone and air containing organs. Contrast and spatial resolution of USG images needs to be increased further.

We reviewed literature and compare with our study. Success rate of the puncture under USG guidance is 100% in our study as with published literature [8,9].First pass success achieved 98% of the cases as compared with 72%in Troianos *et al.* [8] and 82% in Denys *et al.*[9].Complications associated with puncture are hematoma at puncture site or remote from puncture site, pseudo aneurysm formation, vessel laceration, compression neuropathy or traumatic nerve injuries, infection etc. Complications rates (table -1) are significantly more in Landmark guided than image guided approach [8,9,10,11]. Greater success in subclavian vain cannulation using ultrasound for inexperienced operators as demonstrated by Gualtieri *et al.* [12].

CONCLUSION

USG guided percutaneous puncture has turned into founding landmark in radiology interventional Procedures. It reduces complications associated with punctures significantly. It proves an idiom “well begun is half done” to the perfection. Reduction in procedure time and patient comfort are additional benefits leading to decrease in morbidity –mortality. Our study highlights the importance of image guidance comparing with historical evidence. We strongly recommend use of USG guidance for percutaneous puncture. Future studies will optimise the technique further to maximise the benefits to the patients

Disclosure: Authors have no conflict of interest to declare. Artistic Line diagram are drawn by the corresponding Author himself. USG images are sourced from data base of our Department.

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Source of Support: None Declared
Conflict of Interest: None Declared