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ORIGINAL ARTICLE

# Large bore ultrasound guided vascular access: Single tertiary center experience.

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**ABSTRACT… Objective:** To share our ultrasound guided experience and demonstrate the need for implementation of ultrasound guided access in interventional cardiology and structural heart disease training programs in Pakistan. **Design:** Non-randomized, Cross Sectional Observational study. **Setting:** The study was conducted at Peshawar Institute of Cardiology. **Period:** January 2022 to June 2024. **Methods:** We conducted a retrospective study about the patients who underwent ultrasound guided vascular access for cardiac intervention from January 2022 to June 2024 at our center, Peshawar Institute of Cardiology, Pakistan. We categorized the patients on the basis of size / French of the delivery sheath. Patients who had a delivery sheath size of more than 6 French were classified as large bore access. **Results:** A total number of 89 patients underwent cannulation for various cardiac procedures, all had large bore access sheaths / devices. All had ultrasound guidance used for access site puncture. Forty-eight patients underwent transcatheter aortic valve replacement with 14F or 16F equivalent sheaths, one underwent balloon aortic valvuloplasty for severe aortic stenosis with 8F sheath and 40 patients underwent coarctation of aorta stenting with 14F sheaths. **Conclusion:** This study demonstrates the safety and efficacy of using of ultrasound for vascular access at a local center for percutaneous cardiovascular procedures requiring large bore arterial access.

**Key words:** Coarctation of Aorta, Transcatheter Aortic Valve Replacement, Ultrasound.

## INTRODUCTION

Ultrasound guided vascular access for different interventions has been in practice for the last four decades.[1]

It has been shown that ultrasound guided access (USGA) reduces the risk of access site complications, cannulation time, inadvertent vessel punctures and increases the chances of first-pass success rate[2] as compared to relying upon anatomic landmarks.[3-5]

The larger the bore of the devices used, the higher chances of complications. For procedures using large bore access, the access site complications are as high as 14%. Ultrasound guidance has been shown to reduce this risk by half.[6]

Over the recent years large bore access is becoming more common with a shift towards percutaneous interventions. Interventionists in training need to master this skill more than ever. The international guidelines for intensive care medicine and anesthesia have emphasized the use of ultrasound for venous access.[7] This recommendation is based on evidence to reduce complications, number of attempts, health expenditure and increase success rate.[8]

In different training curricula around the world, USGA is integral part of the training. For example, in the curriculum of the United Kingdom e-Portfolio it is imperative for every trainee to learn and apply the skill throughout their training.[9] In interventional cardiology the leading society of cardiovascular angiography and interventions (SCAI) has recommended the same in an expert consensus document.[10]

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The curricula for interventional cardiology and structural heart disease of the college of physicians and surgeons of Pakistan (CPSP) includes learning standard methods of vascular access procedures during the training[11] but unfortunately it is practiced by few. As a result, the complications rate is also expected to be higher than regions where USGA is practiced rigorously, though no registry or trial data is available locally.

Fellows and residents under training in our local setups are not comfortable with USGA.

Review of different trails demonstrate the advantage of USGA in terms of safety, higher success rate and lesser mean access time, reduced accidental non-target vessel puncture and radiation dose.[12-14]

As our tertiary Centre has pediatric and structural services available with active participation of trainees, implementing the USGA as a part of the formal training, they will be ready to transit smoothly towards the standard practice.

For the future of cardiology, we think that large bore access will become a routine and a handy skill since a myriad of trans-catheter procedures are being performed nationally in the current era.

We looked into the data of our patients for safety and in-hospital outcomes of ultrasound guided large bore access in this study at our Centre and report our findings to emphasize the need for our national practice to change.

## METHODS

This cross sectional study was conducted at Peshawar Institute of Cardiology from Jan 2022 to June 2024 after approval from ethical committee (IRC/23/30) (20-3-23). A total of 89 patients who underwent cannulation for percutaneous procedures with large bore access sheaths / devices at our center for cardiac procedures. The study sample was non-randomized convenience sampling including all comers of all ages and either gender. The study design was cross sectional interventional study.

All access site cannulation were acquired under real time ultrasound guidance for which we used Mindray 75L53EA linear ultrasound transducer (Shenzen, China)[15] with frequency 7.5 MHz. Two views were taken i.e. long axis and cross sectional of the respective vessel tracking the needle tip. Immediate post procedure and in-hospital access site complications were observed. All cannulations were performed by expert interventionists having sound knowledge and skill of the procedure.

Demographic and procedural data were obtained from our local database hospital management information system. The retrieved data were analyzed independently by two assessors and we used SPSS version 25 for our final data analysis. The complications are reported according to Valve Academic Research Consortium 3 updated definitions (Table-IV).

## RESULTS

Forty-eight patients underwent Transcatheter aortic valve replacement (TAVR) with 14F or 16F equivalent sheaths, one had balloon aortic valvuloplasty done with 8F femoral access sheath and 40 patients underwent coarctation of aorta stenting with 14F sheaths. Closure devices such as Proglide and Angioseal were used for patients with TAVR and coarctation of aorta (CoA) stenting: all patients who received TAVR had preclosure with proglides, 42 patients had 2 proglides each, 3 patients had 3 proglides each, 3 patients needed 1 proglide and 1 angioseal (8F) each, one patient who had balloon aortic valvuloplasty (BAV) done also had 2 Proglides. Among CoA stenting patients had one Proglide device each for access site hemostasis in 39 patients who had 14F access while in one patient manual compression was used for 10f access site. The details are shown in Table-III.

A digital subtraction image was taken for the puncture site after the procedure (Figure-1a). All patients were observed for access site complications in-hospital.

Table-I shows the baseline characteristics of the study patients and Table-II shows the procedures performed and size of the access bore size.

| Baseline Characters | Total group | TAVR/BAV(%) | CoA Stenting (%) |
|---|---|---|---|
| Number of patients | 89 | 49 (55) | 40 (45) |
| Age | | 72.3 ± 9.17 years | 23.3 ± 9.75 years |
| Gender | | Male = 32<br>Female = 17 | Male = 26<br>Female = 14 |
| HTN | | 29 | 27 |
| DM | | 19 | 0 |
| Smoking | | 01 | - |
| Family History of CAD | | 12 | - |
| Hb before procedure (mean) | | 12.7 ± 2.1 g/dl | 13.8 ± 1.9 g/dl |
| Creatinine level (mean) | | 1.16 ± 0.38 mg/dl | 0.79 ± 0.20 mg/dl |
| LV ejection Fraction | | 54.2 ± 8.07 % | 62.2 ± 11.2 % |

**Table-I. Baseline characteristics. (CAD: coronary artery disease, CoA: coarctation of aorta, DM: diabetes mellitus, Hb: hemoglobin, HTN**

| Procedure | Number of Patients | Size of Access Site Cannulation |
|---|---|---|
| TAVR | 48 | 14 F, 16F |
| CoA stenting | 40 | 14 F |
| BAV in severe AS | 01 | 8 F |

**Table-II. Procedures performed and access site bore sizes. (BAV: balloon aortic valvuloplasty, CoA: coarctation of aorta TAVR: transcatheter aortic valve replacement)**

| Type of Procedure Performed | n | Access Site hemostasis Method Used<br>Closure Devices Used Per Patient | | |
|---|---|---|---|---|
| | | Proglide | Angio Seal | Manual Compression |
| TAVR | 42 | 02 | | |
| | 03 | 03 | | |
| | 03 | 01 | 01 | |
| BAV | 01 | 02 | | |
| CoA stenting | 40<br>39<br>01 | 01 | | 01 patient* |
| Total | 89 | | | |

**Table-III. Detailed breakup of closure methods used. (BAV: balloon aortic valvuloplasty, CoA: coarctation of aorta TAVR: transcatheter aortic valve replacement)**
***in one patient manual compression was used for 10F access.**

| VARC-3 Bleeding Complications | TAVR / BAV | CoA stenting / BAV |
|---|---|---|
| Type 1 | 2 | 0 |
| Type 2 | 01 (2 RCC transfusions) | 01 (2 RCC transfusions) |
| Type 3 | 0 | 0 |
| Type 4 | 0 | 0 |
| **VARC-3 Vascular complications** | | |
| Major | 03<br>VARC type 2 bleeding = 01<br>Irreversible neurologic impairment = 02 | 01<br>VARC type 2 bleeding |
| Minor | 06<br>CFA stenosis = 01<br>Closure device failure = 02<br>Pseudoaneurysm = 01<br>Hematoma = 02 | 0 |
| **VARC-3 Access-related non-vascular complications** | | |
| Major | 0 | 0 |
| Minor | 0 | 01 (Access site infection) |

**Table-IV. Complications according to Valve Academic Research Consortium (VARC) 3 updated definitions. (BAV: balloon aortic valvuloplasty, CoA: coarctation of aorta TAVR: transcatheter aortic valve replacement)**

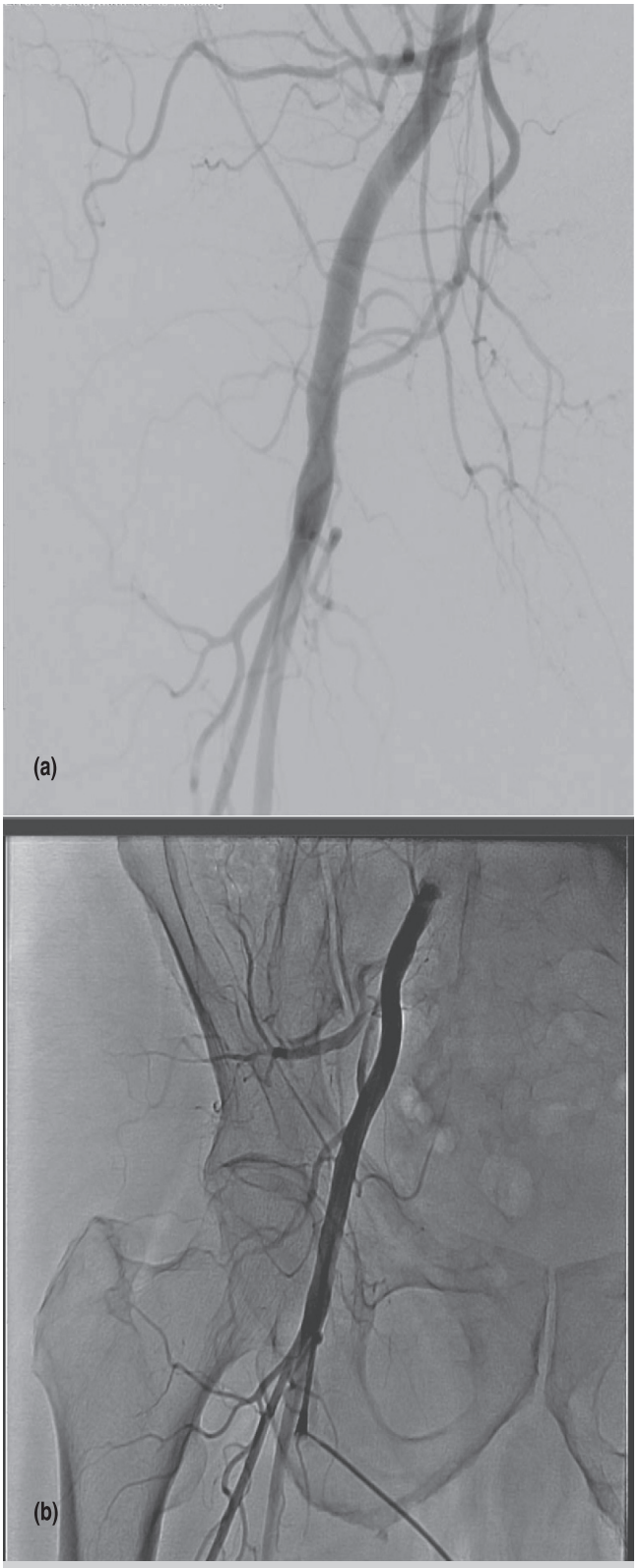


Figure 1: (a) Digital subtraction image of the right femoral artery post procedure.
(b) angiographic view at the access site.

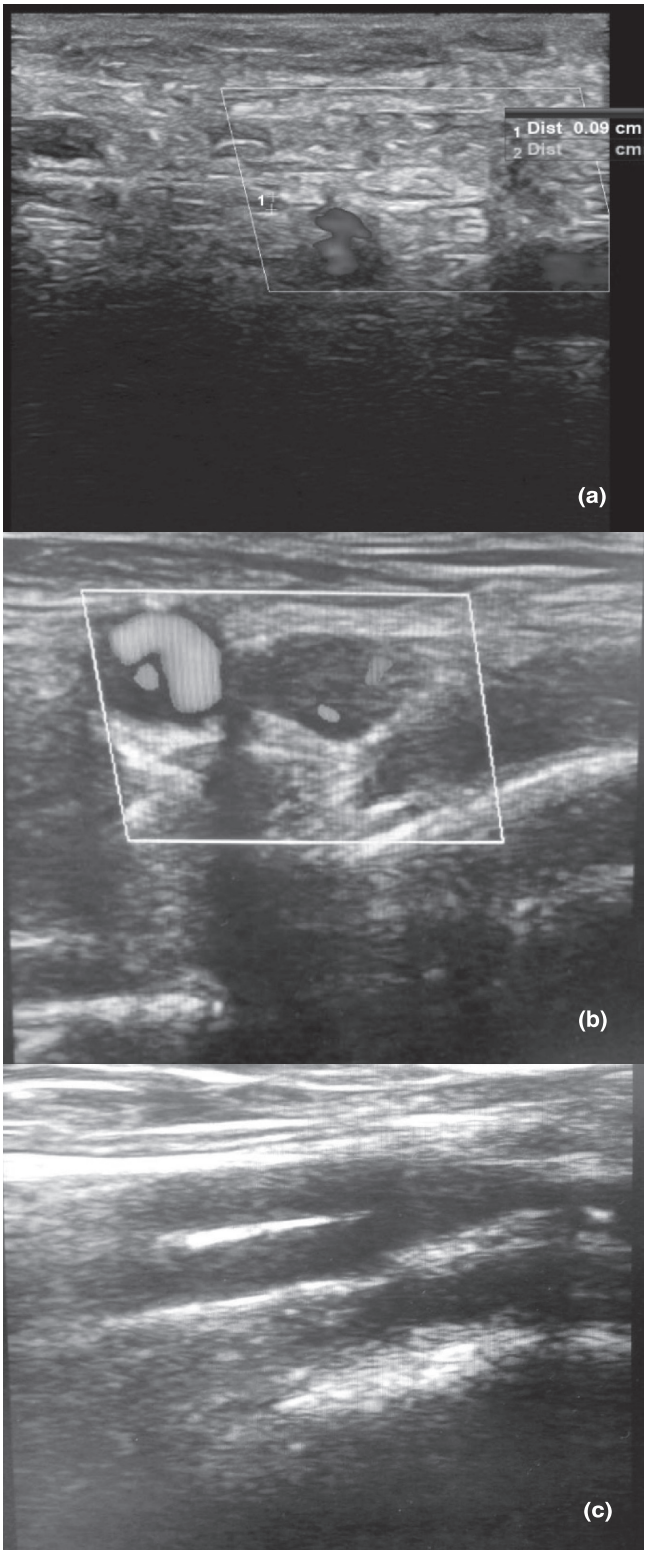


Figure 2: (a) Ultrasound images of (a) Bifurcation of common femoral artery, (b) common femoral artery in relation to the femoral vein and head of femur and (c) in longitudinal view at the level of bifurcation of common femoral artery

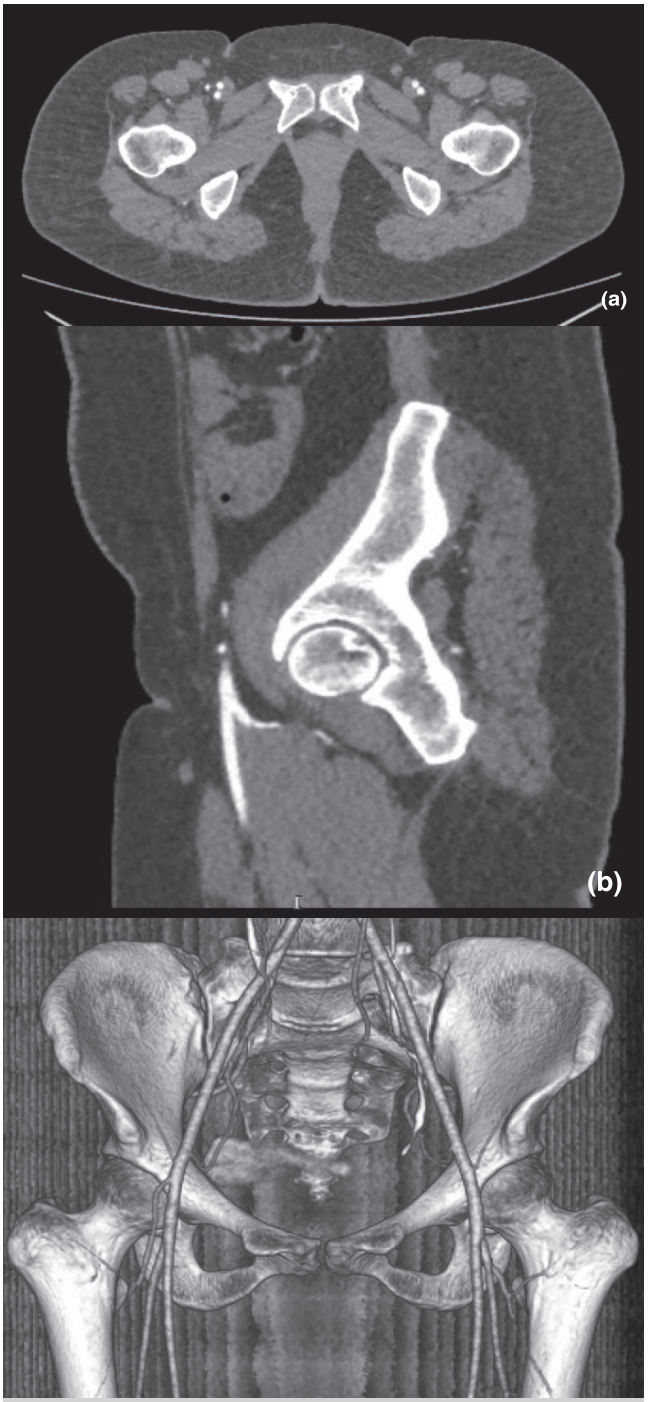


**Figure 3: (a) Computerized tomography (CT) images of a study patient (a) axial view distal to common femoral artery bifurcation, (b) sagittal view showing the bifurcation in relation to the femus head, (c) 3-dimentional CT frontal view.**

## DISCUSSION

Vascular access site complications are one of the most common ones after a cardiac procedure, especially with large bore access. This study was a non-randomized approach to demonstrate the effectiveness of a standard recommended procedure which needs to be practiced more in our local setup.

We studied 89 patients who underwent ultrasound guided access for cardiac procedures with large bore access (> 6F) and encountered non-fatal access site related vascular complications in only 4 patients (4.4%), with only 2 patients having VARC type 2 bleed / hematomas shown in table 4.

Reduction in the overall rates of complications has been found consistently in the literature. Ultrasound enables us to visualize the course, depth and size of the vessel, and characteristics of vessel wall as presence of calcium; information which cannot be gained by mere anatomical palpation. Furthermore, due to the variability in optimal femoral artery access site, the complications rate can be still high even in expert hands relying on anatomical landmarks as opposed to ultrasound guidance – 18%vs 4%.[17]

Review of different trails has demonstrated that there is high safety in USGA for vascular access from different routes.[12-14] Our data replicates the same profile with only two patients had hematoma formation, managed with red cell concentrate transfusion. Our rates of bleeding complications are not much different than reported in the literature.[18,19] While there was no life-threatening bleeding in our patients, the difference in rates of bleeding complications (z-statistic -1.08 p-value 0.281) and major strokes (z-statistic -0.056, p-value 0.956) were non-significant in comparison to international data (using Two-proportion Z-test).

These complications mainly occurred in the initial days of the study. As the experience grew the rate of complications dropped, which reflects the general trend of a team adapting to any new skill.

One of the most common complications of TAVR procedure is related to the access site which is reduced by ultrasound guidance as shown in a meta-analysis.[6] Our results highlight the importance of incorporating USGA in routine

training of our national residency program. We argue that with this practice in all the interventional centres across the country, we will be able to come up with our own data to analyze and to cut costs of our already strained health care system by preventing complications and their subsequent treatment.

Comparing the curriculum of the United Kingdom e-Portfolio with our own[9,11], has both demonstrated that it is an important skill to learn. The learning curve is incredibly short[12,14], given our region with high population to health care facilities ratio, to attain acceptable expertise in the skill, it is easy to get our health care staff trained USGA for different procedures.
Although some recent trials comparing routine radial or femoral access with US guidance vs non-ultrasound guidance has shown no advantage in terms of vascular complications and bleeding but it included access bore of only up to 8F and even though not statistically significant, the results are still skewed towards the USGA group.[20,2] Therefore, the findings cannot be generalized especially for procedures requiring access bore larger than 8F. Nonetheless, we need to apply USGA in even small-bore procedures in training institutes in order to master the skill especially by young professionals.

The argument of non-availability of ultrasound machine in cardiac catheterization laboratory is worth considering in our hospitals but at the same time the costs to treat the complications efficiently takes a much higher toll on the same system. In fact, the overall cost cutting is more than the expenditure itself[21,22] and to maintain and transfer the skill in academic institutions. The fact that no local vendor has sterile probe sleeve and gel available in the country reflects its minimum demand in the medical community. The authors had to arrange for them on their own. If a modality is used frequently in routine in the cardiac catheterization laboratory, it becomes an essential component and then can be easily provided.

Moreover, closure devices used in procedures which require large bore access come with a cost that most hospitals cannot bear, but such procedures have high stakes for the patients in whom the risk of vascular complications cannot be taken for mere saving of a fraction of the total cost of such important procedures.

Another advantage of USGA is that patients with blood dyscrasias and vasculopathies can be treated with invasive procedures with minimum risk for vascular complications. In our experience which is beyond the scope of this paper, we have used ultrasound guidance for arterial access in coronary angiogram via the right brachial artery with the in a patient with vasculopathy to avoid any bleeding and access site related complication. So, we recommend that ultrasound is not only for large bore access but other patients as well for their benefit and safety. Procedures requiring large bore access are becoming common in our country by the day and to keep up with the international standards and patients' safety we have to adopt ultrasound guidance for securing appropriate vascular access.

Limitations of our study include a single centered observational design, having no control group and patients with different procedures were included.

## CONCLUSION

This study demonstrates the safety and efficacy of using of ultrasound for vascular access at a local Centre for percutaneous cardiovascular procedures requiring large bore arterial access.

## CONFLICT OF INTEREST

The authors declare no conflict of interest.

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| 2 | **Fazal Akbar:** Data collection. |
| 3 | **Muhammad Ishaq Khan:** Write up and data analysis. |
| 4 | **Ijaz Hussain:** Data collection. |
| 5 | **Muhammad Suleman:** Data collection. |
| 6 | **Shah Zeb:** Data collection. |
| 7 | **Abid Ullah:** Data collection. |
| 8 | **Rafi Ullah Jan:** Data collection. |
| 9 | **Qaiser Aleem:** Data collection. |
| 10 | **Syed Ali Shan:** Data collection. |
| 11 | **Attiya Hameed Khan:** Data analysis. |
| 12 | **Mohammad Waleed:** Critically review. |