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ORIGINAL ARTICLE

Single-centre Initial Experience of Transradial Access for Abdominal Interventional Radiology

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ABSTRACT

Background: *Transradial access (TRA) has long been used for coronary and noncoronary angiographic procedures with substantial benefits when compared with transfemoral access, including earlier ambulation, readily achieved haemostasis, and shorter hospital stay. However, the transfemoral technique remains the mainstay of vascular access in interventional radiology. We herein present a single institution's experience with transradial intervention and evaluates its feasibility and safety.*

Methods: *A total of 94 TRA procedures were performed in 69 patients (16 women and 53 men) between April 2017 and May 2020. These included 68 chemoembolisations of liver tumours, 15 procedures for selective internal radiation therapy with yttrium-90, which included mapping and administration, eight renal angiomyolipoma embolisations, one uterine artery embolisation, one left internal iliac embolisation for abdominal aortic aneurysm, and one pelvic angioembolisation for trauma.*

Results: *Mean age of the patients was 65.9 years. Technical success was achieved in 90 of the 94 cases (95.7%). Four cases (4.3%) required a change to transfemoral access (failed catheterisation of celiac axis or superior mesenteric artery, very small radial artery, and an aortic anatomical variant). Two patients (2.1%) developed small access site haematomas after the procedures. Mortality, stroke and radial artery occlusion rates at 30 days after TRA procedures were 0%.*

Conclusion: *TRA is a safe, feasible and effective technique for abdominal interventional radiology procedures.*

Key Words: *Angiography; Femoral artery; Radial artery; Radiology, interventional*

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Data Availability: All data generated or analysed during the present study are available from the corresponding author on reasonable request.

Ethics Approval: This retrospective study was approved by the Kowloon Central/Kowloon East Research Ethics Committee (Ref: KC/KE-21-0013/ER-2). The requirement for patient consent was waived by the ethics board. The patients provided written informed consent for all treatments and procedures.

中文摘要

腹部介入放射學經橈動脈通路的單中心初步經驗

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背景：經橈動脈通路（TRA）長期用於冠狀動脈和非冠狀動脈血管造影術，與經股動脈通路相比的顯著優勢包括更早行走、易於止血和更短住院時間。然而，經股動脈技術仍然是介入放射學中血管通路的常用通路。我們分享單中心經橈動脈介入治療的經驗，並評估其可行性和安全性。

方法：2017年4月至2020年5月期間，69名患者（16名女性和53名男性）共進行94例TRA手術。其中包括68例肝腫瘤化療栓塞、15例包括定位和給藥的選擇性內放射治療、8例腎血管平滑肌脂肪瘤栓塞術、1例子宮動脈栓塞術、1例因腹主動脈瘤需要進行左髂內動脈栓塞術，以及1例因創傷需要進行盆腔血管栓塞術。

結果：患者平均年齡65.9歲。94例中技術成功佔90例。4例（4.3%）需要改用經股動脈通路（腹腔軸或腸系膜上動脈導管插入失敗、橈動脈非常小和主動脈解剖變異）。兩名患者（2.1%）術後出現通路部位小血腫。TRA術後30天死亡率、中風率和橈動脈閉塞率均為 0%。

結論：TRA是一種安全、可行和有效的腹部介入放射學技術。

INTRODUCTION

Transradial access (TRA) was initially described for coronary angiography in 1989 by Campeau.[1] There has been a growing body of evidence suggesting that TRA has substantial benefits over transfemoral access (TFA) since that time. Findings from meta-analyses such as RIVAL,[2] MATRIX,[3] RIFLE-STEACS,[4] and STEMI-RADIAL,[5] published in the cardiology literature, have driven the switch from TFA to TRA. These studies demonstrated statistically significant reduction in bleeding, access site complications, and mortality with TRA compared with TFA. TRA has increased in popularity in non-coronary endovascular procedures more recently. The aim of this study was to depict a single institution's experience in the technical approach of transradial intervention and evaluate corresponding feasibility and safety.

METHODS

Retrospective analysis of the technical success and associated complications was conducted for all TRA procedures between April 2017 and May 2020.

Demographics of the patients, including age and sex, indications for the procedures, the type of procedure, technical success (defined by procedure completion through the chosen method of access), and postprocedural complications were obtained from electronic patient records.

Transradial Access Technique

Preprocedural Assessment and Setup

The Barbeau test[6] was performed on each patient before TRA procedures to assess the completeness of the palmar arch in order to reduce the risk of digital ischaemia. The left radial artery is exclusively accessed to minimise catheter length requirement and to limit manipulation at the aortic arch. In this test, a pulse oximeter is clamped on the patient's thumb and the corresponding morphology of the plethysmography tracing is recorded. Waveform analysis is then continued for 2 minutes with manual compression of the radial artery. Waveforms are categorised into four types (A-D [Figure]). Patients with types A and B responses have uninterrupted arterial filling during radial artery occlusion (RAO) while those with a type C response represents the recruitment of collaterals in which there is initially absent interrupted arterial filling with recovery of the waveform within 2 minutes. Type A to C waveforms suggest ulnopalmar arch patency. The Type D waveform suggests absence of sufficient arterial collateralisation and excludes the patient from transradial catheterisation. The size of the radial artery is ensured to be at least 1.7 mm in diameter as measured by ultrasound with a compact linear array (hockey-stick) ultrasound probe.

Patients lie on the angiography table in the supine position. There are two methods of positioning the

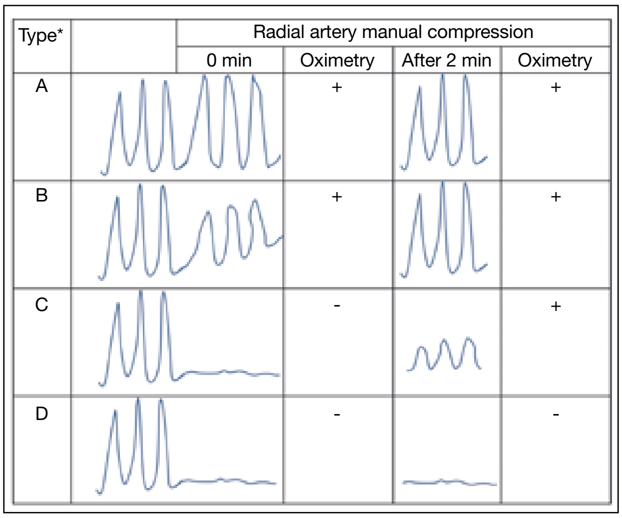

Figure. Barbeau test waveform analysis.
* Type A: no damping; Type B: slight damping of pulse tracing; Type C: loss followed by recovery; Type D: no recovery of pulse tracing within 2 minutes.

patient's arm, depending on the operator's preferences and the patient's body build. In one, the left arm is abducted at 90 degrees and placed on an arm board. The second one would be the left shoulder adducted with flexed elbow and pronated wrist which is placed over the left groin, allowing placement of instruments over the patient's draped body, which enables operator and monitor positioning comparable to that of TFA, although it may be more difficult to achieve in obese patients.

If a distal transradial approach is adopted, the patient's hand is partially clenched with the anatomic snuffbox facing upwards.

Access

Depended on operators' preferences, one of two different methods of radial access, conventional radial access or a distal transradial approach (dTRA, "snuffbox approach"), was used. In conventional radial access, after standard aseptic surgical preparation of the radial access site, 1% lignocaine is injected into the subcutaneous tissue around the radial artery from approximately 1 to 2 cm proximal to the radial styloid over a distance of 4 to 5 cm. Aseptic technique and local anaesthetic application are similarly performed for dTRA at the anatomical snuffbox.

The operator may choose a double-wall through-and-through approach or a single-wall anterior puncture. The double-wall approach is mainly used for radial arterial puncture at the wrist level while the single-wall puncture method is employed for dTRA at the anatomical snuffbox.

In the double-wall approach, a 20-gauge angiocatheter is angled at approximately 45° from the skin and is slowly inserted to puncture the anterior wall of the radial artery under ultrasonic guidance or by palpation. Once backflow of arterial blood is observed, the whole apparatus is advanced further to puncture the posterior wall of the artery. The needle is then removed and the angiocatheter is slowly withdrawn until pulsatile blood is observed. The second method is to use a 21-gauge 38-mm needle (Radifocus Introducer Transradial Kit; Terumo Interventional System, Somerset [NJ], United States) to puncture the anterior wall of the radial artery under ultrasonic guidance. Once pulsatile arterial blood return is confirmed, a 0.021-inch guidewire is advanced into the radial artery. A 5-Fr hydrophilic sheath is placed over the wire using Seldinger technique. A total of 3000 IU of heparin and 200 μg of nitroglycerin is injected into the arterial sheath after insertion to prevent vasospasm and radial artery thrombosis during and after the procedure.

For repeat procedures, most patients who underwent TRA for the first time again undergo TRA for subsequent interventions due to its benefits and also because of technical success achieved in the first attempt. For the remaining few who underwent TFA in their second or subsequent interventions, the choice of vascular access was largely based on operator's dependence and experience.

Among the cases performed, none was omitted from heparin administration due to its intrinsic purpose to reduce the risk of RAO which is the primary procedure-related complication of concern.

Catheter Selection

In majority of the cases, a 5-Fr 125 cm (Merit Ultimate 1; Merit Medical Systems, Inc, South Jordan [UT], United States) or a 5-Fr 120-cm catheter (Terumo TIG diagnostic catheter; Terumo Interventional System, Tokyo, Japan), and a 150-cm Terumo guidewire are used for catheterisation. Fluoroscopic guidance is used for investigation when resistance is encountered during advancement into the left arm and is universally used from the level of the axillary artery and beyond to prevent entry or over-manipulation of the vertebral artery. The target vessels are selected and catheterised as desired following access to the abdominal aorta, and angiography of the desired site is then performed.

Haemostasis

Haemostasis is achieved using compression. Compression tape with haemostatic foam (STEPTY; Nichiban, Tokyo, Japan) is applied over the puncture site after removal of the sheath. Palpation of the radial pulse with corresponding waveform analysis is performed to confirm its patency to achieve non-occlusive haemostasis. The STEPTY foam is kept in place for 4 hours before removal. If secondary bleeding is observed, manual compression is applied. When haemostasis is achieved, simple dressing is applied to the wound.

Discharge from Hospital

In general, patients are monitored by the referring clinical team for secondary bleeding and postprocedural complications until they are deemed fit for discharge.

RESULTS

From April 2017 to May 2020, a total of 94 TRA procedures were performed on 69 patients (16 female and 53 male) at our institution for abdominal interventions with a technical success rate of 95.7% (90 of 94 procedures). More than one TRA procedures were performed in some of the patients. The radial artery was re-assessed before each repeated procedure.

Of the 94 TRA procedures performed, the dTRA/snuffbox approach was employed in 18 cases while the transradial approach was adopted in the other 76 cases.

Procedures included 68 chemoembolisations of liver tumours in 44 patients; 15 procedures for selective internal radiation therapy with yttrium-90 in 14 patients, which included mapping and administration; eight renal angiomyolipoma embolisations in eight patients; one uterine artery embolisation; one left internal iliac embolisation for abdominal aortic aneurysm; and one pelvic angioembolisation for trauma.

The mean age of the patients was 65.9 years. Four cases (4.3%) required crossover to TFA (failed catheterisation of celiac axis or superior mesenteric artery, very small radial artery, and aortic anatomical variation).

Barbeau's test results were documented in 55 of 94 procedures (58.5%) in which all of them demonstrated types A to C waveforms (type A: 29, type B: 19, type C: 6).

There is no standardised follow-up after each TRA procedure in our institution and therefore the incidence of RAO after TRA procedures is unknown. Among the repeated TRA procedures, none of the patients was discovered to have RAO during preprocedural assessment.

Small haematomas at the insertion site developed after two out of 94 (2.1%) TRA procedures and these were treated conservatively.

The mortality and stroke rates at 30 days after TRA procedures were 0%.

DISCUSSION

TRA is a safe, feasible and effective technique for abdominal interventional radiology procedures.

Benefits of Radial Access

Dual blood supply of the hand and the superficial position of the radial artery are intrinsic advantages when compared with the transfemoral approach. Anastomosis from the ulnar artery prevents harm if inadvertent injury to the radial artery occurs. Haemostasis via compression without the need of a vascular closure device is also easier, as the radial artery is more superficial. In contrast, there is risk of retroperitoneal haemorrhage in TFA due to inadvertently high punctures. Haemostasis is also more difficult in TFA.

Mobilisation after the procedure is immediate for TRA patients, while those with TFA require monitoring and bed rest to ensure haemostasis. The TRA therefore reduces patients' discomfort and the risks of bleeding complications.

For cases with moderate bleeding risk, it is recommended that the international normalised ratio should be <1.5 according to The Society of Interventional Radiology and Cardiovascular and Interventional Radiology Society of Europe consensus guidelines. However, Titano et al[7] concluded from 2271 patients that those with an international normalised ratio >1.5 are still safe to undergo TRA. Due to easier haemostasis, TRA can also be adopted in patients with uncorrectable coagulopathy or thrombocytopenia. The TRA is therefore superior to TFA for transarterial chemoembolisation in patients with liver disease–related coagulopathy or thrombocytopenia. In addition, anticoagulation therapy in patients with conditions such as metallic heart valves or, rarely, protein C or S deficiencies can remain uninterrupted during the procedure.

It can be challenging to locate the common femoral artery in obese patients. Moreover, atherosclerotic calcifications may render TFA cannulation of the femoral arteries difficult. Radial arteries are easier to access and less often affected by calcified plaque. As such, transradial approach is more favourable in obese patients.

Yamada et al[8] demonstrated that 81% of patients who experienced both approaches would prefer TRA over TFA due to less pain and earlier mobilisation.

Potential Complications of Radial Access

Significant haematoma formation, pseudoaneurysm formation, symptomatic RAO, temporary or permanent ischaemic or neurological events including stroke are the potential complications. During TRA access, the great vessels are crossed with wires and catheters, which may increase the risk of stroke. In abdominal intervention, the risk of stroke in TFA is negligible but not absent in TRA.

In the two patients who developed local haematomas at puncture sites, neither was on antiplatelet nor anticoagulant therapy. The complication was attributed to either inadequate manual compression or suboptimal positioning of the STEPTY haemostatic material, for which further training should be given to interventionists for outcome improvement. No other particular adjustment for haemostasis is made in patients on antiplatelet drugs or anticoagulants, as TRA itself imposes a lower bleeding risk than that in TFA.

There are studies reviewing neurological complications after TRA. Patel et al[9] concluded that TRA is not associated with a significant increase in stroke rate compared with TFA in coronary arterial intervention. Posham et al[10] analysed more than 1500 TRA procedures for non-coronary interventions and none of them experienced a stroke event up to 30 days after the procedure. Regardless, potential complications including stroke are discussed and explained in the informed consent.

For our patients with documented Barbeau test results, none showed the type D waveform. Barbeau et al[6] revealed among 1010 consecutive patients that only 1.5% showed the type D waveform and were excluded from TRA. In short, TRA is feasible in most cases.

In four of the cases in which TRA could not be achieved, one of them was related to a very small radial artery. Although Barbeau's test revealed a type B waveform, TRA was unsuccessful under ultrasound guidance and by palpation due to the very small calibre. Crossover to a right transfemoral approach was therefore performed to complete embolisation of a left renal angiomyolipoma.

Anatomical variation at the aortic arch may also render TRA unsuccessful. We had a patient with a type 3 aortic arch in which the guidewire could not be manipulated into the descending aorta, and crossover to a right transfemoral approach was required.

It can be challenging to catheterise small vessels originating near the aortic arch in TRA, as significant catheter manipulation is required. This is demonstrated in cases of bronchial artery embolisation, in which acute turns or forming reverse curves are necessary to catheterise the bronchial arteries.

Other drawbacks of TRA include increased distance from the lower torso as compared with the transfemoral approach, limiting its application in intervention beyond the inguinal regions owing to unavailability of catheters of sufficient length. The radial artery cannot accommodate arterial sheaths larger than 6 Fr, which limits the size of stents or balloons that can be deployed. TFA may therefore be preferable to TRA in such circumstances.

Emergency cases requiring intervention usually involve pathology in the abdominopelvic region, and under life-threatening conditions, rapid vascular access is of the utmost importance. In these situations, TFA remains the preferred route of vascular access due to the shorter distance from the lower torso and shorter time taken to secure access.

There are no standardised follow-up protocols and documentations of complications following TRA procedures in our institution. This retrospective analysis may therefore underestimate the number of complications. However, there was no significant morbidity after TRA procedures documented in the electronic patient records, such as severe bleeding requiring transfusion, stroke, or death. The incidence of radial artery thrombosis is probably underestimated, as there is no regular interval follow-up Doppler ultrasound assessment of the radial artery after TRA procedures. It is typically asymptomatic for mild radial artery thrombosis and may therefore not be called to the physicians' attention. A systematic review and meta-analysis[11] showed that the incidence of RAO varied from 1% to 33%. It also revealed that the incidence was 7.7% within 24 hours after TRA.

In recent years, the dTRA/snuffbox approach was proposed to overcome some of the limitations of TRA, such as the risk of RAO. Kiemeneij et al[12] first evaluated the safety and feasibility of this approach in 2017. The radial artery branches before reaching the anatomical snuffbox. In dTRA, access is acquired distal to the branch point, which ensures preservation of vascular flow to the palm from other branches in case of vessel occlusion occurring at the puncture site. Flow interruption to the palm is therefore also minimised during haemostatic compression over the access branch in this approach. Positioning is flexible, as the snuffbox is in the dorsum of the hand. For instance, it permits shoulder adduction with the left wrist pronated over the lower abdomen or suprapubic region. This is beneficial for patients with frozen shoulder who have limited shoulder abduction and in patients with upper limb contractures (e.g., due to prior stroke) with difficulty in exposing the palmar aspect of the wrist for conventional radial access.[13]

From a prospective analysis,[14] absence of blood flow during haemostasis increases the risk of RAO. Another retrospective analysis comparing the duration of haemostasis concluded that occlusive haemostasis was the only independent predictor of RAO, while maintenance of flow in the radial artery after sheath removal (patent haemostasis) has been shown to reduce the rate of RAO after TRA, where dTRA would therefore serve as a more favourable approach.

Patent haemostasis or non-occlusive haemostasis can be adopted to minimise the chance of RAO. A radial compression device — the "TR Band" (Terumo) may help to achieve this goal. After the procedure, the device can be placed on the patient's wrist with the strap fixed tightly to prevent excessive movement. The TR band balloon is inflated slowly by injecting 15 to 18 mL of air on top of the puncture site while the sheath is simultaneously removed. The amount of air in the balloon can then be titrated until the bleeding stops. A reverse Barbeau test is performed in which both ulnar and radial arteries are compressed simultaneously at first until the plethysmographic wave is lost. Pressure on the radial artery is then released to evaluate the waveform. The waveforms indicating the degree of flow in the radial artery can guide the extent of balloon inflation.

We applied STEPTY haemostatic foam instead of the TR band in our institution as the former is more cost-effective.

Limitations

This was a retrospective study without a control group. However, the aim of this study was to show the safety and feasibility of TRA rather than any superiority of TRA over TFA. Patients were not randomised to TRA or TFA but based largely on the operator's preferences. Results may therefore be affected by selection bias. As discussed above, the number of complications may be underestimated, as there are no standardised follow-up protocols and documentation after TRA procedures. Finally, results observed may not apply to all institutions and should depend on the experience of operators and number of TRA procedures performed.

CONCLUSION

TRA is a safe, feasible, and effective technique for abdominal interventional radiology procedures. In view of its substantial benefits, TRA might be considered in conditions not limited to abdominal interventional radiology procedures.

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