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Scientific Publishing

Clinical Application Research of the Transradial Approach in Neurointerventional Surgery

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Abstract: This study aims to comprehensively investigate the clinical application and advantages of the transradial approach in neurointerventional procedures. Through in-depth analysis, it was found that the transradial approach significantly reduces the occurrence of surgical complications, improves patient comfort, and effectively shortens hospital stays, thereby lowering overall medical costs. The study content elaborates on the technical essentials and operational procedures of this approach in neurointerventional surgery, including preoperative preparation, precise puncture techniques, catheter manipulation, and other critical links.

Keywords: Transradial Approach; Neurointerventional Procedures; Clinical Application

With the rapid development of neurointerventional techniques, the transradial approach, as an emerging therapeutic pathway, has demonstrated unique advantages in the interventional treatment of neurovascular diseases. This approach not only significantly reduces surgery-related complications and enhances patients' overall comfort but also brings a more efficient and economical treatment option by shortening hospital stays and reducing medical costs.

1. Advantages of the Transradial Approach in Neurointerventional Surgery

1.1 Reduction of Complications

The application of the transradial approach in neurointerventional surgery exhibits notable advantages, particularly in reducing the occurrence of complications. This advantage stems primarily from the anatomical characteristics of the radial artery. Its superficial location avoids the risk of injury to the complex vascular structures in the groin region, and its dual blood supply enhances surgical safety. During the procedure, patients enjoy free upper limb movement and rapid postoperative recovery, minimizing complications arising from prolonged bed rest, such as deep vein thrombosis.

The transradial approach is particularly crucial for special patient populations, such as the elderly and those using blood thinners, who typically face higher surgical risks. This approach significantly reduces the incidence of vascular complications, such as radial artery occlusion, providing a safer treatment option for these patients.

1.2 Enhanced Patient Comfort

Patient comfort during surgery is significantly improved with the transradial approach. Traditional transfemoral access requires puncture in the groin region, which is not only rich in blood vessels but also located deeply, making surgical manipulation relatively complex. Patients often need to maintain a prolonged supine position, which may lead to local discomfort or even pain. In contrast, the transradial approach involves puncture at the wrist, which is superficial and easy to access. Patients can maintain a more natural posture during surgery, and their upper limbs can move appropriately, greatly reducing discomfort during the procedure.

Postoperative comfort is also significantly improved. After transfemoral access surgery, patients need to remain in bed for an extended period to prevent bleeding and hematoma formation at the puncture site, limiting their range of motion and increasing physical discomfort. From a psychological perspective, the transradial approach reduces patients' fear and anxiety. Due to its minimal trauma and rapid recovery, patients' concerns about the surgical process and postoperative recovery are correspondingly reduced.

1.3 Shorter Hospital Stay

The transradial approach in neurointerventional surgery offers significant advantages, with shortened hospital stays being a crucial aspect. Firstly, this approach reduces the risk of complications during and after surgery, such as groin hematomas and deep vein thrombosis, which often necessitate extended hospital stays for observation and treatment. Secondly, patients can usually ambulate immediately after transradial access surgery, unlike those undergoing transfemoral access, who require prolonged bed rest. This feature not only enhances patient comfort but also accelerates physical recovery.

1.4 Reduced Medical Costs

Due to the minimal trauma and rapid recovery associated with the transradial approach, patients can ambulate earlier after surgery, reducing their reliance on hospital beds and nursing care. Furthermore, the transradial approach minimizes the occurrence of complications, further lowering medical costs. Traditional transfemoral access surgery involves puncture in the groin region, which can lead to complications such as bleeding, hematoma, and deep vein thrombosis postoperatively. The treatment of these complications not only increases patient suffering but also adds additional medical expenses.

2. Technical Key Points and Operational Procedures of the Transradial Approach in Neurointerventional Surgery

2.1 Preoperative Preparation

Before adopting the transradial approach for neurointerventional surgery, an accurate assessment of the patient's radial artery condition is crucial. Common assessment methods include ultrasound examination and the Allen test.

Ultrasound examination is a non-invasive and intuitive assessment tool that can clearly display the diameter, course, presence of plaques, and stenosis of the radial artery. Through ultrasound, doctors can evaluate the patency, elasticity, and vessel wall thickness of the radial artery, providing a basis for selecting the appropriate puncture site and technique.

The Allen test is a simple yet effective method to assess the collateral circulation between the radial and ulnar arteries. The patient is instructed to extend their palm while both the radial and ulnar arteries are compressed. The compression on the ulnar artery is then released, and the recovery of blood flow to the palm is observed.

Routine preoperative tests, such as blood routine, coagulation function, liver and kidney function, should also be completed to assess the patient's overall condition and ensure surgical safety.

2.2 Puncture Technique

In terms of preoperative medication, doctors will administer appropriate anti-anxiety, anticoagulant, and vasodilator drugs based on the patient's specific conditions to reduce the risks of vascular spasm and thrombosis during surgery. For instance, midazolam can be given to alleviate the patient's anxiety; heparin to prevent thrombosis; and verapamil to reduce vascular spasm. Local anesthesia is typically used, with an appropriate amount of 1% lidocaine or similar anesthetic agents injected around the puncture site to minimize pain.

Regarding puncture skills, the surgeon must be familiar with the direction and depth variations of the radial artery to accurately select the puncture site and needle insertion angle. Careful control of the insertion force and speed is crucial to avoid puncturing the posterior wall of the artery or damaging surrounding tissues. When inserting the guidewire and sheath, gentle manipulation is essential, and the patient's response should be closely monitored.

2.3 Catheter Manipulation

Based on preoperative imaging data and surgical planning, the location and route of the target vessel, which may include the carotid artery, vertebral artery, etc., are clearly identified. Before advancing the catheter, an appropriate catheter size and length should be selected

to ensure its smooth arrival at the target location. Guided by the guidewire, the surgeon must advance the catheter gently, avoiding excessive speed or force to prevent damage to the vessel wall or induce vasospasm. Maintaining the stability of the guidewire within the catheter is crucial to prevent its dislodgment or kinking.

During catheter navigation, complex situations such as vessel curvature and bifurcation may be encountered. In case of abnormalities like a drop in blood pressure or an increase in heart rate, the procedure should be immediately halted to investigate the cause.

Once the catheter successfully reaches the target vessel, its position must be confirmed and a necessary angiographic examination performed. Angiography provides a clear visualization of the target vessel's morphology, course, and any pathological changes, serving as a vital basis for subsequent interventional treatments.

3. Clinical Application of Radial Artery Access in Neurointerventional Procedures

3.1 Intracranial Aneurysms

Compared to the traditional femoral artery access, the radial artery approach avoids the need for groin preparation, thereby reducing patients' psychological discomfort. Postoperatively, except for the wrist joint on the punctured side, the movement of other joints is unrestricted, significantly enhancing patient comfort. The radial artery approach eliminates the need for prolonged bed rest, thereby reducing the risks of deep venous thrombosis and pulmonary embolism in the lower extremities. Additionally, the incidence of complications such as bleeding at the puncture site, pseudoaneurysm, arteriovenous fistula, and arterial dissection is significantly lower, avoiding severe complications like retroperitoneal hematoma that may occur with femoral artery access.

For instance, at the Third Ward of Neurology, Xi'an Gaoxin Hospital, the surgical team successfully treated a patient with an unruptured large aneurysm in the cavernous sinus segment of the right internal carotid artery using the novel Pipeline™Flex flow-diverter device via the right radial artery access. The procedure was smooth, and the patient recovered well, demonstrating the safety and effectiveness of the radial artery approach in the treatment of intracranial aneurysms. With continuous technological advancements and accumulated clinical experience, the application prospects of the radial artery approach in the field of neurointerventional procedures will become even broader.

3.2 Carotid Artery Stenting

Compared to the traditional femoral artery access, carotid artery stenting via the radial artery approach is less invasive. Due to the superficial location of the radial artery, it is easy to puncture and compress for hemostasis, and there are no vital nerves or blood vessels in its vicinity, significantly reducing surgical risks. This approach also minimizes the occurrence of postoperative complications such as bleeding, hematoma, and pseudoaneurysm, enhancing surgical safety. Patients do not need prolonged bed rest and can ambulate immediately after surgery, avoiding discomfort and the risk of deep venous thrombosis in the lower extremities associated with prolonged bed rest.

For example, the First Ward of Neurology, Yan'an People's Hospital, successfully completed a carotid artery stenting procedure via the radial artery access. The patient was a 67-year-old male with a history of type 2 diabetes and hypertension who presented with sudden speech difficulties and coughing when drinking water. Angiography revealed severe stenosis at the origin of the left internal carotid artery. After successful stent implantation via the radial artery approach, the patient recovered well, and radial artery compression was released eight hours postoperatively. This case fully demonstrates the feasibility and effectiveness of the radial artery approach in carotid artery stenting.

3.3 Mechanical Thrombectomy

In the treatment of acute ischemic stroke, time is brain. The radial artery approach can bypass the aortic arch and severely tortuous or atherosclerotic thoracoabdominal aorta, directly accessing the target vessel, significantly reducing the puncture and recanalization time. Establishing this rapid access route is crucial for salvaging brain tissue on the verge of necrosis while minimizing bleeding risks and other complications during surgery. The traditional femoral artery approach requires prolonged bed rest for patients, which not only increases their pain and discomfort but also may lead to complications such as deep venous thrombosis in the lower extremities. In contrast, the radial artery

approach avoids these issues, allowing patients to ambulate immediately after surgery, enhancing comfort and reducing complication rates.

For instance, the Neurology Department of a hospital successfully performed a mechanical thrombectomy via the radial artery approach. The patient was an 83-year-old man who presented with sudden speech difficulties accompanied by left-sided limb weakness and was diagnosed with acute ischemic stroke. After thoroughly assessing the patient's condition and vascular anatomy, the medical team decided to perform mechanical thrombectomy via the radial artery approach. During the procedure, the doctors successfully punctured the radial artery and guided the catheter and thrombectomy device to the target vessel, successfully removing the thrombus and restoring blood flow. The patient recovered well postoperatively, with gradual improvement in neurological functions. This case fully demonstrates the feasibility and effectiveness of the radial artery approach in mechanical thrombectomy.

Conclusion

As an innovative and effective treatment approach, the radial artery access route demonstrates significant advantages in neurointerventional procedures. It not only significantly reduces the incidence of surgical complications such as bleeding, infection, and vascular injury but also greatly enhances patient comfort, minimizing postoperative pain and discomfort. Furthermore, this approach accelerates the patient's recovery process, effectively shortening hospital stays, thereby further reducing medical costs and alleviating the economic burden on patients and society.

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