Minimally Invasive Parafascicular Surgery

- Microvascular Cortical Dynamics in Minimal Invasive Deep-Seated Brain Tumour Surgery
- Optimization and Economic Impact of Expedited Minimally Invasive Parafascicular Surgery (MIPS) Protocol for Spontaneous Intraparenchymal Hemorrhage
- Cost-Effectiveness Analysis of Early Minimally Invasive Removal of Intracerebral Hemorrhage
- Minimally invasive interventions for intracranial pathologies using tubular retractors in the pediatric population: Safety, efficacy, technical aspects and outcomes
- Minimally invasive trans-sulcal parafascicular surgery for the early evacuation of spontaneous intracerebral hemorrhage: the ENRICH trial
- Tubular retractor-assisted minimally invasive parafascicular approach for dermoid cyst
- Diffusion changes in minimally invasive parafascicular approach for deep-seated tumours: impact on clinical outcomes
- In Situ Light-Source Delivery During 5-Aminulevulinic Acid-Guided High-Grade Glioma Resection: Spatial, Functional and Oncological Informed Surgery

Minimally Invasive Parafascicular Surgery (MIPS) is an advanced surgical technique designed for the safe and efficient removal of deep-seated brain lesions, such as tumors or intracerebral hemorrhages (ICH). This approach combines modern technologies and minimally invasive principles to reduce tissue damage, improve outcomes, and speed recovery.

Principles of MIPS

1. **Minimized Disruption**: The parafascicular approach navigates along natural white matter tracts, avoiding critical brain regions and minimizing damage to functional areas.

2. **Small Access Corridors**: Utilizes tubular retractors to create narrow access paths, protecting surrounding brain tissue.

3. **Visualization**: Employs high-definition endoscopy or exoscopes to provide magnified visualization within the surgical corridor.

Indications

- **Intracerebral Hemorrhage (ICH)**: Evacuation of hematomas in deep locations, such as basal ganglia or thalamus.

- **Deep-Seated Tumors**: Removal of gliomas or metastases in challenging locations.

- **Cystic Lesions or Abscesses**: Aspiration or excision of infectious or non-infectious cystic structures.

- **Hydrocephalus**: Placement of shunts or fenestration of cysts near critical structures.

Technology and Tools

1. **Navigation Systems**: Preoperative imaging combined with intraoperative navigation ensures accurate targeting.

2. **Tubular Retractors**: Devices like the BrainPath endoport system maintain a gentle, stable corridor for tissue protection.

3. **Microsurgical Instruments**: Specialized tools designed for maneuverability within confined spaces.

4. **Intraoperative Imaging**: Tools like ultrasound or fluoroscopy for real-time guidance.

5. **Endoscopy or Exoscopes**: Provide enhanced visualization of deep structures.

Benefits

- **Reduced Morbidity**: Avoids wide craniotomies and excessive retraction.

- **Improved Recovery**: Less disruption to healthy tissue shortens recovery time.

- **Enhanced Precision**: Integration of navigation and imaging technologies allows for safe lesion targeting.

- **Potential for Outpatient Procedures**: In some cases, smaller interventions may not require lengthy hospital stays.

Challenges and Limitations

- **Steep Learning Curve**: Requires training and familiarity with new equipment and techniques.

- **Cost**: High initial investment in navigation systems and retractors.

- **Case Selection**: Not all lesions are suitable for MIPS; careful patient selection is critical.

- **Visualization Constraints**: Limited field of view compared to open craniotomy.

Future Directions

- **Robotic Assistance**: Integration of robotic systems for enhanced precision and stability.

- **Improved Navigation**: Advancements in artificial intelligence for real-time imaging and decision support.

- **Expanded Indications**: Continued refinement may allow for broader use in neurosurgical cases.

MIPS represents a significant advancement in neurosurgery, offering a patient-centric approach to treating deep brain pathologies with minimal impact on surrounding tissue. Its success hinges on careful planning, skilled execution, and appropriate patient selection.

Single-center retrospective cohort studies

The impact of surgical approach-transsulcal approach (TS) versus transgyral approach (TG) - and respective entry points in clinical and imaging outcomes was assessed. 82 patients (35 male; 47 female, average age 43.94 ± 22.85 years) were included. 84% presented with neurological deficit and glioblastoma was the commonest diagnosis (38.24%). Surgical approach was not relevant for the number of patients that showed postoperative peritubular injury (TS: 20 (37.74%) versus TG: 8 (27.59%), p = 0.354) or its volume (TS: 0.95 ± 1.82 cc versus TG: 0.43 ± 1.32 cc, p = 0.1435). When adjusted for preoperative volume and depth of tumour, TS approach was associated with less diffusion restriction (p = 0.030). Temporal lobe access points had the highest volume of diffusion restriction (temporal lobe-2.50 ± 3.54 cc versus frontal lobe - 1.15 ± 1.53 versus parietal lobe-0.51 ± 0.91 cc, p = 0.0096), particularly in the TS approach (p = 0.0152). Superior motor outcomes were demonstrated in the TS versus the TG approach (postoperative improvement: TS: 14.63% versus TG: 6.9%, p = 0.015), especially for parietal approaches (p = 0.039). TS approach was related with a significantly decreased length of stay (TS-11.67 ± 14.19 days versus TG - 23.97 ± 18.01 days, p = 0.001). Transsulcal approach demonstrated a better motor outcome profile, particularly in parietal lobe, and shorter length of stay. The superior temporal sulcus was more susceptible to ischaemic changes. Therefore, transgyral route can be considered in temporal lobe MIPS [1)]

The study demonstrates the advantages of the transsulcal approach in specific contexts, particularly in improving motor outcomes and reducing hospital stay. However, the findings on temporal lobe ischemia caution against its indiscriminate use. While the TS approach appears to be superior for parietal and frontal lobe surgeries, the TG approach might still have a role in temporal lobe cases. Future research should address the study's limitations by including larger, more balanced cohorts, long-term outcomes, and a broader range of pathologies. Furthermore, functional assessments should accompany imaging findings to better understand their clinical significance.

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