IJMSRI
International Journal of Medical Science Research and Innovations

Volume 2 Special Issue 1 (Feb) 2025, Article 25 (pp.61-62)
ISSN-3048-9067

Original Investigation | Neurology

Revolutionizing Skull Base Tumor Resection: The Role of Pulsed Laser-Induced Liquid Jet in enhancing Neurovascular Preservation A Systematic Review

Farhad Islam[1], Onyekachi Emmanuel Anyagwa[2], Oluwatoyin Adalia Dairo[2]

MD, Tbilisi Medical State University, School of Medicine, Georgia[1], MD, New Vision University, School of Medicine, Georgia[2]

Key Points

Question:
How does pulsed laser-induced jet system (LIJS) enhance skull base tumour resection while preserving neurovascular structures?
Can LIJS improve intraoperative safety and postoperative outcomes compared to traditional dissection instruments?

Findings:
LIJS enables precise tissue resection, minimizing thermal and mechanical trauma.
In a study of 46 patients, LIJS preserved intratumorally arteries in over 84% of cases while preventing complications.
The technology demonstrated effective devascularization and protection of adjacent structures like the cavernous sinus and optic chiasm.
LIJS has been particularly useful in complex tumour resections, including pituitary adenomas and meningiomas.

Meaning:
LIJS offers a promising alternative to conventional surgical tools for skull base tumour excision.
It reduces the risk of neurovascular damage while enhancing precision in tumour debulking.
Future improvements in catheter design could further optimize its performance in minimally invasive neurosurgery.

Abstract

Importance:
The surgical management of skull-base and soft tissue tumors constitutes considerable challenges due to the need of preserving vital neurovascular structures; however, advancements in minimally invasive techniques, such as the transsphenoidal approach for ventral skull base lesions (e.g., pituitary tumors), have significantly enhanced outcome. These procedures continue to present dangers, including vascular damage resulting from thermal or mechanical trauma during tissue debulking. Conventional technologies such as Doppler probes and micro-hook blades are still prevalent, while recent findings report the effectiveness of water jet systems in accurate tissue resection and preservation of neurovascular structures.

Objective:
This study is focused on investigating the potential benefits of a pulsed laser-induced jet system (LIJS) for skull base tumor procedures, prioritizing intraoperative safety and improved postoperative results relative to traditional dissection instruments.

Evidence Review
This systematic review assesses randomized clinical trials, multi-institutional studies, and experimental investigations conducted in the last decade. Data was gathered utilizing online databases, including PubMed, Cochrane and Google Scholar, with applicable search phrases. Eight relevant papers, selected using the PRISMA-P technique (refer to Figure 1), were reviewed to evaluate the utilization of LIJS in the surgical management of skull base tumors.

Findings
Numerous institutional studies have demonstrated that utilizing pulsed LIJS for the excision of skull base tumors, especially pituitary adenomas, yields accurate tissue resection and tumor de-bulking. Our study revealed the preservation of intratumorally arteries in over 84% of cases among 46 patients. LIJS demonstrated excellent devascularization while securely preserving adjacent tissues, such as the cavernous sinus. No complications developed in any of the 46 procedures. Furthermore, its utilization in complex tumors like meningiomas, assisted in the preservation of the optic chiasm and the associated neurovascular structures.

Volume 2 Issue 1 (Feb) 2025, Article 25 (pp.61-62)
ISSN-3048-9067

Conclusion and Relevance

The pulsed LIJS has demonstrated the ability to safeguard essential neurovascular systems during tumor excision, preventing heat injury or mechanical trauma usually associated with conventional micro-incisional instruments. The accurate tissue debulking it provides could substitute traditional techniques in skull base procedures. Concerns have been expressed about the system's capacity to produce internal stress in brain tissues, which may impact the maneuverability of the jet axis. Future modifications to catheter design could enhance its efficacy in minimally invasive neurological surgeries.

References

Ogawa Y, Nakagawa A, Takayama K, Tominaga T. Pulsed laser-induced liquid jet for skull base tumor removal with vascular preservation through the transsphenoidal approach: a clinical investigation. Acta Neurochirurgica. 2011;153(4):823-830. doi:https://doi.org/10.1007/s00701-010-0925-x

Ogawa Y, Nakagawa A, Toshikatsu Washio, Tatsuhiko Arafune, Tominaga T. Tissue dissection before direct manipulation to the pathology with pulsed laser-induced liquid jet system in skull base surgery—preservation of fine vessels and maintained optic nerve function. Acta Neurochirurgica. 2013;155(10):1879-1886. doi:https://doi.org/10.1007/s00701-013-1817-7

Nakagawa A, Ogawa Y, Amano K, et al. Pulsed Laser-induced Liquid Jet System for Treatment of Sellar and Parasellar Tumors: Safety Evaluation. 2015;76(06):473-482. doi:https://doi.org/10.1055/s-0034-1396436

Kato T, Tatsuhiko Arafune, Toshikatsu Washio, et al. Measurement and analysis of internal stress distributions created in gelatin simulated-brain tissue by a pulsed laser-induced liquid jet. PubMed. Published online August 1, 2014. doi:https://doi.org/10.1109/embc.2014.6944604

Nakagawa A, Hirano T, Hidefumi Jokura, et al. Pulsed holmium:yttrium-aluminum-garnet laser—induced liquid jet as a novel dissection device in neuroendoscopic surgery. Journal of neurosurgery. 2004;101(1):145-150. doi:https://doi.org/10.3171/jns.2004.101.1.0145

Article Information

Accepted for Publication: December 24-2024
Published: February 13-2025.

Corresponding Author: Farhad Islam, MD, Tbilisi Medical State University, School of Medicine, Georgia.
Acknowledgment: - MedVentures (CPD no.-#784331) for providing financial support for Publishing, Alte University.