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Introduction to VSI: Migraine surgery in JPRAS open[☆]

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It is with great pleasure that we share this special JPRAS edition “Headache Surgery” with you. In this series of articles, you will find expert opinions on starting your headache surgery practice in both private practice and at academic institutions. We further provide insight on the delays in surgical treatment of patients suffering from headaches, as well as the efficacy and cost of conservative versus surgical treatment which is important from an insurance coverage standpoint. In addition, new surgical techniques and advanced concepts in headache surgery are introduced.

We hope that this well-rounded issue will spark your interest in headache surgery and help you start your own practice.

Become a member of the Migraine Surgery Society to find resources to start your own migraine surgery practice such as screening forms, information for insurance companies and headache surgery

[☆] Following the short introduction by Dr Gfrerer and Dr Austen, we would like to share a message by our current Migraine Surgery Society President Dr. Ziv Peled, who has provided an overview of headache surgery history and its future.

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I was fortunate to be introduced to the idea of headache surgery near its inception. These procedures have become and remain one of the most common that I perform. They are intricate from a technical standpoint and immensely gratifying from a clinical standpoint. They continue to evolve and expand and I firmly believe will represent a key pillar of peripheral nerve surgery, itself a burgeoning sub-field within plastic surgery. There are a few things which are positive about aging, one of these being perspective. From my point of view, being intimately involved in this arena for over 15 years, it is remarkable how far we have come in such a short time and invigorating to think about where we can and will go in the future.

Headache surgery: looking back & moving forward

Chronic headaches affect people all over the world and within nearly every demographic.¹ This fact is validated by the most recent Global Burden of Disease Study that lists migraine headaches, just one form of chronic headache, as the second leading cause of years lived with disabilities worldwide.² From a fiscal standpoint, it follows that the direct costs (e.g., cost of medications & diagnostic imaging) related to chronic headaches constitute a tremendous burden to medical systems both in the US and abroad.³⁻⁷ Moreover, there are significant indirect costs in terms of diminished quality of life as well as lost days of work for adults and school days for children.^{8,9} Even when not suffering acutely from a headache episode, the impact of such symptoms often results in decreased productivity and ability to care for oneself and others during, a phenomenon known as the ‘interictal burden’.^{10,11} Clearly, medicine has a long way to go in understanding and treating these types of chronic headaches more effectively.

Interestingly, the surgical approach to chronic headaches is not new. Areteus of Cappadocia (2nd century A.D.) was the first to codify different types of headaches and perhaps one of the first physicians to describe what we today term facial neuralgias.¹² He went on to suggest that bloodletting might offer some clinical benefit in these latter patients.¹³ Abul-Qasim Al-Zahrawi (936–1013), in his landmark treatise *Kitab-al Tasrif*, described cauterization therapy for specific types of headache disorders.^{14,15} Ambrose Paré (1510–1590) added to these foundations in his work entitled “The Gentle Art of Surgery”. He described various surgical procedures such as arterial ligation for certain types of headache symptoms, developed specific instruments for use in neurosurgical procedures on the cranial region and focused on the careful execution of such operations to minimize patients’ pain.¹⁶ Fast forward to the turn of the millennium when Bahman Guyuron made a very fortuitous observation, that patients having undergone browlift procedures with a prior history of migraines reported a decrease or elimination of their headache symptoms in 80% of cases, even 4 years following their operations.¹⁷ It was from this paper that the modern field of headache surgery began anew.

Headache surgery: 2001–2011 – a decade of “re”-discovery

Following his initial retrospective observations, Dr. Guyuron demonstrated that botulinum toxin could be used as a diagnostic tool to identify which patients might be suffering from nerve compression as a cause for their frontal & anterior temporal headaches. This first, prospective study demonstrated that 21/22 surgical patients experienced significant relief or elimination of their headache pain. Not long after, formalisation of the procedure for diagnostic injections was described.¹⁸ Over the ensuing years, others took up this work as well and an understanding of the relevant anatomy throughout the head and neck became clearer. The anatomy of the glabellar musculature along with the compression topography of the supraorbital and supratrochlear nerves was described in detail.^{19,20} Similar studies shed light on the compressive elements in both the temporal regions and occipital regions

of the head and neck²⁰⁻²⁶ and surgeons within both academic and private practice began to achieve promising results.^{27,28}

These relatively early observations created the basis for two landmark papers that closed out this initial period of surgical innovation. In 2009, Bahman Guyuron definitively demonstrated the efficacy of surgical intervention in a single-blinded, prospective, randomized, sham-surgical trial with 75 patients.²⁹ Two years later, long-term follow-up of 79 patients showed that the early, positive results presented to date, persisted even five years following surgical intervention.³⁰

Headache surgery: 2012–2022 – refinement & optimization

If the initial decade of headache surgical experience centered on discovery and definition, the ensuing 10 years were about technical refinement and outcomes optimization. In 2012, the first economic data demonstrating fiscal benefits to surgical intervention for chronic headaches was published.³¹ Subsequent financial modeling showed the superiority of surgical management of chronic migraines in appropriately selected patients when compared with optimal medical management.^{32,33} Diagnostic acumen was also enhanced, made less expensive and streamlined for efficacy with the proliferation of data demonstrating the utility of diagnostic nerve blocks for appropriate patient selection.³⁴⁻³⁶ In addition, it became apparent that patients themselves were reporting successful outcomes when they could do so anonymously on social media and through a myriad of validated and reliable instruments.^{37,38}

While simultaneously reporting these advances, more light was shed on etiologic factors contributing to mechanical compression of cranial nerves that could benefit from surgical treatment. Electron microscopic and proteomic analysis showed that abnormal neural ultrastructure within nerves adjacent to blood vessels could predispose people to neuritis and neuralgia.³⁹ Several years later the role of muscle fascia in occipital nerve compression was revealed and shown to be amenable to surgical release.⁴⁰

Technically, novel surgical approaches and anatomic discoveries with respect to nerves already established as surgical targets were also illustrated during this time. The feasibility of novel surgical approaches to the temporal and occipital nerves through different incisions than originally described offered surgeons several types of potential exposure in the OR thereby allowing surgeons to tailor their approach to the specific clinical situation.^{41,42} New compression points and anatomic structures were further studied in already established occipital operative fields.⁴³⁻⁴⁵ Similarly, the importance of the supraorbital rim and adjacent vasculature in addition to the glabellar musculature in frontal headaches was ascertained.^{46,47} This work ultimately culminated in a formal position statement by the American Society of Plastic Surgeons. The policy stated that when conventional treatment modalities have proven inadequate, surgical intervention is not only safe and effective, but should be considered standard of care and incorporated into a treatment algorithm for chronic headache patients.⁴⁸

Headache surgery: 2023 & beyond – 5 developments shaping the future

Having progressed so much over the past 20 years, one question I often find myself pondering is, ‘What’s in store for the next decade?’ While no one can foresee the future with complete accuracy, it is often a fun exercise to try and predict trends that might shape the current landscape in days to come. One of the first things that will define this field in the near future is the realization that there are even more compression points and nerve targets for intervention than we currently appreciate. For example, we have already seen descriptions of nerves in the forehead potentially thought to explain residual symptoms in that region even following adequate surgical treatment of the supraorbital and supratrochlear nerves.⁴⁹ Additionally, neurogenic thoracic outlet syndrome is known to present with occipital headaches in over 70% of cases suggesting that decompression of the trunks of the brachial plexus along with scalenectomy might be surgical options in select cases.⁵⁰ Even more recent descriptions of the greater auricular nerve have been postulated as additional nuchal compression sites.⁵¹ It would therefore not surprise me if other nerve targets (e.g., infratrochlear, infraorbital and zygomaticofacial nerves) are recognized as trigger points amenable to surgical intervention.

A second development that has already proven fruitful is better collaboration with our neurology colleagues. Neurologists are the specialists traditionally and most often tasked with treating headache patients and working to understand how they define, speak about, and treat headaches will continue to be beneficial to both specialties and most importantly, to patients.^{52,53} This type of partnership, in turn, fosters a better understanding of what we as surgeons can offer such patients and provides a presence in the neurology literature⁵⁴ backed not only by data in the plastic surgery pantheon, but by other viewpoints on the anatomy and physiology of chronic headaches that challenge long held norms.^{55,56} This type of teamwork will open up surgical treatment to many patients in the future, likely as part of a multimodality approach to their condition.

Third is a recognition that no surgical procedure or intervention is perfect. A mature discipline always makes room for improvement and a thorough evaluation of what may have happened when outcomes were not what we had hoped. For example, when decompression failed in the past, the presumption was that the nerves treated were too damaged by the initial injury and nerve transection was the fallback option, often at the price of permanent numbness.⁵⁷ However, fat grafts are now recognized as a rich source of stem cells known to release cytokines that enhance peripheral nerve regeneration.^{58,59} Not surprisingly then, we have already seen the use of fat grafting for recalcitrant headaches with some success, although much more work remains to be done.⁶⁰ Furthermore, we have seen the application of other peripheral nerve surgical techniques and novel approaches such as targeted muscle re-innervation, regenerative peripheral nerve interfaces and reset neurectomy to headache surgical patients providing surgeons with additional options when nerve transection is required.⁶¹ Even minimally invasive surgical options are now available to patients with certain headache presentations.⁶²

A fourth development is the recognition that there are more headache sub-types that might be treated successfully by surgical decompression. For example, Chen et al. have shown that estrogen-associated headaches can be treated effectively with surgical intervention.⁶³ Nummular headaches, while rare are often recalcitrant to traditional medical management.^{64,65} However, they have been shown to be amenable to surgical resection⁶⁶ Additionally, with over 100 million people having been infected with COVID-19 world-wide, one of the most common symptoms of long-COVID being headaches, and with activation of the inflammatory cascade known to occur with infection, this patient population may be a new demographic that may benefit from surgical treatment. Anecdotally, I and others have found chronically enlarged lymph nodes compressing various nerves in the head and neck and causing neuralgic headaches following COVID infection (personal communication). Certainly, more research must be done, but it will indeed be interesting to see whether these patients can benefit from decompression or nerve resection.

Finally, diagnostic tools continue to improve our ability to better select patients who will benefit from surgical treatment. Some are brilliant in their simplicity such as pain sketches that can predict outcomes⁶⁷ and the use of readily available, handheld doppler interrogation to identify trigger points in the office.^{36,68,69} Others are more technically advanced and include the use of high frequency ultrasound and artificial intelligence algorithms to accurately predict which patients will be the best responders.^{70,71} Undoubtedly, technological advances in other imaging modalities such as MRI are not too far away from becoming available to clinicians in everyday use.

Indeed, this are of surgical therapy is progressing rapidly and fruitfully to the benefit of many thousands of patients annually. It is with great pride that I can say the future is truly bright for the field of headache surgery and hopefully for the many patients who will no longer have to suffer the scourge of chronic pain.

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