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Use of ultrasonic aspirator for CNS tumour resection

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Abstract

Ultrasonic aspirator (UA), or the Cavitron Ultrasonic Aspirator (CUSA) as it is commonly referred to, utilizes ultrasonic waves of variable range of frequencies to disintegrate and excise tumours. It is developed as a substitute of bipolar diathermy; a tool commonly employed for coagulation that uses focussed electric current and may damage tissues by virtue of contact, or by the heat that it produces. Over the last 30 years, CUSA has become increasingly popular in several soft tissue surgeries, especially brain and spine tumour resection, as it allows reduction in the use of bipolar diathermy. It is assumed that CUSA improves both surgical safety and clinical outcomes, and also reduces surgical time. Herein the authors have reviewed the available literature on the advantages of CUSA.

Keywords: Ultrasonic aspirator, CUSA, Brain tumour, Spinal cord tumour.

Introduction

Ultrasonic aspirator (UA) is a useful piece of equipment for surgeries on soft tissues, especially brain and spine tumour resection. It is even considered essential in certain cases. UA employs high frequency ultrasound waves for fragmentation of the tumour tissue, which it then aspirates. It is claimed that it allows a surgeon to perform safe and fast debulking of tumours with minimal risk to surrounding structures.[1] Neural tissue and blood vessels are also relatively protected during dissection, reducing surgical time and intra-operative blood loss, thereby improving surgical efficiency and patient outcomes.[2-5] By virtue of its design, as compared to conventional methods of tumour removal using bipolars, suction and forceps; Cavitron Ultrasonic Aspirator (CUSA), a commonly used brand of UA, allows surgeons to remove tumours without causing much traction or manipulation.[3] It also allows users to irrigate the operative field that improves visibility and tissue identification. Whereas older models were bulky and difficult to use, newer models are not only better designed, but also allow additional functions. Currently, UA is being employed in endoscopic as well as open neurosurgery for resection of brain and spinal cord tumours.[6-8] In this review, we have summarized the existing literature on the use of CUSA in neurosurgical procedures.

Review of Evidence

In one of the earliest studies that assessed the role of CUSA, Fasano et al., had reported their experience of using UA in 52 brain tumour resections, including both intra-axial and extra-axial lesions.[8] They found several advantages of UA compared to conventional surgical techniques such as provision of good visibility of the operative field, better removal of abnormal tissue, sparing of major vessels with haemostatic effect on vessels less than 1mm diameter and negligible brain tissue manipulation, traction and thermal effects on adjacent tissue.[8] Soon after, Fred Epstein published a detailed description on the use of CUSA for different brain tumours, he recommended that with the use of UA, the tumour can be debulked from the centre which makes it easier to dissect the capsule from adjacent neural structures and achieve gross total resection.[9] Since then, UA has been used in the treatment of various neoplasms including meningiomas, gliomas and posterior fossa tumours. Tang et al., published their experience with CUSA Excel, an advanced variant of the UA, in 10 patients with anterior and middle skull-base meningiomas. They had achieved complete tumour resection in all the cases in their series, and recommended routine use of CUSA in all meningioma cases as it helped in avoiding damage to the neurovascular structures.[10]

More recently, several authors have published their experience with UA in endoscopic surgeries, both for skull base and intraventricular tumours. Ledderose et al., reported their experience with Sonopet UA, another brand of UA, for the management of anterior skull base tumours through trans-nasal approach, in a feasibility trial conducted on 10 patients. They found it to be useful especially for highly vascularised tumours, by reducing surgical complications and thereby improving outcomes, but also encountered difficulty in reaching tumours away from the midline via trans-nasal route due to non-flexible tip of the UA.[11] Similar results were

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reported by Oertel et al., where 3 patients with obstructive hydrocephalus and 2 patients with pituitary macroadenoma were treated using UA coupled with neuroendoscope, and the lesions were removed without significant complications.[12] Cinalli et al., reported their experience with UA in endoscopic management of intraventricular, paraventricular and suprasellar tumours in 12 paediatric patients, and reported good outcomes, with gross total or near total resection in up to half of their patients.[13] Although some earlier reports on endoscope coupled UA, had reported temporary loss of visibility due to air bubbles, Cinalli et al. did not encounter this problem.[13,14] Apart from the surgical benefits of using UA, some authors have also reported diagnostic advantages of using UA. In a retrospective study, Rao et al., analysed 73 CNS tumour samples obtained via CUSA, and compared the findings with those on samples obtained via conventional methods. They recommended that tumour sample collected in the UA suction bottle could also be sent for histopathological analysis, although such tissue showed greater anatomical distortion compared to tissue obtained through conventional methods, particularly in glial neoplasms and medulloblastoma.[15]

Lately, CUSA has also been utilized in the resection of spinal tumours with favourable results. Chou et al., published a retrospective case series of paediatric spinal cord tumours operated at their centre over a ten-year period. Seventy-five children with spinal tumours, both intradural and extradural, were included and CUSA was employed for tumour resection along with conventional method. They reported gross total resection in 45% patients, and 91% patients were ambulatory at 3 months after surgery compared to 75% before surgery.[16] Barzilai et al. performed a retrospective review of 6 patients who had undergone resection of intramedullary spinal cord tumours using tip of the UA for intra-operative neurological monitoring. They reported favourable outcomes and recommended that fusing UA and electrophysiological monitoring probe improves safety along with better tumour resection.[17]

There are also negative reports of UA usage. Ridderheim et al., reported a case of vestibular schwannoma, where the use of CUSA intra-operatively was associated with some cases of post-operative seventh cranial nerve palsy, which could likely be due to transmission of strong ultrasonic waves through petrous temporal bone.[18] Another important limitation includes the inability of CUSA to resect calcified, fibrous and firm consistency lesions, and to coagulate larger sized blood vessels for which conventional diathermy/haemostat agents are employed.[9] This however may not be a limitation in the latest, advanced models. In a case control study of 40 patients, Tuncer et al., compared the operating time of patients in whom UA was used to those cases where UA was not employed.[19] They reported longer duration of surgery with UA usage, and cited lack of adequate training of neurosurgeons as the likely cause, recommending appropriate training of staff and subsequent studies to assess the effect.[19]

Conclusion

Although no randomised control trials have been conducted, there is sufficient evidence in literature to support the use of UA in brain tumour resection, and though there are only few smaller case series on its use in spinal tumours, no negative features have been reported. It allows safe tumour resection, and thus improves surgical outcome.

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