Outcome of Visual Functions in Surgery for Meningiomas of the Jugum Sphenoidale and Tuberculum Sellae

WALID M. ABD EL-RAHMAN, M.Sc.**; ABD EL-WAHAB M. IBRAHIM, M.D.*; MOHAMMED T. HOSNY, M.D.**; HATEM I. BADR, M.D.; MOHAMMED A. EL-METWALY MATTAR, M.D.* and EZZAT A. ABD EL-AZIM, M.D.**
The Department of Neurosurgery, Faculty of Medicine, Mansoura University* and Military Medical Academy**, Egypt

Abstract

Background: Jugum sphenoidale and tuberculum sellae meningiomas represent nearly up to ten percent of cranial meningioma cases, presenting mostly by chiasmal syndrome; adult primary optic atrophy with bitemporal field affection. Challenges faced are intra-optic canal neoplasm extension and its vicinity to ± jeopardizing the crucial basal neurovascular architecture.

Objective: Is to make evidence that the innovative maneuver of early cold bone drilling unroofing of the optic canal and tailoring an aggressive skull base unlocking aiming at gentle wise removal of extended tumor portion from the interior of the optic canal before removal of the gross tumor is superior to late execution of the same maneuver after removal of the gross tumor, in minimizing surgical insults of the endangered nervus opticus achieving a better promising outcome of visual functions. Nimodipine dripped topically intraoperatively aiming at neutralizing result bias made by vasa nervosa vasospasm from surgical manipulations.

Patients and Methods: It is a prospective study in which 50 candidate patients for surgery were selected and included in the study, from the cases presenting to Neurosurgery Departments of the Chief Military Hospitals (Maadi, International Medical Center, Galaa, and Kobri El-Kobba Military Hospitals) and Mansoura Teaching Hospital at Mansoura University. The study was done during a three years period starting from 2014 and all the selected patients are managed through microsurgical resection of meningioma of the tuberculum sellae or Planum sphenoidale via a pterional approach. The cases are divided to 20pts in the early group in which the patients underwent early unlocking of the basis cranii in the form of optic canal unroofing, tailored anterior clinoidectomy, and opening of the falciform ligament, and 20 pts in the late group in which the same maneuver is done but after dissection of the gross tumor, and 10pts in the none group in which no canal extension is done in some cases and intentional incomplete bony resection as appropriate in the others). Post-operative care, neurological, radiological, laboratory, and ophthalmological assessment are done in early post-operative and re-evaluation after 2 and 4 months later were scheduled.

Results: The study revealed 70% visual acuity improvements in the early group in comparison with 30% improvement in the late group, the visual deterioration was 10% and 20% in the early and late groups respectively, but in the none group stabilization of visual functions achieved in 70% and deterioration in 30%. We noticed that in cases chosen for application of topical intraoperative Nimodipine irrigation in the field of surgery in the form of half cases in each of the three groups: There was 48% of visual acuity improvement in the half of study cases who the Nimotop used with in comparison to 32% in the other half of study cases who the Nimotop was not used with.

Conclusion: The early optic canal unroofing accompanied by skull base unlocking in the form of tailored anterior clinoidectomy, cutting the falciform ligament, and opening the nervus opticus sheath, using cold ultrasonic bone drilling, with the concurrent use of intraoperative field irrigation with Nimodipine for microsurgical removal of the optic canal extension of the jugum sphenoidale and tuberculum sellae meningiomas before attacking the gross tumor, is superior for late execution of the same maneuver after removal of the gross tumor in preserving and improving the outcome of visual functions.


Introduction

THE study reinvestigates the concept of early optic canal unroofing and unlocking of the basis cranii to remove the extended portion of the meningioma from inside the optic canal, prior to excision of the gross tumor with the concurrent use of ultrasonic bone dissection and intermittent topical irrigation of Nimodipine in the field of surgery, may raise the possibility of improved outcome of
visual functions in surgery for meningiomas of the jugum sphenoidale and tuberculum sellae.

Aim of the study:
The study is aiming to prove that the early unroofing of the optic canal and tailoring an aggressive unlocking of the basis cranii using cold bone drilling (bizoelcetric cavitron ultrasonic aspirator) to excise the extended tumor portion from the interior of the optic canal before removal of the gross tumor is superior than late execution of the same maneuver after removal of the gross tumor, in minimizing surgical insults of the endangered nervus opticus achieving a better promising outcome of visual functions.

The rationale for early unroofing of the optic canal and tailoring aggressive unlocking of the basis cranii is the high incidence 70% of optic canal extension insulting the nervus opticus in jugum sphenoidale and tuberculum sellae meningiomas [1].

By unlocking of the basis cranii consisting of anterior clinoidectomy, cutting the falciform ligament and opening the sheath of the nervus opticus, we could safely resect intracanalicular tumor extension reversing the preoperative nerve ischaemia giving it the ability of free and safe mobility to sustain and survive possible further iatrogenic insult like surgical traction and vasospasm, without such maneuver the preoperatively ischemic nervus opticus has no reserve and no capability to withstand and survive any further iatrogenic ischaemia and may progress to complete loss of function [2].

The jugum sphenoidale meningioma lies within the anterior cranial fossa and originates from dura lining the sphenoidal yoke which is a part of the sphenoid sinus roof related anteriorly to ethmoid bone and limited posteriorly by the limbus sphenoidale which is the superior limbus of the sulcus chiasmaticus marking the posterior end of the anterior cranial fossa [3].

The tuberculum sellae meningioma lies in the middle cranial fossa originating from the dura lining the limbus sphenoidale, the sulcus chiasmaticus, limbus chiasmaticus, and the tuberculum behind the jugum sphenoidale characterized by a suprasellar subchiasmal midline position, the optic chiasm is postfixed in both cases, it is usually compressed and raised in a posterior and superior direction, and the nervi optici are displaced laterally resulting in visual manifestations and hormonal abnormalities, the meningioma lies anterior to the pituitary stalk, the supracclinoi segment of the internal carotid artery and the anterior cerebral arteries may be involved or ensheathed by the tumor, the nervus and chiasmus opticus receive most their arterial supply from their inferior surface and mostly comes from superior hypophyseal branches that come from the supracclinoi part of the internal carotid artery, operative dissection of the meningioma from the inferior aspect of the nervus and chiasmus opticus is a more prohibited maneuver than excision of the meningiomas from above the nervus and chiasmus opticus [4].

Cold bone dissection with innovative CUSA bone dissector (cavitron ultrasonic aspiration) which effectively drilled the bone with special ultrasound frequency using a special hand piece (bizoelcetric ultrasound) without any heat production and saved the optic nerve rescue the nervous opticus from irreversible damage due to heat insult.

Nimodipine is a selective cerebral vasodilator irrigated topically in the surgical field to guard against vasospasm of the feeders and the vasa nervosa of the nervus and chiasmus opticus neutralizing the result bias made by vasospasm.

Anatomical abnormalities is not uncommon in this region and should be kept in mind during surgical planning and searched for by appropriate investigations before surgery so as not to be surprised in theatre and to rescue the patients from serious intraoperative injuries and complications [5], examples are duplication of the optic canal, hyperpneumatisation of the anterior clinoid process, and ossified interclinoid ligament (caroticoclinoid foramen of Henle) [6].

It should be mentioned that even though complete tumor removal was the proposed surgical target for all the surgical interventions in our study we feel that this should not be imperative and be
executed at the expense of higher morbidity [7]. Recurrence of the tumors was very low and we believe this is due to the relative small amount of patients included in the study.

**Patients and Methods**

**Patients inclusion criteria:**

The criteria for selection of patients included in this study are adult age group from 27 to 60 years old of both sex harboring tuberculum sellae or jugum sphenoidale meningiomas and are candidates for surgery.

**Patients exclusion criteria:**

The patients who were excluded from the study are those patients with medical co-morbidities rendering them anesthetically unfit for surgery, the patients who had previous cranial surgery for the same pathology or different pathology in the same region, and the patients who suffer chronic medical or psychiatric illness affecting the postoperative recovery are all excluded.

It is a prospective study in which 50 candidate patients for surgery were selected and included in the study, from the cases presenting to Neurosurgery Departments of the Chief Military Hospitals (Maa-di, International Medical Center, Galaa, and Kobri El-Kobba Military Hospitals) and Mansoura Teaching Hospital at Mansoura University. The study was done during a three years period starting from 2014 and all the selected patients are managed through microsurgical resection of meningioma of the tuberculum sellae or Planum sphenoidale via a pterional approach. The cases are divided to 20pts in the early group in which the patients underwent early unlocking of the basis cranii in the form of optic canal unroofing, tailored anterior clinoidectomy, and opening of the falciform ligament and optic sheath before dissection of the gross tumor, and 20pts in the late group in which the same maneuver is done but after dissection of the gross tumor, and 10pts in the none group in which no canal extension is done in some cases and intentional incomplete bony resection as appropriate in the others. Post-operative care, neurological, radiological, laboratory, and ophthalmological assessment are done in early post-operative and reevaluation after 2 and 4 months later were scheduled.

**Results**

The study revealed 70% visual acuity improvements (14 patients out of 20 cases) in the group of patients who underwent late optic canal unroofing, mean-while the visual deterioration was 10% (2 patients out of 20 cases) in the early group in comparison with 20% (4 patients out of 20 cases) in the late group, and in the none group that includes 10 patients there was stabilization of visual functions in 70% (7 patients out of 10 cases) and deterioration of visual functions in 30% (3 patients out of 10 cases).

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Deteriorated count</th>
<th>Died count</th>
<th>Improved count</th>
<th>Stable count</th>
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<tr>
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<td></td>
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<td>Early</td>
<td>2</td>
<td>1</td>
<td>14</td>
<td>3</td>
</tr>
<tr>
<td>Late</td>
<td>4</td>
<td>1</td>
<td>6</td>
<td>9</td>
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<td>3</td>
<td>0</td>
<td>0</td>
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Table (1): Outcome of vision in relation to early versus late bony unlocking in the form of tailored anterior clinoidectomy, unroofing of the optic canal, and opening of the falciform ligament and optic sheath.

<table>
<thead>
<tr>
<th>Outcome</th>
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<th>Improved count</th>
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<td>1</td>
<td>8</td>
<td>11</td>
</tr>
<tr>
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<td>4</td>
<td>1</td>
<td>12</td>
<td>8</td>
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Table (2): Outcome of vision in relation to application of topical Nimotop in the field of surgery.

<table>
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<th>Died count</th>
<th>Improved count</th>
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<tbody>
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<td></td>
</tr>
<tr>
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Table (3): Outcome of vision in relation to presence of canal extension.

It is noticed that in cases chosen for application of topical intraoperative Nimodipine irrigation in the field of surgery in the form of half cases in each of the three groups: There was 48% (12 patients out of 25 cases) of visual acuity improvement in the half of study cases who the Nimodipine used with in comparison to 32% (8 patients out of 25 cases) in the other half of study cases who the Nimodipine was not used with.

In the 50 cases of the study optic canal extension from the jugum sphenoidale and tuberculum sellae meningiomas was found in 35 patients with a percent of 70%, visual functions improvement occurred in 17 patients of the 35 cases with optic canal extension with a significant ratio of 48.5%,
and stabilization of visual functions occurred in 13 patients of the 35 cases with optic canal extension with 37% ratio, totally improvement and stabilization together equal 85.5% of the 35 cases with optic canal extension.

The visual acuity deteriorated in 9 patients out of 50 cases with a percent of 18%, and improved or stabilized in 39 patients out of 50 cases with a percent of 78% which is highly significant ratio and indicating success in achieving the aim of the study.

It is found that improvement and deterioration of visual acuity after surgery were not age related. There was a noticeable negative relationship between the favorable outcome and the degree of visual impairment prior to surgery as the improvement and stabilization mostly occurred in the group of mild and moderate pre-operative visual impairment rather than in the group of marked preoperative visual impairment, the same was noticed in the relation between the outcome of vision and the degree of preoperative optic nerve atrophy, visual field defect and duration of pre-operative visual impairment.

There was no solid relation between the preoperative duration of symptoms and the development of vascular adhesions but there was a strong relation inbetween the existence of peritumoral oedema and the presence of vascular adhesions. It was noticed that in most cases of predominantly vertical growth of the meningioma there were no optic canal extension of the tumour. A strong relationship found between peritumoral oedema and absence of intact arachnoid plane which is oftenly associated with vascular adhesions.

Accordingly improvement of visual functions was not noticed in cases of vascular adhesions, optic nerve adhesions, dominant vertical growth of the tumour, peritumoral oedema, non intact arachnoid plane, and subtotal excision according to Simpson grade.

Complications occurred in the study:

Out of 50 cases CSF leak in the form of rhinorrhea happened in 2 cases (4%) postoperatively, both of them treated conservatively and the leakage stopped within 2 weeks, one patient suffered brain infarction after one week of surgery, 2 patients (4%) percent died 10 days post-operatively with cardiac arrest both of them were suffering preoperative ischemic heart disease.

Discussion

Traditional drilling devices produces heat harming the nearby optic nerve so using the recent piezoelectric ultrasound devices that give no heat to perform bony unlocking of the skull base is superior to the ordinary drilling devices. Early optic canal unroofing is proved to give better results regarding visual acuity as it liberates the nerve from compression and ischaemia before gross tumour resection, otherwise it will not survive surgical manipulations and vasospasm that occurs during dissection which may lead to complete loss of vision. Intermittent topical irrigation of Nimodipine in the field of surgery proved to be useful to guard against iatrogenic vasospasm from surgical manipulations that may affect the prognosis of the surgery. Vision enhancement of 78% and stabilizing vision of 21% were gained on the side of surgery in a similar study done in Cleveland 2009 in comparison to 70% vision enhancement and stabilizing vision of 15% were achieved in our study [1].

Conclusion:

The early optic canal unroofing accompanied by unlocking of the basis cranii in the form of tailored anterior clinoidectomy, cutting the falci-form ligament, and opening the nervus opticus sheath, using cold ultrasonic bone drilling, for microsurgical removal of the optic canal extension of the jugum sphenoidale and tuberculum sellae meningiomas before attacking the gross tumor, is superior for late execution of the same maneuver after removal of the gross tumor in preserving and improving the outcome of visual functions by reversing the preoperative ischaemia of the nervi opticius and gave the nervus opticus the ability of safe mobility to sustain and survive possible further surgical insults like traction and vasospasm, without such maneuver the preoperatively ischemic nerve had no reserve and no capability to withstand and survive any further iatrogenic ischaemia and might progress to complete loss of its functions.

The best results achieved with the concurrent use of intra-operative field irrigation with Nimodipine with the use of cold ultrasonic bone drilling to avoid heat insult made by traditional drilling devices.

(Huge jugum sphenoidale meningioma, pre and postoperative images and visual field.

References

آثر الاستئصال الجراحي للأورام السحائية

حول التجفيف السريري على وظائف العصب البصري

إن التفسير المقيد للقائمة العصبية للعنقية الحقيقية يزيد من إحتلال ضعف وظائف العصب البصري بعد جراحات استئصال الأورام السحائية حول التجفيف السريري بحاجة للدراسة.

وفيما يتعلق ببعض الأجزاء العصبية من منطقة التجفيف السريري بحاجة إلى تدقيق وظائفها بعد جراحات استئصال الأورام السحائية وضمان ضعف وظائف العصب البصري بعد جراحات استئصال الأورام السحائية.

وهناك، نتائج دراسة آلية تتعلق ببعض الأجزاء العصبية من منطقة التجفيف السريري بحاجة إلى تدقيق وظائفها بعد جراحات استئصال الأورام السحائية وضمان ضعف وظائف العصب البصري بعد جراحات استئصال الأورام السحائية.

وبعض الدراسات تظهر أن ضعف وظائف العصب البصري بعد جراحات استئصال الأورام السحائية يزيد من إحتلال ضعف وظائف العصب البصري بعد جراحات استئصال الأورام السحائية.

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