



Multidisciplinary team efforts improve the surgical outcomes of sellar region lesions during pregnancy

Hui Ping Zhong¹ · Hao Tang² · Yong Zhang² · Yan Luo³ · Hong Yao² · Yu Cheng⁴ · Wei Ting Gu² · Yong Xu Wei² · Zhe Bao Wu²

Received: 18 June 2019 / Accepted: 6 August 2019 / Published online: 17 August 2019
© Springer Science+Business Media, LLC, part of Springer Nature 2019

Abstract

Purpose Treatment of space-occupying lesions (SOLs) in the sellar region is a clinical challenge, especially in pregnant women because many treatment decisions are restrained due to pregnancy. We attempt to discuss the surgical indications and timing for pregnant patients and highlight the importance of multidisciplinary team (MDT) treatment.

Methods From August 2017 to February 2018, four pregnant women were admitted to our hospital with severe visual impairment due to sellar region SOLs, including two cases of tuberculoma sellae meningioma, one case of giant pituitary adenoma and one case of a pituitary abscess. All four patients were safely treated by surgery during the second and third trimesters of pregnancy through concerted efforts of the MDT, including a neurosurgeon as the team leader in combination with experts in obstetrics, ophthalmology and endocrinology.

Results The SOLs were removed completely from all four patients, resulting in significantly improved vision without operation-related complications. Pregnancy continued postoperatively to full-term delivery in three of the four patients. The other patient with a pituitary abscess selected to terminate the pregnancy at a gestational age of 20 weeks because of her own concerns. The four babies (including a pair of twins) were born healthy and had developed normally at the 6-week postpartum follow-up.

Conclusions With the MDT guiding the decision-making process, surgical resection of sellar region SOLs in pregnant women with severe visual impairment is practical to improve the prognosis without affecting the outcomes of pregnancy for either the mother or the infant.

Keywords Multidisciplinary team (MDT) · Pregnancy · Sellar region lesion · Visual impairment

These authors contributed equally: Hui Ping Zhong, Hao Tang, Yong Zhang

✉ Zhe Bao Wu
zhebaowu@aliyun.com

¹ Department of Obstetrics, Ruijin Hospital, Shanghai Jiao Tong University School of Medicine, Shanghai, China

² Department of Neurosurgery, Center of Pituitary Tumor, Ruijin Hospital, Shanghai Jiao Tong University School of Medicine, Shanghai, China

³ Department of Anesthesiology, Ruijin Hospital, Shanghai Jiao Tong University School of Medicine, Shanghai, China

⁴ Department of Ophthalmology, Ruijin Hospital, Shanghai Jiao Tong University School of Medicine, Shanghai, China

Introduction

The sellar region is one of the sites where intracranial tumours are most likely to occur. Sellar region space-occupying lesions (SOLs) originating from different histological sources account for more than 20% of all intracranial tumours [1], including pituitary tumour, meningioma, craniopharyngioma, Rathke's cyst and glioma. When these SOLs grow to a certain extent, they often compress the optic nerve and the pituitary stalk, causing endocrine impairment, narrowing of the visual field, visual loss or blindness, and even threatening the life of the patients. Treatment of sellar region SOLs has long been a clinical challenge due to its unique location surrounded by important structures, especially in pregnant women because both the doctor and the patient have to make a dilemmatic decision at the risk of sacrificing the health of the mother and the foetus.

There have been limited studies reporting the outcomes of surgical treatment for pregnancy-complicated sellar region SOLs, including a systematic analysis on surgical indications and the timing of surgery [2–10]. In addition, the impact of surgical procedures on maternal and foetal health remains unclear. In this study, we present our experience with successful surgical treatment of four pregnant women with sellar region SOL-induced severe visual impairment, with a discussion of the surgical indications, timing of surgery and impact of the surgery on maternal and foetal health, and highlight the importance of multi-disciplinary team (MDT) treatment, hoping that the results can be used as guidance for clinical practice.

Patients and methods

Patients

During the period from August 2017 to February 2018, 102 patients in total with sellar region SOLs were operated on by our neurosurgery department. Among them, four pregnant women, aged from 28 to 36 years (with a mean of 32 years), including three primiparas and a multipara with a previous history of caesarean section, were admitted to our hospital. Of the four patients, three had singleton pregnancies and one had a twin pregnancy with a gestational age of 10–22 weeks at the time of disease onset. The gestational age at the time of neurosurgery was 18–32 weeks, and 20–40 weeks at the time of pregnancy termination (Table 1).

All four patients sought medical consultation mainly because of progressive exacerbation of visual impairment during pregnancy, including unilateral near blindness due to gradual exacerbation of blurred vision in three patients and bilateral near blindness due to gradual progressive exacerbation of photophobia and blurred vision in the fourth patient. Patient 3 also presented headache and nausea, who was diagnosed with Rathke's cyst and received transsphenoidal surgery in another hospital more than 1 year ago (Table 1). Her visual acuity was normal at that time. All patients received MRI examination, confirming the diagnosis of sellar region SOLs compressing the optic nerve and chiasm (Fig. 1). The pituitary hormone levels were assessed preoperatively, showing a low level of thyroid stimulating hormone (TSH) in one patient, for whom thyroxin was supplemented routinely, and otherwise no evidence of hypopituitarism was noticed (Table 2). The foetuses of all four patients developed normally. The initial diagnosis was tuberculum sellae meningioma in two patients, giant pituitary adenoma in one patient and suspicious recurrence of Rathke's cyst in the remaining patient, which was later confirmed as a pituitary abscess.

Table 1 General patient information

Patient	Age	Number of gravidity	Number of parity	Gestational weeks of disease onset	Relevant medical history	Preoperational symptoms during pregnancy	Type of sellar region lesion	Gestational weeks of operation	Gestational weeks of pregnancy termination
1	36	2	2	18	None	Blurred vision, progressed to near blindness in one eye	Tuberculum sellae meningioma	32	36 ^{+2d}
2	29	1	1	14	None	Blurred vision, progressed to near blindness in one eye	Pituitary adenoma	22	40
3	28	1	1	10	Rathke's cyst resection (deteriorating vision preoperation, completely recovery postoperation)	Photophobia, blurred vision, progressed to near blindness in both eyes, headache and nausea	Pituitary abscess	18	20
4	36	1	1	22	None	Blurred vision, progressed to near blindness in one eye	Tuberculum sellae meningioma	32	38 ^{+1d}

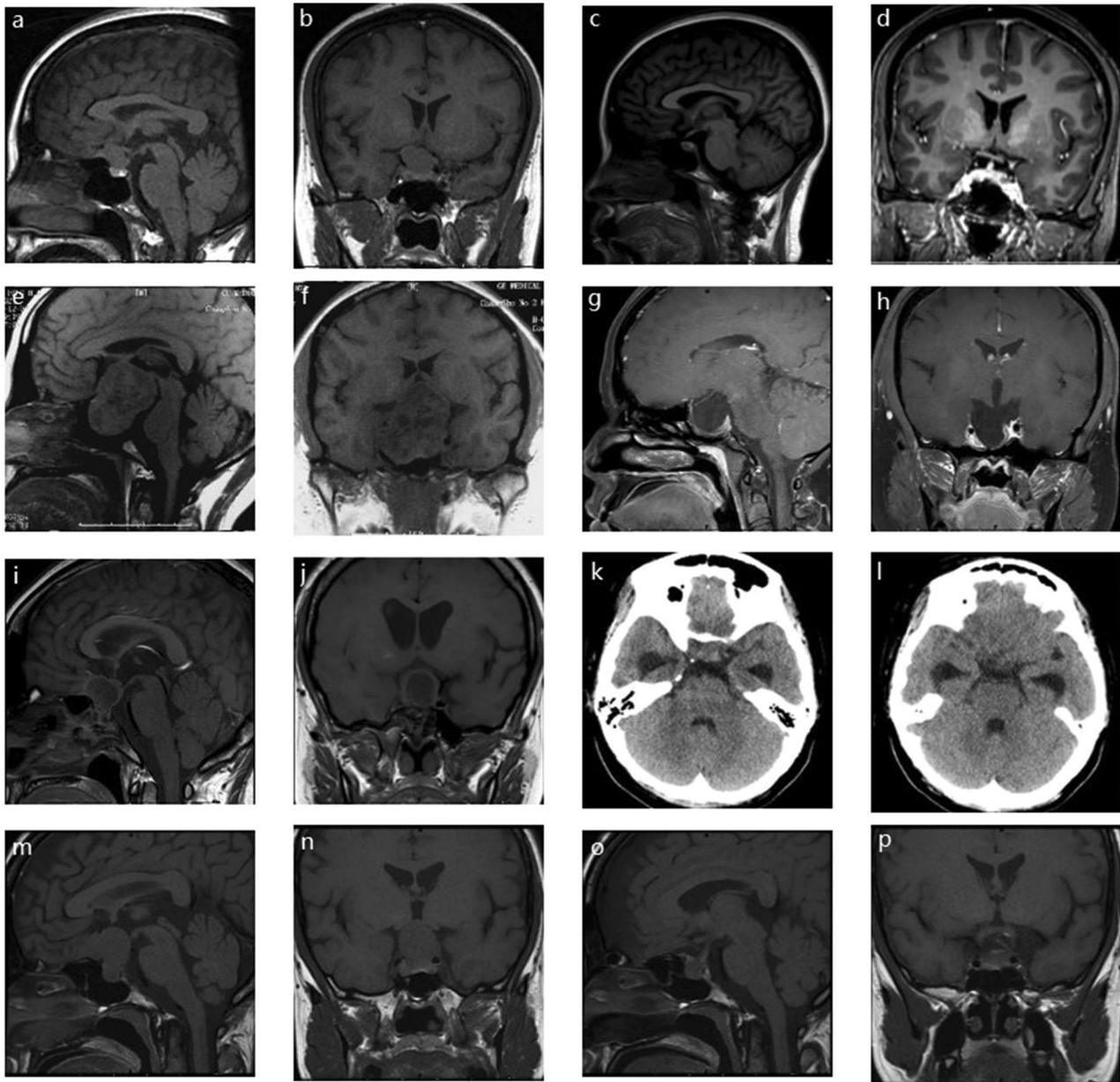


Fig. 1 Pre- and postoperative images of the four patients with sellar region space-occupying lesions **a, b** Preoperative MRI of patient 1; **c, d** Postoperative MRI of patient 1; **e, f** Preoperative MRI of patient 2; **g, h** Postoperative MRI of patient 2; **i, j** Preoperative MRI of patient 3; **k, l** Postoperative CT of patient 3; **m, n** Preoperative MRI of patient 4; **o, p** Postoperative MRI of patient 4

Table 2 Preoperational pituitary endocrine function

Patient	Growth hormone (ml)	Blood cortisol (8:00 a.m.) (ug/dl)	Adrenocorticotrophic hormone (pg/ml)	Thyrotropin (uIU/ml)	Luteinizing hormone (mIU/ml)	Follicle stimulating hormone (mIU/ml)	Prolactin (ng/ml)	Estradiol (pg/ml)	Progesterone (ng/ml)	Testosterone (ng/ml)
1	6.815	7.54	42.06	0.32	0.63	0.08	144.34	>1000	>40	0.37
2	0.998	19.22	47.99	1.01	0.08	2.6	26.71	>1000	>40	2.88
3	1.175	18.25	25.23	0.08	0.22	0.09	16.72	>1000	21.9	0.49
4	1.639	15.71	54.07	0.38	<0.07	0.06	>200	>1000	>40	0.32

Treatment protocols

After the initial clinical diagnosis, all four patients were sent for joint first consultation by the MDT, including a neurosurgeon as the team leader in combination with experts in obstetrics, ophthalmology and endocrinology, to discuss the surgical strategy, and establish the timing of operation (as soon as possible versus waiting for the foetus to mature further).

The timing and surgical plan were submitted to the ethics committee of our hospital for approval immediately. Subsequently, patients and relatives were informed in detail about the current condition and available treatment options (conservative observation or surgery), especially the treatment recommendations made by the MDT. After the patients fully understood the implications of surgery, they decided to accept the treatment plan recommended by the MDT.

The four patients were then admitted into the neurosurgical ward at the appropriate time according to the first MDT recommendation, and relevant preoperative examinations were further performed. Based on the results of the examination, a second MDT discussion was made and the perioperative therapeutic protocols were planned jointly. The gestational age at the time of surgery was 18–32 weeks, with two patients in the second trimester (18 and 22 weeks), and two patients in the third trimester (32 weeks) (Table 2). All surgical procedures were performed under general anaesthesia, through the supraorbital keyhole approach in three cases and via the neuroendoscopic transsphenoidal approach in the other case.

Three days before surgery, the patients began to receive vaginal progesterone gel (90 mg) daily to prevent abortion or premature delivery. The patient with a pituitary abscess discontinued the use of the gel after surgery because of her decision to terminate the pregnancy due to her own concerns, and the other three patients continued with the gel until 10 days after surgery. Foetal monitoring was intensified perioperatively. Two of the four patients who received surgery in the third trimester (32 weeks of gestation) received dexamethasone before the operation to facilitate lung maturity of the foetuses. During the operations, the foetal heart rate (FHR) and uterine contractions were monitored at the same time, and the preparations were made for accidental delivery and neonatal rescue procedures.

Results

Surgical outcomes

Surgery was performed successfully with the SOLs excised completely in all four patients, who were discharged

7–14 days after surgery. Pathologically, the four SOLs were diagnosed postoperatively as meningioma in two cases, non-functioning pituitary adenoma in one case, and a pituitary abscess in one case (Table 1). Except for short-term mild insipidus in two patients, no other new postoperative complications occurred, such as cerebrospinal fluid leakage, electrolyte disturbance, intracranial infection, nasal bleeding, cranial nerve dysfunction or epilepsy. The visual acuity of the four patients improved to varying degrees. In the four patients with only light perception and counting finger impairments in four eyes, their sight restored to the normal reading state postoperatively (Table 3 and Fig. 2). Imaging follow-up examination at 6–12 months after surgery showed that all the tumours were removed completely with no evidence of recurrence (Fig. 1). The mean follow up duration was 8 months, and the visual state was stable and better than that before surgery in all four patients.

A postoperative pituitary hormone test showed no newly added endocrine dysfunctions. Cortisone acetate was administered empirically for a short time to prevent potential postoperative hypocortisolism in all four patients, and the drug dose was tapered gradually from 1 to 2 weeks until normal recovery of cortisol levels. Two patients presented a short-term low level of TSH postoperatively, which was restored to the normal level after 2–4 weeks' pharmacological supplementation. Two patients presented mild symptoms of insipidus postoperatively, which were spontaneously restored to normal after 1 week of low-dose desmopressin (Table 3).

Obstetric outcomes

No signs of late-stage abortion or premature delivery were observed during or postoperation. The patient with a pituitary abscess chose to terminate her pregnancy in the second trimester (20 weeks) by labour induction via intraamniotic injection of Rivanol postoperatively because she was apprehensive about the potential adverse effects of postoperative administration of meropenem and vancomycin. The other three patients decided to continue with their pregnancies until full-term delivery, including full-term caesarean section in two patients and full-term natural delivery in one patient. A discussion was had by the MDT before delivery. The timing and mode of pregnancy termination mainly depended on the obstetric factors (Table 4). In the two patients who had a caesarean section, intra- and postpartum uterine contractions were good without bleeding, and a postpartum follow-up visit at 42 days showed good incisional healing and uterine involution. The natural birth process of one patient was smooth with no postpartum bleeding, and the postpartum follow-up visit at 42 days showed good uterine involution. The Apgar score of the

Table 3 Vision, pituitary hormone and 24 h urine volume pre- and post-operation

Patient number	Vision		Pituitary hormone		24 h urine volume	
	Preoperation	Postoperation	Preoperation	Postoperation	Preoperation	Postoperation
1	L 4.7	L 4.7	No special	TSH↓, no other abnormalities (cortisone and thyroxine supplement)	Normal range	Normal range
2	R light perception	R 4.1	No special	No special (cortisone and thyroxine supplement)	Normal range	Normal range
	L finger counting	L 4.2				
3	R 4.3	R 4.7	TSH↓, no other abnormalities	No special (cortisone and thyroxine supplement)	Normal range	Normal range (antidiuretic hormone supplement)
	L finger counting	L 4.2				
4	R light perception	R light perception	No special	TSH↓, no other abnormalities (cortisone and thyroxine supplement)	Normal range	Normal range (antidiuretic hormone supplement)
	L light perception	L 4.2				
	R 4.6	R 4.7				

four newborns (including a case of twins) was 10, with no apparent deformities, and the postpartum follow-up visit at 42 days showed normal development of all the infants (Table 4).

Discussion

Surgical treatment of pregnant women with visual impairment due to sellar region SOLs should be selected with prudence, knowing that the high oestrogen and progesterone environment may increase peritumoural oedema or even stimulate tumour growth. Sellar region SOLs themselves generally do not affect the progress of pregnancy per se, but the therapeutic implications do [11]. Therefore, whether surgery should be selected, the timing of surgery, and the details of postoperative management need to be discussed carefully.

Given the characteristic features of sellar region SOLs in pregnancy, MDT cooperation is of primary importance. Other than involving experts in neurosurgery and obstetrics, participation of experts in anaesthesiology, neonatology, endocrinology and ophthalmology is also necessary. During each treatment of the four patients in our series, we organized at least four MDT meeting sessions to ensure smooth procession of treatment and safety of the foetus.

Right after the initial clinical diagnosis, the patients were arranged for their first MDT consultations. Experts from related disciplines established the timing of surgery according to the degree of visual impairment and gestational age, and finally, the surgical decision was made: as the second and third patients had serious binocular visual impairment and the gestational age was young, the MDT decided to perform surgical SOL decompression as soon as possible; as the first and fourth patients had not suffered significant impairment in monocular vision, and the gestational age was already further along, it was recommended to wait until the 32nd week of pregnancy while visual changes were monitored closely until the foetus further matured. Even if a premature birth had occurred during surgery, there was a greater probability of ensuring the survival of the fetuses in the first and fourth cases.

After the patients were admitted to the neurosurgical ward, before surgery, the second MDT meeting was convened for preoperative discussion. Experts from the endocrinology department made an assessment to determine whether there was any sign of pituitary and hypothalamus functional impairment and whether hormone replacement therapy was necessary; the experts from the anaesthesiology department made an assessment on the heart and lung functions, as well as circulation reserve; the experts from the obstetrics department made an assessment on the foetal status, decided to maintain foetal stability by the advanced use of progesterone

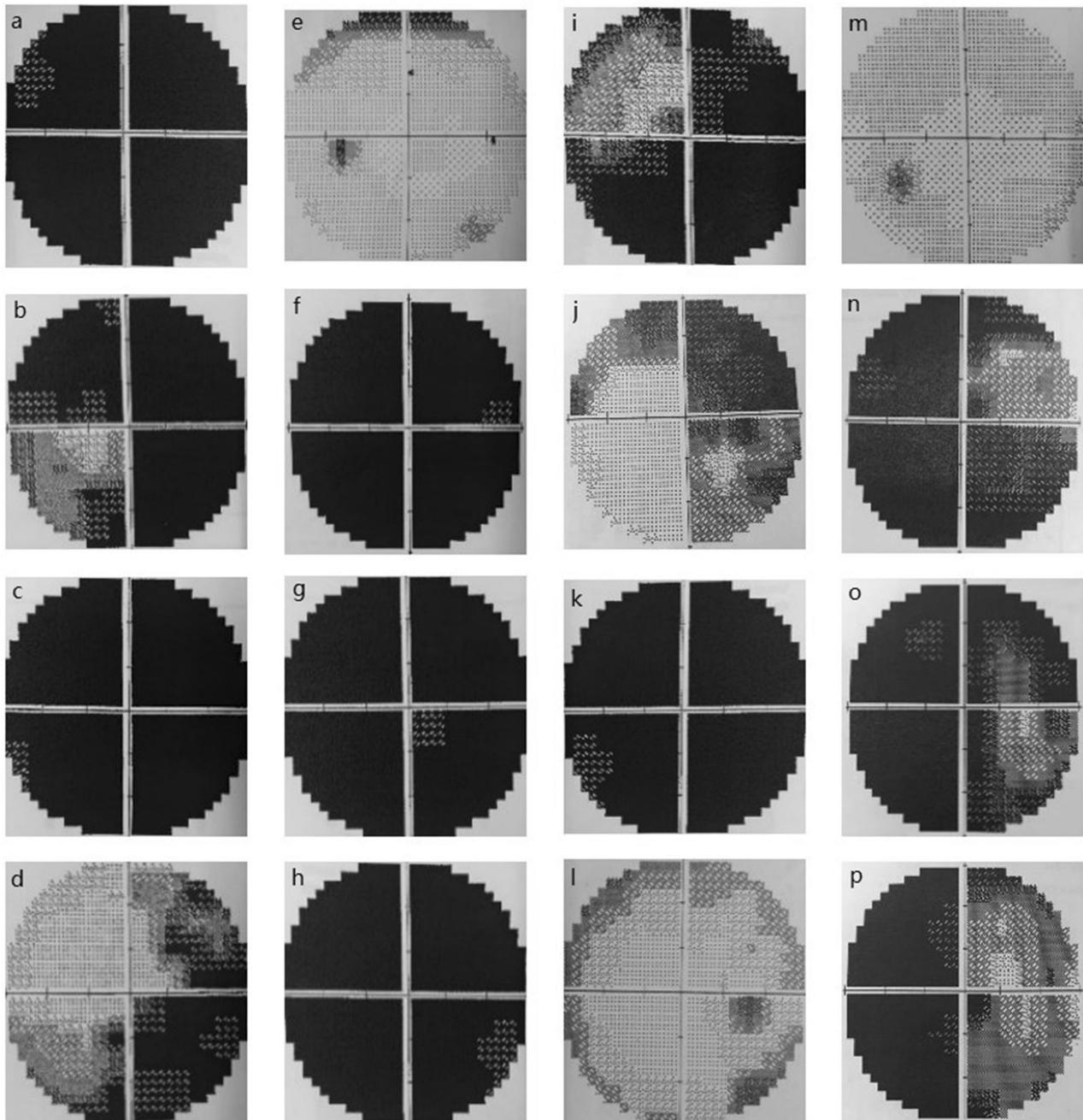


Fig. 2 Pre- and postoperative examination of the visual field of the four patients. **a–d** Preoperative right eye visual field of patient 1–4; **e–h** Preoperative left eye visual field of patient 1–4; **i–l** Postoperative

right eye visual field of patient 1–4; **m–p** Postoperative left eye visual field of patient 1–4

Table 4 Fetal outcome

Patient	Obstetric abnormality	Gestational weeks of pregnancy termination	Method of delivery	Neonate information		
				Birth weight (g)	APGAR score	Complication
1	Gemellary pregnancy, scarred uterus	36 ^{+2d}	C-section	3030/2600	10/10/10	None
2	None	40	Vaginal delivery	3370	10/10/10	None
3	Pre-pregnancy hypothyroidism	20	Induced labor via intraamniotic injection of Rivanol	/	/	None
4	Pregnancy-induced hypertension	38 ^{+1d}	C-section	2780	10/10/10	None

gel and dexamethasone (in the third trimester), and worked together with neonatology department to design a contingency plan should premature birth occur and prepare for FHR monitoring throughout the surgical process. At the same time and place, experienced doctors from multiple disciplines sat together to make a joint decision and perfect all the details of surgical treatment and discuss their concerns about perioperative care, prognostic treatment and emergency preplanning, thus avoiding disharmony in any subsequent multidisciplinary consultations with the respective doctors.

During the surgery, experienced doctors from the departments of anaesthesiology, neurosurgery and obstetrics were present simultaneously to attend to their own duties: the anaesthesiologist was responsible for controlling anaesthesia and analgesia with the goal of minimizing the adverse effects of anaesthesia on the foetus; the obstetrician helped place the patient in an appropriate position and monitored the FHR throughout the process; all the surgical procedures from the skin incision and removal of the tumour by microscopy or neuroendoscopy to closing the wound (nasal packing) were performed by an experienced neurosurgeon in order to shorten the time of operation to minimize potential hazards of anaesthesia on the foetus. In the treatment of a pregnant woman with craniopharyngioma, Zoia et al. [12] reported the necessity of concerted efforts from an MDT to improve preoperative planning, minimize intraoperative trauma, prevent postoperative complications, and perfect postoperative follow-up visits. A third MDT meeting was held again 1–2 weeks after the operation and before discharge from the department of neurosurgery to evaluate the surgical outcome, assess the foetal safety, and to evaluate and correct any associated endocrine complications. A fourth MDT meeting was held before delivery to assess the maternal and foetal statuses.

Although several studies [13–15] reported that pregnancy-complicated tuberculoma sellae meningioma would shrink and the symptoms would be ameliorated spontaneously after delivery, Grković et al. [16] performed a statistical analysis on postoperative recovery of visual acuity in 40 patients with sellar region tumours and noted that the tumour size and the preoperative visual state were two statistically significant factors affecting the postoperative recovery of visual acuity. On the other hand, several cases demonstrated that neurosurgical operations in the second and third trimesters were, to some extent, safe [2–7, 9, 10, 17]. In cases, in which the sellar region SOL becomes progressively larger or the impairment of visual acuity or visual field deteriorates progressively, prepartum surgery should be considered. There are also case reports that describe artificial promotion of foetal lung maturation and delivery shortly before lesion resection in pregnant women who were approaching full-term delivery [8, 12, 18].

In view of the therapeutic and follow-up outcomes in the four cases of our series, the SOLs were removed completely,

vision was improved to varying degrees, the endocrine function was preserved, the babies were delivered at full term and anaesthesia was implemented safely. We therefore believe that the selection of surgery, rather a passive wait-and-see method, is a sensible choice for pregnant women with sellar region SOL-induced severe visual impairment.

Currently, there is no authoritative report about the optimal mode of baby delivery in pregnant women with sellar region SOLs. Some researchers recommend caesarean section as the main mode of delivery, knowing that breath holding in the second stage of labour would increase intracranial pressure, which is unfavourable to pregnant women with intracranial SOLs [19, 20]. Nevertheless, the mode of delivery in such patients should primarily depend on obstetric factors. For women whose SOLs have been removed, natural delivery could still be considered as long as meticulous monitoring is assured.

Conclusion

In pregnant women with sellar region SOLs and severe visual impairment, positive surgical resection should be considered at an appropriate gestational age. MDT cooperation from experts in neurosurgery, obstetrics, anaesthesiology, endocrinology and ophthalmology is suggested to facilitate perioperative decision-making and pre- and postoperative management, knowing that multidisciplinary participation in the surgical intervention can apparently improve the prognosis of patients without affecting the outcomes of either the pregnant mother or the infant and therefore has clinical guiding significance.

Funding This study was funded by Shanghai Science and Technology Commission and Program of Shanghai Academic Research Leader (ZBW) (grant number: 18XD1403400).

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

Informed consent Informed consent was obtained from all individual participants included in the study.

Publisher's note Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

References

1. W. Saeger, D.K. Ludecke, M. Buchfelder, R. Fahlbusch, H.J. Quabbe, S. Petersenn, Pathohistological classification of pituitary tumors: 10 years of experience with the German Pituitary Tumor Registry. *Eur. J. Endocrinol.* **156**(2), 203–216 (2007). <https://doi.org/10.1530/eje.1.02326>

2. H.C. Kim, S.G. Kang, P.W. Huh, S. Yoo do, K.S. Cho, D.S. Kim, Pituitary abscess in a pregnant woman. *J. Clin. Neurosci.* **14**(11), 1135–1139 (2007). <https://doi.org/10.1016/j.jocn.2006.03.012>
3. S. Shitara, N. Nitta, T. Fukami, K. Nozaki, Tuberculum sellae meningioma causing progressive visual impairment during pregnancy. *Neurol. Med Chir.* **52**(8), 607–611 (2012)
4. O.E. Idowu, M.T. Shokunbi, S.D. Amanor-Boadu, O.A. Roberts, C. Eyo, Surgical management of tuberculum sellae meningioma in a patient with a twin pregnancy: case report. *Surg. Neurol.* **62**(1), 60–63 (2004). <https://doi.org/10.1016/j.surneu.2003.07.007>
5. E. Grillo-Mallo, J. Jimenez-Benito, E. Diez-Feijoo, I. Alonso Alonso, A. Ferrero Collado, S. Munoz Quinones, [Acute visual loss in pregnancy caused by craniopharyngioma]. *Arch. Soc. Esp. Oftalmol.* **89**(4), 152–156 (2014). <https://doi.org/10.1016/j.oftal.2012.09.016>
6. A. Tandon, J. Alzate, P. LaSala, M.P. Fried, Endoscopic endonasal transsphenoidal resection for pituitary apoplexy during the third trimester of pregnancy. *Surg. Res Pract.* **2014**, 397131 (2014). <https://doi.org/10.1155/2014/397131>
7. B.H. Priddy, B.A. Otto, R.L. Carrau, D.M. Prevedello, Management of skull base tumors in the obstetric population: a case series. *World Neurosurg.* **113**, e373–e382 (2018). <https://doi.org/10.1016/j.wneu.2018.02.038>
8. M. Zoli, M. Faustini-Fustini, D. Mazzatenta, E. Pasquini, G. Frank, Tuberculum sellae meningioma growing during pregnancy: a difficult decision-making process. *J. Clin. Endocrinol. Metab.* **97**(5), 1418–1419 (2012). <https://doi.org/10.1210/jc.2012-1155>
9. P. Witek, G. Zielinski, M. Maksymowicz, W. Zgliczynski, Transsphenoidal surgery for a life-threatening prolactinoma apoplexy during pregnancy. *Neuro Endocrinol. Lett.* **33**(5), 483–488 (2012)
10. S. Moscovici, S. Fraifeld, J.E. Cohen, S. Dotan, U. Elchalal, Y. Shoshan, S. Spektor, Parasellar meningiomas in pregnancy: surgical results and visual outcomes. *World Neurosurg.* **82**(3–4), e503–e512 (2014). <https://doi.org/10.1016/j.wneu.2013.06.019>
11. E. Lioret, P. Francois, C. Hommet, [Tumors of the neuraxis and neuraxial sheaths during pregnancy (excluding tumors of the sellar region)]. *Neurochirurgie* **46**(2), 76–87 (2000)
12. C. Zoia, A. Cattalani, E. Turpini, V.M. Custodi, M. Benazzo, F. Pagella, P. Carena, E. Lovati, P. Lucotti, P. Gaetani, Haemorrhagic presentation of a craniopharyngioma in a pregnant woman. *Case Rep. Neurol. Med.* **2014**, 435208 (2014). <https://doi.org/10.1155/2014/435208>
13. B. Vizner, J. Talan-Hranilovic, Z. Gnjidic, M. Sekso, M. Berkovic, V. Altabas, Z. Rumboldt, Lymphocytic adenohypophysitis simulating a pituitary adenoma in a pregnant woman. *Coll. Antropol.* **26**(2), 641–650 (2002)
14. S. Sakatsume, T. Kawataki, M. Ogiwara, H. Sato, H. Kinouchi, [Spontaneous improvement in visual symptom after delivery in a case of tuberculum sellae meningioma]. *No Shinkei Geka* **46**(7), 607–613 (2018). <https://doi.org/10.11477/mf.1436203777>
15. J.G. Chacko, J.L. Miller, E.J. Angtuaco, Spontaneous postpartum resolution of vision loss caused by a progesterone receptor-positive tuberculum sellae meningioma. *J. Neuroophthalmol.* **30**(2), 132–134 (2010). <https://doi.org/10.1097/WNO.0b013e3181da9d59>
16. D. Grkovic, T. Bedov, [Outcome of visual acuity after surgical removal of pituitary adenomas]. *Srp. Arh. Celok. Lek.* **141**(5–6), 296–303 (2013)
17. A. Atmaca, S. Dagdelen, T. Erbas, Follow-up of pregnancy in acromegalic women: different presentations and outcomes. *Exp. Clin. Endocrinol. Diabetes* **114**(3), 135–139 (2006). <https://doi.org/10.1055/s-2005-873004>
18. F.H. Ebner, A. Bornemann, H. Wilhelm, U. Ernemann, J. Honnegger, Tuberculum sellae meningioma symptomatic during pregnancy: pathophysiological considerations. *Acta Neurochir.* **150**(2), 189–193 (2008). <https://doi.org/10.1007/s00701-007-1417-5>. discussion 193
19. E.M. Kasper, P.E. Hess, M. Silasi, K.H. Lim, J. Gray, H. Reddy, L. Gilmore, B. Kasper, A pregnant female with a large intracranial mass: reviewing the evidence to obtain management guidelines for intracranial meningiomas during pregnancy. *Surg. Neurol. Int* **1**, 95 (2010). <https://doi.org/10.4103/2152-7806.74242>
20. J. Pallud, H. Duffau, R.A. Razak, P. Barbarino-Monnier, L. Capelle, D. Fontaine, M. Frenay, F. Guillet-May, E. Mandonnet, L. Taillandier, Influence of pregnancy in the behavior of diffuse gliomas: clinical cases of a French glioma study group. *J. Neurol.* **256**(12), 2014–2020 (2009). <https://doi.org/10.1007/s00415-009-5232-1>