The objective of transsphenoidal surgery for pituitary lesions is relief of mass effects and cure of endocrinological syndromes. Large masses in the narrow confines of the sella often lead to damage of the anterior visual pathway, such as visual field defects or decline of visual acuity, oculomotor and facial sensitivity disturbances in the case of parasellar extension to the cavernous sinus, and even obstructive hydrocephalus when the third ventricle is invaded. For ophthalmological symptoms, early decompression of the chiasm and the optic nerves significantly improves visual outcomes. However, due to the narrow field exposed by the transsphenoidal approach, the visualization of supr- and parasellar tumor remnants is often not possible. Furthermore, radical resection may lead to an increased incidence of complications such as CSF fistula with subsequent meningitis, hypopituitarism, and diabetes insipidus, or damage to the adjacent cranial nerves or the ICA.

Intraoperative MR imaging allows a quick evaluation

Abbreviations used in this paper: ICA = internal carotid artery; iMR = intraoperative MR.
Intraoperative MR imaging and visual outcome of progress during transsphenoidal procedures, an update of images for intraoperative navigation tools, and the exclusion of imminent complications such as hemorrhage before the site is closed. Intraoperative MR imaging has been used in transsphenoidal surgery for more than a decade and numerous studies discussing its feasibility, workflow, and surgical results have been published.\textsuperscript{2,3,6,8,15,16,21,22,25,35,44,49,51,54–56,59–63,69,70,73,80} Even if there is good visualization of a residual tumor with iMR imaging, the extent of resection is often restricted. In these cases the benefit of iMR imaging is to ensure sufficient decompression of sensitive structures such as the optic chiasm. The aim of this study is to evaluate the correlation between visual improvement and optic nerve decompression detected by iMR imaging in patients undergoing transsphenoidal resection of pituitary lesions.

**Methods**

**Patient Population and Clinical Assessment**

Thirty-two patients with sellar lesions causing symptoms due to compression of the optic chiasm underwent transsphenoidal surgery at our institution and were included in this study (Table 1). The mean age of the study sample was 57 ± 17.9 years. Twenty-three patients (72%) were men. Histological confirmation of the diagnosis was obtained in each case, showing inactive adenoma in the majority of patients (26 patients [81%]). There were individual patients suffering from acromegaly, macroprolactinoma, sellar abscess, malignant teratoma, thrombosed ICA aneurysm, and pituicytoma. The 2 patients with acromegaly and macroprolactinoma underwent preoperative therapy with cabergoline, but the tumor volume did not shrink and visual symptoms persisted. Two patients (Cases 6 and 8) harbored hemorrhagic inactive macroadenomas. One of these patients (Case 6) experienced rapid deterioration of vision while receiving warfarin therapy because of atrial fibrillation. The patient presenting with an unexpected thrombosed ICA aneurysm (Case 5) was postoperatively evaluated using digital subtraction angiography, which showed no aneurysm remnant. These postoperative findings correlated with the preoperative MR angiography. In this case, the aneurysm wall and clot could be documented in the histological evaluation.

In 20 cases (63%) a sellar lesion was diagnosed as a consequence of complaints of visual symptoms by the patient. In the remaining 12 patients (37%) ophthalmic deficiencies were detected by a thorough ophthalmological examination, including testing of visual acuity and color vision, visual field testing with the Goldmann perimeter, and retinal fundus examination. The mean latency period between detection of symptoms and transsphenoidal decompression was 14.9 ± 19.5 weeks. On the day of admission, each patient again underwent a comprehensive screening for ophthalmological and endocrinological symptoms by the specialists at our hospital. In addition, a cranial CT scan was performed for use with frameless stereotactic navigation.

Visual field damage was diagnosed in 31 patients (97%). Sixteen (52%) of these 31 patients presented with various degrees of bitemporal hemianopsia, defined as temporal scotoma with involvement of more than 1 quadrant on Goldmann perimetry. The other 15 patients (48%) suffered from bitemporal quadrant anopsia, defined as scotomas restricted to the temporal quadrants of the visual field. Loss of visual acuity was defined as follows: slight, 15%–40% loss of central vision; moderate, 40%–70% loss of central vision; severe, > 80% loss of central vision; and absent, 100% loss of central vision. In cases involving asymmetrical visual acuity, the more impaired eye was referred to. Various stages of optic nerve atrophy due to extrinsic compression (visual acuity deficit) were detected in 28 cases (87.5%). Grade of visual acuity loss was slight in 11 patients, moderate in 11, and severe in 5. One patient suffering from drug-resistant macroprolactinoma (Case 14) had absent vision in 1 eye and severe loss of visual acuity on the other side.

Mean tumor diameters were 2.1 ± 0.75 cm (lateral), 2.3 ± 0.72 cm (anterior-posterior), and 3.0 ± 1.16 cm (apicobasal). Volume of the lesions was assessed using the formula proposed by Lundin and Pedersen\textsuperscript{12} and ranged from 0.9 cm\textsuperscript{3} to 55.7 cm\textsuperscript{3} (mean 9.8 ± 11.7 cm\textsuperscript{3}). The extension of the lesion was classified by the modified version of the Hardy grading system\textsuperscript{29,32} as follows: Grade I (diameter < 10 mm), no patients; Grade II (diameter 10–20 mm and suprasellar extension within 10 mm of the sphenoidal plane), 5 patients (16%); Grade III (diameter 20–40 mm and suprasellar extension of up to 30 mm), 22 patients (69%); and Grade IV (diameter > 40 mm and extension far beyond the sellar space), 5 patients (16%).

The extent of resection depicted by iMR imaging was graded as follows: R0, total resection, no remnant visible; R1, subtotal resection, small remnants visible; and R2, biopsy/debulking, most of the lesion still in situ. The postoperative follow-up included comprehensive endocrinological and ophthalmological testing within the 1st month after surgery and 1.5-T MR imaging 3–6 months after surgery.

**Surgical Technique**

The PoleStar N20 system (Medtronic Navigation) with a permanent magnet that delivers a 0.15-T magnetic field was used in all of the listed procedures. Each patient gave informed consent for the use of iMR imaging. A radiofrequency shield (StarShield) was installed during the scanning sequences and magnetic field shielding was increased by active compensation, with constant monitoring of magnetic fields outside the PoleStar system. The anesthesiology equipment was compatible with MR imaging, and the surgical instruments that were not compatible were removed during the scanning procedure.

All patients were placed supine with their heads fixed in an MR imaging–compatible head clamp. A radiofrequency coil was attached around the patient’s head. Because the PoleStar device needs to be placed very close to the shoulders to attain optimum image quality around the sella, soft bandages were attached to the shoulders and gentle traction was applied to reduce pressure. The CT data set for frameless stereotactic navigation was referenced with the support of the patient’s face and processed by StealthStation TREON (Medtronic).
In the first step, 24-second e-steady sequences (time-reversed fast imaging with steady-state processing) were performed to test the accuracy of the scanning position. Thereafter, 11-minute, 2-mm-slice, Gd-enhanced, T1-weighted scans were performed to obtain another data set for intraoperative navigation.

The transnasal surgical approach was performed by an otorhinolaryngologist. After the sphenoid sinus had been opened and the anterior wall of the sella turcica had been displayed to its lateral borders, the procedure was continued by the senior authors (H.L. and J.F.). The sella turcica was opened and the dura was incised in an x-shaped fashion. The removal of the lesion was performed with tumor-grasping forceps and with an assortment of curettes and suction devices. A second scan (11-minute, 2-mm-slice, Gd-enhanced, T1-weighted) was obtained if intraoperative visualization of the sella suggested complete resection, or if further probing for possible remnants was not safely possible (for example, in the case of bulging of the sellar diaphragm). If there was evidence of an accessible residual lesion, removal was continued after updating the navigation software with the latest iMR imaging data set. Additional scans were only performed if additional resection was reasonably possible. Once lesion removal was completed, the sella turcica and the sphenoid sinus were sealed with subcutaneous fat tissue and bone fragments. In the case of a CSF fistula, lumbar drainage was installed.

### TABLE 1: Clinical characteristics and intraoperative radiological findings*

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<th>Case No.</th>
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<th>Diagnosis</th>
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<th>Modified Hardy Grade</th>
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* hemi = bitemporal hemianopsia; NFA = nonfunctioning adenoma; quadrant = bitemporal quadrant anopsia; VAD = visual acuity deficit; VFD = visual field deficit.
† Deficits only detected by ophthalmological examination.
Intraoperative MR imaging and visual outcome

Statistical Analysis

The resulting data were analyzed using GraphPad statistical software. The results were evaluated using contingency table analysis with the Fisher exact test. Probability values < 0.05 were considered statistically significant. This study was approved by the institutional review board of the Kantonsspital Aarau.

Results

Intraoperative Findings

The intraoperative workflow is summarized in Fig. 1. The first iMR imaging examination after resection showed complete tumor removal in 17 patients (53%), and a residual mass in 15 (47%). Of the latter, 9 lesions were subtotally resected (Grade R1), and 6 partially resected (Grade R2). Initial modified Hardy grades for R0 resections were Grade II in 3 cases, Grade III in 12, and Grade IV in 2. For R1 resections there were 2 Grade II lesions, 6 Grade III lesions, and a single Grade IV lesion. For R2 resections there were 4 Grade III lesions and 2 Grade IV lesions. The majority of remnants (9, 60%) were located in the suprasellar confines, with consequent persistent compression and dislocation of the optic chiasm. The other remnants were intra- and parasellar in 4 and 2 cases, respectively. Additional tissue was removed in 9 cases (60%; 5 suprasellar, 2 parasellar, 2 intrasellar). In 1 patient (Case 31) a suprasellar coagulum was misinterpreted as residual tumor. A second iMR imaging examination after additional resection was performed in 6 patients. These images showed R0 resection in another 4 cases, leading to a gross-total resection rate of 66% (21 of 32 patients) documented by iMR imaging.

Decompression of the optic chiasm was documented by iMR imaging in 27 patients (84%). Mean tumor volume in these cases was 8.2 ± 8.7 cm³ (range 0.94–43.23 cm³); modified Hardy grades were Grade II in 5 patients, Grade III in 19, and Grade IV in 3. In the remaining 5 patients the procedure was abandoned without further possibility of decompression of the chiasm. Mean tumor volume in these cases was 18.3 cm³ (range 3.56–55.73 cm³), and the modified Hardy grades were Grade III in 3 cases and Grade IV in 2. Three of these patients (Cases 7, 15, and 28) presented with suprasellar tumor parts densely fixed to the diaphragm and optic nerves. One patient harboring a sellar abscess (Case 2) underwent drainage and partial removal of the abscess wall, but the final scan showed remains of the capsule still fixed to the chiasm.

Postoperative Findings and Follow-Up

On short-term ophthalmological follow-up within 1 month after surgery, overall improvement of visual field deficits was observed in 27 (87%) of 31 patients, while in 23 (74%) the visual field was normal. In 5 patients visual field deficits persisted (hemianopsia in 4 patients, quadrant anopsia in 1 patient), with correlating optic nerve compression on iMR imaging in 4 cases. Normal or improved visual acuity after surgery was documented in every patient with a decompressed optic chiasm on iMR imaging. Overall, improvement of visual acuity was noted postoperatively in 24 (86%) of 28 patients. In 18 (64%) of these patients visual acuity had already normalized on short-term follow-up, while in 6 (21%) there was a marked improvement. Every one of the 4 patients with persistent visual acuity deficiencies also suffered from lasting visual field deficits. The only case (Case 2) in which visual acuity and the visual field normalized, instead of continuing contact of the lesion with the optic chiasm, was a patient with a drained sellar abscess. This may be explained by sufficient drainage and lack of compression by the residual capsule. Other than 2 patients (Cases 22 and 30) with CSF leaks detected during the procedure, there were no adverse effects of surgery such as hemorrhage or postoperative infection. It is noteworthy that no patients suffered from loss of visual acuity or visual field due to the surgical intervention. The course of endocrinological deficits was not assessed in this study.

In 2 patients transcranial procedures were indicated due to residual tumors compressing the optic chiasm. A 19-year-old patient (Case 21) harboring a malignant teratoma (modified Hardy Grade III, volume 9.4 cm³, R2 resection) underwent further resection via a pterional approach and presented with improved vision. A 41-year-old patient (Case 30) with an inactive giant adenoma (modified Hardy Grade IV, volume 55.7 cm³, R2 resection) underwent further tumor resection via a frontotemporal and interhemispheric approach. The patient remained without recurrence and showed improved vision on ophthalmological follow-up over 2 years.

While the gross-total resection rate was 66% as assessed using iMR imaging, there was no residual tumor detected in 4 patients (all R1 resections with intra- and parasellar remnants) on follow-up high-field (1.5-T) MR imaging. This resulted in a gross-total resection rate of 78%. The specificity for detection of R0 resection by iMR imaging was 0.84 (95% CI 0.63–0.95) and sensitivity was 1 (95% CI 0.56–1). During a mean follow-up of 20 ± 11 months, each of the 30 patients who underwent only transsphenoidal resection remained free of recurrence of visual symptoms. Adjuvant medical therapy had to be continued due to persistence of symptomatic hormone excess and pathologic endocrinological testing in the 2 patients suffering from acromegaly (Case 7) and macroprolactinoma (Case 14). While the latter patient was quite resistant to therapy with dopamine agonists, a target for Gamma Knife surgery could be defined by decompression of the optic chiasm guided by iMR imaging.

Sex, volume of lesion, latency between onset of symptoms and decompression of the optic chiasm, type of visual field deficiencies, and severity of visual acuity loss did not significantly correlate with early prognosis of visual field or visual acuity recovery. The only statistically significant factor in this study group was the detection of a decompressed optic chiasm on iMR imaging. The correlation between a decompressed optic chiasm on iMR imaging and visual field improvement was significant (p = 0.0007), as well as the correlation with visual acuity recovery (p = 0.0002). The sensitivity, specificity, and predictive values for decompression of the optic chiasm on iMR imaging and recovery of ophthalmological symptoms are listed in Table 2.
Illustrative Case

This 60-year-old woman (Case 22) presented with a 6-week history of bitemporal hemianopsia and slightly diminished visual acuity (30% loss of central vision). On MR imaging, a sellar lesion with suprasellar extension (modified Hardy Grade III, $21 \times 20 \times 30$ mm, 7.16 cm$^3$) was detected (Fig. 2A). The endocrinological workup showed insufficiencies of the adrenocortical axis and hypogonadotropic hypogonadism. The extent of the tumor as detected on the initial intraoperative scan correlated well with the iMR imaging findings before resection.

An easily dissolving tumor was resected until descent of the sellar diaphragm blocked the view to the left side of the sella. On iMR imaging a suprasellar remnant could be detected, causing compression of the right optic nerve (Fig. 2B). After further resection, sufficient decom-

| Table 2: Decompression of optic chiasm as noted on iMR imaging and recovery of symptoms |
|---------------------------------|----------------|----------------|
| Variable                        | Value          | 95% CI         |
| visual field recovery sensitivity| 0.96           | 0.81–0.99      |
| specificity                     | 0.80           | 0.28–0.99      |
| positive predictive value       | 0.96           | 0.81–0.99      |
| negative predictive value       | 0.80           | 0.28–0.99      |
| visual acuity recovery sensitivity| 1.00           | 0.85–0.99      |
| specificity                     | 0.80           | 0.28–0.99      |
| positive predictive value       | 0.96           | 0.79–0.99      |
| negative predictive value       | 1.00           | 0.40–1.00      |
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Fig. 2. Case 22. A: Coronal preoperative 1.5-T T1-weighted contrast-enhanced MR image showing a large sellar mass with suprasellar extension and dislocation of the optic chiasm. B: Coronal iMR image revealing a residual suprasellar mass (arrowhead) with compression of the right optic nerve. C: Coronal iMR image confirming total tumor removal (arrowhead). D: Coronal postoperative 1.5-T T1-weighted enhanced MR image showing the decompressed optic chiasm.

Discussion

This study demonstrated the prognostic value of intraoperative MR imaging findings in predicting early improvement of visual deficits after transsphenoidal resection of sellar lesions. Various intraoperative imaging procedures have been used to increase the effectiveness and safety of transsphenoidal surgery. The earliest modalities used were radiographic fluoroscopy and intraoperative cisternography. Intraoperative CT was the first modality to allow direct detection of tumor residuals, but due to its restricted selectivity in defining soft-tissue differences, it was not well accepted. Intraoperative MR imaging, ultrasonography and Doppler ultrasonography, and endoscopy are the complementary tools used in today's procedures. Recent studies have demonstrated that early decompression of the optic nerves significantly improves visual outcomes. These interesting time-related prognostic factors for recovery of vision were mainly established by authors treating patients in countries with a relative lack of neurosurgical facilities. In Indian patients with severe impairment of optic functions, a significant threshold for good prognosis was observed if surgery was delayed more than 4 weeks. Nevertheless, even in as many as 29% of patients with preoperative blindness, a visual improvement was observed. Favorable factors affecting the outcome in these blind patients were reported to be male sex, shorter duration of blindness, presence of apoplexy, extension of tumor, and soft tumor consistency. The visual prognosis of the patients in our study published by Jones and Ruge in 2007 is the only report focusing on ophthalmological outcome with regard to the use of iMR imaging. So far, data on the impact of iMR imaging-assessed decompression of the optic chiasm are lacking in the literature.

Factors Influencing the Course of Ophthalmological Symptoms

While ophthalmological symptoms have been attributed to sellar lesions in earlier centuries, Harvey Cushing was the first to describe the classical chiasm syndrome that consisted of primary optic atrophy with symmetric bitemporal hemianopsia. However, true bitemporal hemianopsia is a rare event. Although it is well-recognized that the exact pattern of visual field loss is related to the site of chiasmal damage, the pathophysiology of visual loss, pattern of visual loss, and field defects in suprasellar tumors is still subject to debate. Bergland postulated a correlation between the blood supply of the central part of the optic chiasm from below and the mass effect of sellar lesions. However, this theory does not explain why compression from above also causes bitemporal hemianopsia. McIlwaine et al. introduced a mathematical theory based on crossing and noncrossing axon cylinders. According to these authors, the susceptibility to damage of the crossing nasal fibers with subsequent temporal deficits is due to the relatively greater pressures in the location of these fibers for any external compressive force acting on the chiasm. This model was tested using Foley catheters positioned beneath the chiasm in cadaveric specimens.

Recovery from optic nerve symptoms caused by sellar lesions is often observed within days after surgical decompression, with continued improvement over several months. Early phase recovery may be attributed to release of optic nerve ischemia, as postulated by Bergland, or axonal compression, as in the model demonstrated by McIlwaine et al. Remyelination may contribute to delayed recovery, but the exact mechanisms are poorly understood. It is noteworthy that the vast majority of the patients presented in this study experienced early improvement (87%) or even full recovery (74%) of their visual field deficit within 1 month.

Greater lesion size, greater age, and a high degree of preoperative visual acuity compromise are prognostic factors predicting poor postoperative visual recovery. Several studies have demonstrated that early decompression of the optic nerves significantly improves visual outcomes. These interesting time-related prognostic factors for recovery of vision were mainly established by authors treating patients in countries with a relative lack of neurosurgical facilities. In Indian patients with severe impairment of optic functions, a significant threshold for good prognosis was observed if surgery was delayed more than 4 weeks. Nevertheless, even in as many as 29% of patients with preoperative blindness, a visual improvement was observed. Favorable factors affecting the outcome in these blind patients were reported to be male sex, shorter duration of blindness, presence of apoplexy, extension of tumor, and soft tumor consistency. The visual prognosis of the patients in our study...
did not depend on the size of tumor, sex, latency to decompression of the chiasm, or severity of visual field or visual acuity deficiencies as prognostic factors. In our series, only decompression of the optic chiasm depicted by iMR imaging was statistically significant as a single prognostic factor with a positive predictive value of 0.96 for improvement of visual acuity and 0.96 for improvement of the visual field. Tokumaru et al.\(^6\) reviewed pre- and postoperative follow-up imaging to determine changes in the optic nerves depicted by high-field MR imaging. These investigators reported a significant correlation between detection of optic nerve hyperintensity lesions on T2-weighted MR imaging with both the degree of optic chiasm compression and with the presence of diminished visual acuity. However, improvement of signal intensity abnormalities after decompression was not a significant prognostic factor in those patients.

**Results With and Without the Use of iMR Imaging**

Over the past 30 years, several studies have analyzed ophthalmological outcome after transsphenoidal surgery without the use of iMR imaging.\(^{12,17,21,31,41–43,62,63,66,70}\) As cited by Jones and Ruge,\(^{35}\) improvement of vision was noted in 48% to 92% of the patients, but the differences in visual scoring methods, time to follow-up, and severity and duration of deficits may have led to a possible bias when the individual results were compared.

With iMR imaging becoming a part of the neurosurgical operating theater during the past decade, various investigators have reported data on visual outcome (Table 3).\(^{6,8,21,56,70,80}\) Nevertheless, it is noteworthy that these studies were not designed to analyze visual outcome in detail. In general, the reported rates of visual improvement were higher (up to 100%) than in studies without the use of iMR imaging. Visual acuity and visual field deficits were not separately analyzed, and details on severity of symptoms and the state of the optic chiasm on iMR imaging are lacking in these studies. In addition, factors possibly affecting the outcome, such as age and tumor size, as well as technical details (such as high-field iMR imaging and additional use of endoscopy)\(^{70}\) vary considerably. A randomized trial in which these variables are controlled may be able to compare the differences in outcome caused by the use of iMR imaging, although it may be questionable to withhold the possible benefit of iMR imaging for the patients in whom this tool is mainly indicated, that is, those with large tumors with suprasellar extension in which assessing completeness without the use of iMR imaging is often difficult.

In the early clinical studies, Fahlbusch et al.\(^{21}\) and Bohinski et al.\(^{3}\) raised the question of the efficacy and reliability of iMR imaging for transsphenoidal procedures. They used a 0.2-T Magnetom Open and a Hitachi AIRIS II, 0.3-T, vertical-field open magnet imaging system, respectively. After the initial resection attempt, the optimal extent of resection had been achieved in only 46% and 34% of their patients, respectively. This is one of the common points also demonstrated by other authors\(^{6,8,21,56,70,80}\) and in this study (Fig. 2). In our series, we performed control scans if intraoperative visualization of the sella suggested complete resection, or if the intraoperative search of possible remnants was limited, for example, due to bulging of the sellar diaphragm. This additional scan enabled further resection in 9 patients (28% of total study group), as shown in Fig. 1. As described in the literature, residual tumor was most frequently detected in the suprasellar space with possible persistent compression of the optic chiasm. These findings become even more important as prognosis of visual deficits may be better if the chiasm is decompressed early, and as an early secondary revision may become obsolete because tumor remnants are detected by iMR imaging.

Not every sellar mass detected on iMR imaging has to be considered a remnant. In our study, 4 patients with suspected intra- and parasellar remnants on iMR imaging showed no residual tumors on the follow-up high-field MR imaging. Compared with postoperative MR imaging, the specificity for detection of gross-total resection by iMR imaging was 0.84 (95% CI 0.63–0.95) and sensitivity was 1 (95% CI 0.56–1). In a comprehensive work on iMR imaging in various pathologies, Hirschl et al.\(^{32}\) compared intraoperative imaging with postoperative high-field MR imaging. In a group of 74 patients, they reported a specificity and a sensitivity for detection of residual tumor of 0.97 and 0.74, respectively. Reasons for failure might include the following problems: the final iMR images were not interpretable, the machine failed due to “noise,” Gd enhancement was poor, image layering missing the tumor, or poor resolution due to low field strength. As encountered in one of our cases with a suprasellar coagulum misinterpreted as residual tumor on iMR imaging, Bohinski et al.\(^{3}\) discussed the difficulty of differentiating remnants of sellar tumor from blood products, which often have an isointense aspect. During the

<table>
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<th>Authors &amp; Year</th>
<th>No. of Patients</th>
<th>No. w/ Impaired Vision</th>
<th>% Vision Improved Postop</th>
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<td>66</td>
<td>65*</td>
<td>3.21</td>
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* Value for total study group.
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first scan, a difference may be observed after administration of a contrast agent. However, in the case of repeat imaging the accumulated blood may be mixed with a contrast agent and reliable differentiation is not possible. Fahlbusch et al.23 even suspected residual tumor in 20% of their cases, but a second look revealed no tumor remnant, which was confirmed 3 months later by follow-up MR imaging. Wu et al.60 concluded in their comparison between iMR imaging and early postoperative MR imaging that iMR imaging is still not satisfactory in estimating the amount of the parasellar residual tumor, and that discrimination between tumor remnants and blood within the venous sinus may be difficult. Based on our experience with detecting decompression of the optic chiasm by iMR imaging, we therefore advocate the use of this tool in patients with large lesions to assess the resection in the suprasellar space. Even in the case of intraoperative complications, such as a patient with extensive suprasellar hemorrhage with compression of the optic nerves as presented by Bohinski et al.,8 iMR imaging may be used to assess the changing anatomical situation and to adjust treatment without abandoning the procedure.

Deterioration of vision is one of the complications of transsphenoidal surgery. Although it was not detected in our patients, worsening of the visual field after procedures guided by iMR imaging was noted by 3 different authors8,50,80 in 3 patients. The apparent incidence of this problem may therefore be approximately 1%, based on the total of 296 patients included in the studies shown in Table 3. The comparison with study groups not using iMR imaging remains difficult and may be biased due to the different techniques applied and variability of risk factors as already discussed. While a single group66 reported an incidence of visual decline of almost 3% among their 101 patients, other groups80,18,34,76,81 including a total of 292 patients did not detect any ophthalmological complications. If adjuvant therapies such as radiosurgery have to be indicated because of subtotal resection or persistent hormonal excess (as in Case 14), decompression of the optic chiasm becomes mandatory to delineate a secure target for dose planning.45,46 In Gamma Knife surgery, there is a correlation between localization of prescription isodose and hormonal response in active tumors. Thus, the greater the volume of the tumor encompassed by the prescription isodose, the shorter the latency period to hormonal normalization.37 To achieve this goal with a low rate of visual side effects, it was suggested that doses to the optic pathways should not exceed 8 Gy, and a space of 5 mm between the optic nerve and residual tumor should be cleared.45,58,71 In our experience with the present study group, iMR imaging enables the surgeon to directly assess whether this safety margin has been reached.

Conclusions

Assessment of optic chiasma decompression using iMR imaging is a reliable method. Intraoperative MR imaging findings correlate with prognosis of visual deficits after transsphenoidal decompression of the optic pathways. The use of iMR imaging may prevent revision surgery in cases involving unexpected symptomatic suprasellar remnants.

Disclosure

The authors report no conflict of interest concerning the materials or methods used in this study or the findings specified in this paper.

Author contributions to the study and manuscript preparation include the following: Conception and design: Fandino. Acquisition of data: Fandino, Berkmann, Zossos, Remonda. Analysis and interpretation of data: all authors. Drafting the article: Fandino, Berkmann. Critically revising the article: Fandino. Study supervision: Fandino.

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