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<td>Authors(s):</td>
<td>Luigi Albano (Corresponding Author), Marco Losa (Co-author), John Flickinger (Co-author), Pietro Mortini (Co-author), Giuseppe Minniti (Corresponding author)</td>
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Review

Radiotherapy of parasellar tumours

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Short Title: Radiotherapy of parasellar tumours

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Abstract

Parasellar tumours represent a wide group of intracranial lesions, both benign and malignant. They may arise from several structures located within the parasellar area or they may infiltrate or metastasize this region. The treatment of the tumours located in these areas is challenging because of their complex anatomical location and their heterogenous histology. It often requires a multimodal approach, including surgery, radiation therapy, and medical therapy. Due to the proximity of critical structures and the risks of side effects related to the procedure, a successful surgical resection is often not achievable. Thus, radiotherapy (RT) plays a crucial role in the treatment of several parasellar tumours. Conventional fractionated radiotherapy and modern radiation techniques, like stereotactic radiosurgery and proton beam radiotherapy have become a standard management option, in particular for cases with residual or recurrent tumours after surgery and for those cases where surgery is contraindicated. This review examines the role of radiotherapy in parasellar tumours analysing several techniques, outcomes and side effects.
Introduction

The parasellar region is a complex anatomical area situated laterally and to either side of the
sella turcica; it contains relevant neurovascular structures (1). For most authors, this region
includes all areas around the sella, encompassing the cavernous sinuses, located lateral to
the sella turcica, the sphenoid sinus, and the suprasellar cistern structures (2). The
cavernous sinus is the most important structure of the parasellar region; it contains cranial
nerves III (oculomotor), IV (trochlear), V1 (ophthalmic division of the trigeminal nerve), V2
(maxillary division of the trigeminal nerve) and VI (abducens). It also includes the cavernous
segment of the internal carotid artery. The suprasellar cistern contains the optic chiasm and
nerves, the anterior third ventricle, the hypothalamus, the pituitary infundibulum and the
infundibular and suprachiasmatic recesses of the third ventricle (2).

Several tumours of different histological nature may arise in the parasellar region or may
infiltrate or metastasize it. Pituitary adenomas are the most common parasellar tumours as
they tend to extend into the parasellar areas. Other benign tumours affecting the parasellar
region include craniopharyngiomas, schwannomas, meningiomas, epidermoid tumours,
dermoid tumours, hamartomas, lipomas, and Rathke’s cyst. Parasellar tumours with
different levels of aggressiveness include chordomas, chondrosarcomas,
hemangiopericytomas, optic or hypothalamic gliomas, whereas malignant lesions are
typically represented by germ cell tumours, primary lymphomas, and brain metastases (1, 3).

The treatment of parasellar tumours is challenging because of their complex anatomical
location and their heterogenous histology. It commonly requires a multimodal approach,
including surgery, radiation therapy, and medical therapy. Surgical treatment is often the
first step as it allows for pathologic analysis and complete or partial tumour removal. Due to
the proximity of critical structures, like blood vessels, optic pathways and cranial nerves, a
successful surgical procedure may often not be achievable due to the high risks related to
the procedure itself (4). Radiation therapy has been usually employed as an adjuvant
treatment in patients with residual or recurrent tumours following surgery or as primary
therapy for those where surgery is contraindicated (1, 4, 5).
In this paper, we provide an overview of different radiation techniques for parasellar
tumours. For convenience, due to the wide published papers about radiotherapy for
pituitary adenomas, we have focused our review on non-adenomatous tumours. Both well-
established and newer indications, results and radiation treatment associated morbidity are
discussed.

Methods and Materials
A literature search was conducted in MEDLINE PubMed that evaluated patient with benign
and malignant parasellar tumours. The MEDLINE and EMBASE databases were searched
using a combination of the following keywords: “parasellar” and “radiation therapy” or
“radiosurgery” or “fractionated stereotactic radiotherapy” or “protons”. Further research
was performed by adding the definitions of different parasellar tumours
(“craniopharyngioma”, “chordoma/chondrosarcoma”, “schwannoma”, “dermoid and
epidermoid tumours”, “hamartomas”, “lipomas”, “Rathke’s cyst” “hemangiopericytomas”,
“optic or hypothalamic gliomas”, “germ cell tumours”, “primary lymphomas”, and “brain
metastases”). The search focused on randomized, prospective and retrospective trials.
Articles were excluded from the review in the following cases: non-English abstract, not
available through PubMed, case studies involving less than ten patients (except for rare
tumours) or duplicated publications. The results of the literature research were used and
included if appropriate.
Radiation techniques

Conventional radiation therapy (CRT) has been traditionally used for residual or recurrent parasellar tumours. It has been reported effective in reducing the rate of local recurrence in many parasellar tumours at a total dose of 45-60 Gray (Gy) using 3-4 coplanar beams delivered in 25-33 fractions (1.6-2.0 Gy per day, five days a week for 5-7 weeks); however, its role has been matter of debate because of the risk of potential long-term toxicity which includes hypopituitarism, radiation-induced optic neuropathy, impairment of neurocognitive function and cranial nerves deficits. In the last decades, radiation techniques have evolved from CRT to 3 dimensional (3-D) conformal and stereotactic techniques, either stereotactic radiosurgery (SRS) or fractionated stereotactic radiotherapy (FSRT) with technical improvements seen in all aspects of radiation treatment, including better immobilization, enhanced imaging, and improvements in planning and dose delivery, resulting in a more precise dose delivery and reduction of normal brain structures irradiated to high radiation doses, such as the optic pathway and the brainstem (6).

SRS, which refers to the delivery of large doses of radiation to small targets, is frequently employed in patients with residual or recurrent parasellar tumours and, more recently, as primary treatment in selected cases when surgery is contraindicated. SRS is usually given in single fraction or, less frequently, in a reduced number of fractions (from 2 to a maximum of 5); in the latter case, it is called hypofractionated stereotactic radiation therapy (SRT) or multisession radiosurgery. The techniques mainly used include Gamma Knife (GK) or a modified linear accelerator (LINAC)-based radiosurgical system.

The GK system consists of an array of 192 or 201 sources of cobalt-60 that align with an inner collimator to direct the resulting photon beams. All the beams converge at a single
point called the isocenter. The dose is typically prescribed at 50% to obtain the maximum
dose at the center of each pinpointed target and minimal dose at target edge. Historically,
GK has been characterized by the application of a stereotactic head frame using four pins
that attach to the skull. The GK Icon, the most recent model, incorporates an onboard cone
beam computed tomography scanner and an infrared intrafraction motion management
system. These two additions allow a thermoplastic mask to be used for immobilization
without the need for an invasive frame (7).
LINAC modified system uses multiple fixed fields or arcs shaped using a multileaf collimator
with a leaf width ranged from 2.5 to 5 mm for shaping the radiation beam to the shape of
tumour and optimal dose distribution can be achieved by modulating leaf movements during
irradiation. Immobilization is usually achieved with the use of more precise mask systems,
with a reported repositioning accuracy of 1-2 mm (8). Combinations of treatment table,
gantry rotations, and collimator rotations are employed to direct the photon beams to the
intracranial target from several directions. As in GK system, the intersecting arcs produce a
high target dose with minimal radiation delivered to the surrounding brain tissue (9). Further
technical advances include the use of orthogonal x-rays (ExacTrac®) and cone beam CT
(CBCT). These are in-room imaging systems that are able to improve patient’s repositioning
accuracy in the treatment room with sub-millimetric accuracy (10-12).
CyberKnife is a relatively new technological device that combines a mobile linear accelerator
mounted on a robotic arm with an image-guided robotic system (13). Patients are fixed in a
thermoplastic mask and the treatment can be delivered as single fraction or multi-fraction
SRS using a variable number of overlapping beams (up to 200), and positioning errors are
corrected by a sophisticated digital X-ray images system achieving similar level of targeting
precision as frame-based SRS (14).
Despite several differences in treatment-related parameters among GK, CK and LINAC, there are no comparative studies demonstrating the clinical superiority of a technique over the others in terms of local control and radiation-induced toxicity for patients with brain tumours. The superiority in terms of dose delivery and distribution for each of these techniques remains a matter of debate.

Particle radiation has been also applied successfully in the treatment of parasellar tumours. Dosimetric characteristics of protons include high dose conformality, better sparing of normal tissue, lower integral dose and no exit dose beyond the target (15). Data on the efficacy of protons in paediatric cancers, ocular melanomas, chordomas and chondrosarcomas are available, with the treatment typically given as conventional fractionation using doses up to 76-78 Gy. Although promising results have been and continue to be reported for many other types of cancers, the small number of patients treated, and the limited follow-up time do not allow for definitive conclusions regarding the superiority of protons over photons.

**Neuroanatomical considerations and risk of radiation-induced toxicity**

Cranial nerves, cavernous sinus and the pituitary gland are among the most important structures at risk of radiation-induced toxicity during radiation treatment for parasellar tumours. The risk following irradiation is influenced by different factors, including the total dose, dose per fraction, number of fractions, and the volume of normal tissue irradiated at high doses. A summary of dose data and clinical risk estimates for skull base structures, based on a combination of clinical observations and reviews, is reported in Table 1 (16-24).

After SRS, a risk of radiation-induced optic neuropathy up to 2% has been reported for doses to the optic pathway less than 8-10 Gy (20); however, the risk remains low for maximum
doses of 10-12 Gy to small portions of the optic pathway. A similar low risk has been reported for maximum doses of 20 Gy in three fractions and 25 Gy in five fractions (20).

This means that the decision of whether to use SRS or FSRT for parasellar tumours is mainly based on the volume of the target lesion and its proximity to sensitive brain structures, e.g. optic pathway; fractionated irradiation is usually preferred over SRS for patients with tumours larger than 3 cm in size and or involving the optic pathways (25). The other nerves enclosed in the parasellar region, like oculomotor nerves and trigeminal nerve, tolerate higher doses. Tishler and co-workers (26) investigated the tolerance of cranial nerves of the cavernous sinus in 29 patients treated by LINAC and 33 patients by GK. Twelve new neuropathies (19.3%) occurred. They concluded that doses up to 40 Gy were relatively safe for nerves in the parasellar region. Although the maximum tolerable dose to the cavernous sinus nerves is unknown, an incidence of radiation-induced toxicity less than 4% has been observed for doses up to 18-20 Gy to the cavernous sinus (4).

Delayed onset of one or more hormonal pituitary deficits is the main side effects of radiation therapy of parasellar tumours, particularly those involving the sella. Several studies have evaluated the relationship between radiation doses to the normal pituitary gland and distal infundibulum, and the development of hypopituitarism. If possible, mean radiation doses to the pituitary gland and stalk should be kept under 15 Gy and 7-10 Gy, respectively, since higher doses have been associated with an incidence of hypopituitarism over 30% at 5 years (6, 27). Although multisession SRS seems represent an effective and safe treatment option for relatively large tumours in close proximity to optic apparatus that are not suitable for single-fraction SRS, larger series with longer follow-up times need to confirm the efficacy and safety of fractionated schedules over other radiation techniques (28). In the respect of the limited follow-up, other complications, such as brain necrosis, second tumours,
cerebrovascular disease, and neurocognitive decline have been rarely reported after stereotactic radiation (22, 29).

Results of radiation treatments in parasellar tumours

Meningiomas

Parasellar meningiomas, usually with benign histopathology (WHO Grade I tumours), may arise from arachnoidal cells of anterior clinoid, tuberculum sellae, diaphragma sellae or inner wing of the sphenoid. Surgical excision is the treatment of choice for accessible parasellar meningiomas; however, complete resection is often not feasible due to the complex anatomy and significant high risks of neurovascular damage. Beyond surgery, radiation therapy, either FSRT or SRS, is frequently used to increase local control after incomplete resection of a large and symptomatic benign meningioma arising at unfavourable locations. In addition, SRS or FSRT have become a primary treatment, alternative to surgical resection, for asymptomatic or mildly symptomatic parasellar meningiomas, like cavernous sinus meningiomas (30-32).

Using postoperative CRT with a dose of 50-55 Gy in 30-33 fractions, local tumour control rates are ranged from 79 to 95% at 5 years (33-36). Recent series report on the use of new radiation techniques for meningiomas (Table 2). In a series of 507 patients with a skull base meningioma who received FSRT (n=376) or IMRT (n=131), Combs and co-workers have observed comparable local control rates of 91% at 10 years for patients with a benign meningioma (37); similar tumour control rates have been observed in other published series (Table 2). Hypopituitarism is reported in 5-15% of patients. Radiation injury to the optic
apparatus, presenting as decreased visual acuity or visual field defects, is reported in 0-3% of irradiated patients. Other cranial deficits are reported in less than 2% of patients (37).

The reported tumour control after proton beam radiotherapy is ranged from 90 to 96% at 5 years, similar to that observed with fractionated photon techniques (Table 2) (38, 39).

The reported actuarial control rates after SRS is in the range of 90-95% at 5 years and 80-90% at 10 and 15 years using a median margin dose to the tumour of 13-15 Gy, with a variable improvement of neurological functions in up to 60% of patients (40-50). The rate of significant complications at doses of 13-15 Gy is less than 10%, being represented by either transient or permanent complications (40, 46). A few studies have reported the use of multisession SRS (2 to 5 daily fractions) for relatively large meningioma close to the anterior optic pathway. Using doses of 21-25 Gy delivered in 3-5 fractions, a few series report a local control of 93-95% at 5 years, and this has been associated with low cranial nerves toxicity (51).

Parasellar atypical meningiomas are rare. Postoperative radiotherapy is recommended for residual tumours after incomplete surgery. Using doses of 55-60 Gy in 30-33 fractions, several studies report a variable median 5-year progression-free survival rates from 40% to 80% and median overall survival rates of 50% to 100% after radiotherapy (52-54). In contrast, the efficacy of postoperative RT versus observation for completely resected atypical meningiomas remains an unresolved question, and conflicting results have been published. The recently closed study ROAM/EORTC 1308 trial (55), including 190 patients randomized to receive early adjuvant fractionated RT or active surveillance, will help answer the important clinical question of the efficacy of RT versus observation following surgical resection of atypical meningiomas.
Craniopharyngioma

Craniopharyngiomas are included among parasellar tumours. Surgery represents the main treatment. Gross total tumour removal is, in fact, associated with the best long-term overall and recurrence-free survival (56, 57). Adjuvant irradiation is frequently employed after subtotal resection or tumour recurrence, providing better long-term tumour control rates at 10 years than surgery alone (58-61). Stripp and co-workers compared 57 patients treated only with subtotal resection to the 18 cases treated with subtotal resection followed by RT, finding a 10-year tumour control rate of 42% after surgery alone and 84% after subtotal resection and radiation (60). In the National Cancer Database, Rao and co-workers confirmed that among 697 patients treated between 2004 and 2012, incomplete surgery followed by radiotherapy was associated with improved survival compared to incomplete surgery alone (62). It is still debated whether radiation should be employed immediately after surgery or at regrowth of the tumour. Some paediatric series indicate that irradiation given immediately after surgery is preferable to radiation therapy at recurrence in terms of reduced morbidity and tumour control (63-65). Different doses between 50 and 60 Gy have been used for fractionated radiation by different authors in both adult and children with craniopharyngiomas (61). New pituitary deficits or a worsening of a partial hypopituitarism represents the most commonly reported late complication of CRT, occurring in 20–60% of irradiated patients after 5–10 years (60, 61, 63, 66-68). The reported incidence of radiation-induced optic neuropathy resulting in visual deficit is 2–8% (61, 64, 69-72). In general, studies reporting on FSRT for craniopharyngiomas have observed low toxicity rates, suggesting that new irradiation techniques could further reduce the toxicity of CRT.

A few case series about proton therapy in craniopharyngioma are available in the medical literature (73, 74). Although local control is comparable with the results of series of FSRT,
protons may represent a better treatment in paediatric patients, possibly limiting potential radiation-induced long-term neurocognitive decline, hypopituitarism, and risk of radiation-induced tumours (61, 75).

Several studies have reported the safety and efficacy of SRS in patients with residual or recurrent craniopharyngiomas after surgery (Table 3) (76-85). In a study of 98 patients treated with SRS, Kobayashi and co-workers reported a 5- and 10-year survival rate of 94.1% and 91% with respective progression-free survival rates of 60.8% and 53.8% at a median follow-up of 65 months (82). Losa and co-workers reported the results of single fraction and multisession GK for craniopharyngioma. With a mean marginal dose ranging from 12 to 14 Gy, 5- and 10-year recurrence-free survival rates were 90.3% and 78.4%, respectively (85).

Late toxicity after SRS includes hypopituitarism and visual deficits, whereas other complications are rare (85). The development of new hypopituitarism is reported between 0 and 38% at 5 years (85, 86). Visual deficits are observed in up to 20% of patients, although most series report lower complication rates (79, 80, 87).

A few studies have investigated the outcomes of multisession SRS in craniopharyngioma (81, 85). In a series of 43 patients treated with single-fraction (14 Gy) or multisession (16-25 Gy in 2-5 fractions) SRS, Iwata and co-workers reported a 3-year tumour control rate of 85% at a median follow-up of 40 months. One patient developed hypopituitarism while no cases of visual deterioration were reported. Although promising, the superiority of multi-fraction SRS in terms of tumour control and long-term toxicity over single-fraction SRS remains to be proven (81, 85).

Chordoma and chondrosarcoma
Chordomas of the parasellar region are rare bone tumours originating from remnants of the notochord with locally aggressive behaviour and high recurrence rates. Postoperative radiation therapy is usually recommended to reduce the risk of local recurrence, even after total resection. Chordomas require high cumulative fractionated radiation doses up to 70-75 Gy, although with increased risks for adjacent neurological structures, e.g. spinal cord, brainstem, and optic pathways. Using CRT at median doses of up to 60 Gy, a few studies report a local control at 5 years in the range of 17–41% (88-91). New radiation techniques, including both IMRT and FSRT, which allow higher doses of radiation to the tumour while sparing more surrounding normal tissue, have been associated with better outcome (Table 4) (92). Using IMRT with a median dose of 76 Gy given in 2 Gy per fraction in 24 patients, Sahgal and co-workers reported a 5-year survival and local control rates of 85.6% and 65.3%, respectively, at a median follow-up of 36 months (92). In another series of 37 patients with skull base chordomas irradiated with FSRT using a median dose of 66.6 Gy, Debus and co-workers observed 5-year overall survival and local control rates of 82% and 50%, respectively, at a median follow-up of 27 months (93). SRS may be valuable for the treatment of small residual or recurrent tumour with a reported local control rates of 21-72% at 5 years (94-98). Complications are reported from 0% to 33%, mainly represented by cranial nerve deficits and brain necrosis; however, serious radiation-related complications are rarely reported. In a multicenter study of the North American Gamma Knife Consortium including 71 patients with small sized chordomas of the skull base treated with GK using a marginal dose of 15 Gy, Kano and co-workers have reported 5-year actuarial overall survival and local control rates of 80% and 66%, respectively (96). At present, surgery followed by proton beam radiotherapy has becoming the standard treatment for skull base chordomas. Several studies have reported the safety and efficacy using doses ranging between 63 and 83
CGE (Cobalt Gray Equivalent) at fractionation of 1.8-2.0 CGE for either adults or children with residual or recurrent chordomas of any size (99-104). In a large study of 169 patients treated with proton beam RT at Massachusetts General Hospital, 5- and 10- year local control rates were 73% and 54%, and respective overall survival rates were 80% and 54%, at a median follow-up of 41 months (100); similar results have been reported in several retrospective studies (103, 104). Late complications have been reported in up to 45% of patients, including visual deterioration (100, 103, 105), pituitary deficits (100, 106, 107), hearing loss (108) and radiation necrosis at the temporal lobe (93, 108, 109). Overall, data from literature support the use of proton beam RT as an effective and safe treatment option for chordomas, although its superiority over photon irradiation in terms of efficacy and toxicity remains matter of debate.

Chondrosarcomas are relatively slow-growing and locally invasive tumours. They are rarely completely resected, similarly to chordomas. Several studies reported higher recurrence rates in patients treated with surgical resection alone than patients who had surgery followed by radiation (110, 111).

Studies using proton radiation reported overall survival and local tumour control rates at 5 years above 90%. Combs and colleagues, in fact, have reported a 5-year progression-free survival of 100% in a series of patients who underwent fractionated proton therapy with doses ranging from 66 to 76 Gy without cranial nerve deficits (112). A similar local control has been observed after postoperative SRS using doses of 15 Gy in patients with small residual tumours (96).

**Rare parasellar tumours**
Rare tumours that appear in the parasellar region may include either benign tumours, e.g. schwannomas, epidermoids, dermoids, hamartomas, lipomas, Rathke’s cyst, or locally aggressive tumours, e.g. hemangiopericytomas, optic/hypothalamic gliomas, or malignant lesions, e.g. germ cell tumours, primary lymphomas, and brain metastases (1). Infiltrative aggressive tumours are typically treated with fractionated RT up to doses of 50-60 Gy, whereas SRS is usually employed for small-to-moderate benign lesions or in the setting of recurrent tumours. A summary of recent selected studies of fractionated RT and SRS for these rare parasellar tumours is shown in Table 5 (113-120).

Conclusion

RT is an effective treatment for incomplete resected parasellar tumours or for those located at inaccessible surgical sites. Both fractionated RT or SRS are associated with a similar local control, and the choice of technique is mainly based on the volume and site of the tumour. In general, fractionated RT is preferred over SRS for large aggressive infiltrative tumours. In the respect of recommended normal tissue dose constrains, the reported radiation toxicity is acceptable. Because of their dosimetric advantages in terms of conformality and reduction of integral radiation dose to normal brain tissue, protons are typically recommended in patients with large aggressive parasellar tumours which require higher doses, such as chordomas and chondrosarcomas. A better understanding of molecular mechanisms underlying tumour progression of different parasellar tumours will help predict which patients will benefit from adjuvant RT.

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Author Contributions

Work and concept were initiated by LA and GM. Literature research and analysis were performed by LA, GM. The manuscript was written by LA, ML, GM. JF and PM critically reviewed the manuscript.
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<td>Park et al., 2018</td>
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<td>Cohen et al., 2018</td>
<td>189</td>
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<td>Snyder et al., 2003</td>
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### Table 3. Summary of selected published studies on radiotherapy for craniopharyngiomas

<table>
<thead>
<tr>
<th>Authors</th>
<th>Patients</th>
<th>Technique</th>
<th>Volume (ml)</th>
<th>Dose (Gy)</th>
<th>Follow-up (months)</th>
<th>Local tumour control (%)</th>
<th>Late toxicity (%)</th>
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<tr>
<td>Regine et al., 1993</td>
<td>58</td>
<td>CRT</td>
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<td>GK</td>
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<td>96 and 91 at 5 and 10 years</td>
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<td>NA</td>
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<td>77 and 66 at 10 and 20 years</td>
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<td>100 at 10 years</td>
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<td>1.6</td>
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<td>68 at last FU</td>
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<tr>
<td>Jimenez et al., 2014</td>
<td>56</td>
<td>PBT</td>
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<td>96 at last FU</td>
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</table>

CRT, conventional radiation therapy; FSRT, fractionated stereotactic radiation therapy; GK, gamma knife radiosurgery; CK, cyberknife radiosurgery; PBT, proton beam radiotherapy; NA, not assessed; FU follow up; Gy, Gray; * range
<table>
<thead>
<tr>
<th>Authors</th>
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<th>Type of RT</th>
<th>Median dose (Gy)</th>
<th>Follow-up (months)</th>
<th>Tumour control (%)</th>
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<td>Watkins et al., 1993</td>
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<td>50-60*</td>
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<td>Catton et al., 1996</td>
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<td>50</td>
<td>62</td>
<td>23 at 5 years</td>
</tr>
<tr>
<td>Debus et al., 1997</td>
<td>37</td>
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<td>66.6</td>
<td>27</td>
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<tr>
<td>Munzenrider et al., 1999</td>
<td>169</td>
<td>PhT/PBT</td>
<td>66-83*</td>
<td>41</td>
<td>73 at 5 years and 54 at 10 years</td>
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<td>Terahara et al., 1999</td>
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<td>41</td>
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<td>Crockard et al., 1999</td>
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<td>51</td>
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<td>Hug et al., 2000</td>
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<td>PBT</td>
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</table>

CRT, conventional radiation therapy; FSRT, fractionated stereotactic radiation therapy; GK, gamma knife radiosurgery; PBT, proton beam radiotherapy; PhT, photon beam radiotherapy; NA, not assessed; FU, follow up; Gy, Gray; * range
### Table 5: Summary of selected published studies on radiotherapy for rare parasellar tumors

<table>
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<tr>
<th>Authors</th>
<th>Type of tumors</th>
<th>Patients</th>
<th>Technique</th>
<th>Volume</th>
<th>Dose (Gy)</th>
<th>Follow-up</th>
<th>Local control</th>
<th>Late toxicity (%)</th>
<th>2016 (%)</th>
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<tr>
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<td>Trigeminal Schwannoma</td>
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<td>GK</td>
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<td>GK</td>
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<td>4.4</td>
<td>12</td>
<td>98</td>
<td>NA</td>
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<td>3</td>
<td>GK</td>
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<td>4.0</td>
<td>12</td>
<td>37.6</td>
<td>100 at 3 years</td>
<td>37</td>
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<td>West et al. 2019</td>
<td>Rathke's cyst</td>
<td>5</td>
<td>GK</td>
<td>5</td>
<td>3.9</td>
<td>12</td>
<td>37.6</td>
<td>100 at 3 years</td>
<td>37</td>
</tr>
<tr>
<td>Combs et al. 2005</td>
<td>Optic/hypophyseal</td>
<td>15</td>
<td>FSTRT</td>
<td>28.3</td>
<td>52.2</td>
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<td>FSTRT</td>
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