Predicaments in Management of Pediatric Cushing’s Disease

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Cushing’s Syndrome (CS): Definition

A syndrome consisting of a large group of symptoms and signs resulting from exposure to prolonged and excessive amounts of either endogenous or exogenous glucocorticoids.

The term *Cushing’s disease* refers to pituitary dependent causes of plasma glucocorticoid excess whereas all other causes of the syndrome are described as “Cushing’s Syndrome”
Cushing’s Syndrome: History

• Harvey Cushing described his first patient with what we now know as “Cushing’s disease”, Minnie G., over a 100 years ago in December of 1910, and although he recognized that she had a distinct clinical syndrome, he had no way of determining what was causing it.

• The function of the pituitary gland was poorly understood at the time—cortisol was not to be isolated and identified for another 40 years.
Harvey Cushing

- He did, however, recognize that the syndrome might be related to the pituitary and included her in his 1912 monograph “The Pituitary Body and Its Disorders”.

- Twenty years later in “The Basophil Adenomas of the Pituitary Body and Their Clinical Manifestations (Pituitary Basophilism),” he described 12 patients, including Minnie G., who had the typical features of Cushing’s syndrome, the general clinical syndrome caused by long-term exposure to excess glucocorticoid levels.

- Most of the patients that he presented in his monograph had died of complications associated with the syndrome, and autopsy had demonstrated small basophilic pituitary tumors.
• However, very little surgery was done for patients with a diagnosis of Cushing’s disease for the next 7 decades.

• It was not until the early 1980s, that pituitary surgery became the initial treatment of choice for patients with Cushing’s disease.
Adrenal cause

• What happened between 1930 and 1980 to persuade the medical and surgical communities that the problem was not in the pituitary?

• Shortly after Cushing’s monograph was published, the focus of determining the presumed basis of the disease became the adrenal.

• Large fraction of patients (9% in Susman’s article and 22% in Costello’s study), had incidental pituitary adenomas at autopsy, many of which were basophilic adenomas and therefore were considered incidental findings rather than the cause of Cushing’s syndrome, and the focus shifted to the adrenal for the next 40 years.
Microsurgery by Hardy: Recognition of Microadenoma

- It was Jules Hardy, shortly after he introduced the operating microscope for pituitary surgery in 1962, who recognized that tumors can also be small and that selective adenomectomy is an effective surgical strategy.
- The following year, he performed the first selective adenomectomy for Cushing’s disease, and that patient is still doing well 48 years later.
- It was the series of patients presented by Hardy at a conference on the diagnosis and treatment of pituitary tumors at the National Institutes of Health in 1973 and subsequent publications of series of patients by Hardy, Salassa and Tyrrell et al that persuaded the medical and surgical communities that the source of the disorder was the pituitary gland, and only after that did neurosurgeons became regular participants in the treatment of patients with Cushing’s disease.
Cushing’s Syndrome: Diagnosis (Step 1)
Who should be tested for hypercortisolism?

- Patients with clinical features suggestive of CS
- Patients with unusual features for age: osteoporosis, hypertension
- Children with growth retardation and increased weight
- Patients with incidentally discovered adrenal tumors (incidentalomas)
- Patients with metabolic syndrome, hypogonadotropin hypogonadism and Polycystic ovarian syndrome

• Nieman LK; et. al. The diagnosis of Cushing’s Syndrome: An Endocrine Society Clinical Practice Guideline. JCEM 2008;93(5):1526-1540
• Findling JW; et. al. Screening and Diagnosis of Cushing’s Syndrome. Endocrinol Metab Clin N Am 34 (2005): 385-402
CASE –

- 11 yr old with weight gain and no gain in height
Cushings Syndrome (CS) is a disorder caused by dysfunction of the hypothalamus-pituitary-adrenal axis (HPAA).

Endogenous CS is most common due to an ACTH secreting pituitary adenoma i.e. Cushing's Disease (CD).

It poses a serious diagnostic and therapeutic challenge due to the complexity in identifying and localizing the lesion when the young age group involved.

Ref 1 - Newell-Price J et al
Cushing's syndrome.
Lancet. 2006;367:1605-1617
Cushing’s Syndrome: Diagnosis

The diagnosis of CS is made in two steps:

1. Establish the presence of CS (hypercortisolism)
2. Determine the source of excessive cortisol secretion
Non-invasive methods of differentiating between pituitary and ectopic source of raised ACTH include -

- High-dose dexamethasone suppression test which is considered the primary noninvasive diagnostic test
- CRH stimulation test
- Urinary cortisol levels
- Cross sectional imaging
High-dose dexamethasone suppresses pituitary secretion of ACTH but not the ectopic ACTH sources. Sensitivity and specificity is only 60%–80% [1].

CRH administration induces majority of the pituitary tumors to increase ACTH secretion. However, many ectopic ACTH-secreting tumors also respond to this stimulation.

The detection rate of pituitary adenomas for pediatric CD varies from 52% to 75% on CT and/or MR scans [2].

Because of the high prevalence of nonfunctioning pituitary incidentalomas (10-20 %) [3], finding of a pituitary lesion on imaging does not definitively diagnose CD.


Hormonal profile

1. High Cortisol levels: 19.9 (5-23 Mcgms/dl)
2. High ACTH levels: 131 (9-52 Pcgma/dl)
3. Petrosal venous sampling:
   Rt. Pituitary location
Cushing’s Syndrome: Treatment

Surgical treatment is primarily recommended for patients with endogenous CS

- Transphenoidal pituitary resection for pituitary dependent causes.
- Unilateral adrenalectomy for adrenal adenoma
- Bilateral adrenalectomy for failed pituitary surgery
- Resection of tumors for EAS or bilateral adrenalectomy for palliation

Persistent and recurrent hypercorticolism have the following options:

- Repeat Surgery
- Radiation Therapy
- Medical Therapy

- Bilateral adrenalectomy- Risk of development of Nelson’s syndrome (concomitant pituitary macroadenoma, high plasma ACTH levels with resultant skin pigmentation.)
Comparisons in the epidemiology, diagnostic features and cure rate by transsphenoidal surgery between paediatric and adult-onset Cushing's disease


OBJECTIVE:

There are few published comparisons between paediatric and adult-onset Cushing's disease (CD). We compare the epidemiology, diagnostic features and cure rate by transsphenoidal surgery (TSS).

DESIGN:

Retrospective review of patient databases in a single university hospital centre.

Totally, 41 paediatric (mean age 12.3 ± 3.5 years; range 5.7-17.8) and 183 adult (mean age 40 ± 13 years; range 18.0-95.0) patients with CD were investigated.

RESULTS:

Paediatric CD was characterised by male (63%) and adult CD by a female predominance (79%, P<0.0001).

There were small but significant differences in clinical presentation.

Biochemical features of CD were comparable except the serum cortisol increase during a CRH test: mean change (105%, n=39) in paediatric and (54%, n=123) in adult subjects (P<0.0001).

Macroadenomas were more common in adult (15%, 28/183) than in paediatric (2%, 1/41, P=0.04) CD. Corticotroph microadenomas were more easily visualised by pituitary magnetic resonance imaging (MRI) in adult (76%, 50/66) compared with paediatric (55%, 21/38, P=0.045) CD with poorer concordance of imaging with surgical findings in children (P=0.058).

The incidence of ACTH lateralisation by bilateral simultaneous inferior petrosal sinus sampling was comparable in paediatric (76%, 25/33) and adult (79%, 46/58; P=0.95) patients with good surgical concordance in both (82% paediatric and 79% adult). Cure rates by TSS were comparable, with a paediatric cure rate of 69%.

CONCLUSION:

Several features of paediatric CD are distinct: increased frequency of prepubertal CD in males, the different clinical presentation, the decreased presence of macroadenomas and the frequent absence of radiological evidence of an adenoma on MRI.
DESIGN: Prospective observational study of 200 pediatric CD pts to examine features influencing outcome of surgery treated at the National Institutes of Health (NIH) from 1982 through 2010.

RESULTS: Mean age at symptom development was 10.6 ± 3.6 years. MRI identified adenomas in 97 patients (50%). MRI accurately defined a discrete adenoma in 96 of the 97 patients (99%), which was more accurate than IPSS laterlaization (accurate in 72% of patients without prior surgery). A total of 195 of the 200 patients (98%) achieved remission after surgery. Factors associated with initial remission (P < .05) included identification of an adenoma at surgery, immunohistochemical ACTH-producing adenoma, and noninvasive ACTH adenoma. Younger age, smaller adenoma, and absence of cavernous sinus wall or other dural invasion were associated with long-term remission (P < .05). A minimum morning serum cortisol of less than 1 μg/dl after surgery had a positive predictive value for lasting remission of 96%.

CONCLUSIONS: Resection of pituitary adenomas in pediatric CD in tertiary setting can be safe, effective, and durable. Early diagnosis and early postoperative endocrine testing predicts lasting remission.
Pediatric pituitary resection: characterizing surgical approaches and complications.
Hanba C, Svider PF et al. (Wayne State University – Michigan)

- **DESIGN:** The Kids’ Inpatient-Database files (2009/2012) were evaluated for pituitary gland excisions.

- **RESULTS:** 1071 cases were analyzed; the majority (77.6%) underwent transsphenoidal resections. These patients had significantly decreased hospital costs and lengths of stay. Patients undergoing transfrontal approaches had significantly greater rates of postoperative diabetes insipidus (DI) (66.5%), panhypopituitarism (38.8%), hydrocephalus, and visual deficits. Among transsphenoidal patients, males had greater rates of postoperative hydrocephalus (5.5%) and panhypopituitarism (17.5%) than females, and patients ≤10 years old had greater rates of these 2 complications (14.5%, 19.4%, respectively) as well as DI (61.3%).

- **CONCLUSION:** A greater proportion of children undergo transfrontal approaches for pituitary lesions than in their adult counterparts. Patients undergoing transfrontal procedures have greater risks for many intraoperative and postoperative complications relative to individuals undergoing transsphenoidal resections. These data reinforce the need for greater vigilance in the postoperative care of younger children undergoing transsphenoidal surgery.
**DESIGN:** Retrospective analysis of 25 pediatric cushings disease patients who underwent Transsphenoidal surgery during a 20 year period. BIPSS was performed in 19 patients (76%), with successful lateralization of the microadenoma in 14. Surgical removal was via the sublabial, paraseptal, transsphenoidal route.

**RESULTS:** Mean age of 13.4 years. Weight gain was the most common presentation (100%), and then growth impairment (96%). Postoperative complications included growth hormone deficiency (36%), transient diabetes insipidus (12%), panhypopituitarism (4%), and transient CSF rhinorrhea (4%). The median follow-up period was 59.5 months. Overall, 15 patients (60%) achieved surgical cure or remission. Ten patients (40%) required postoperative radiotherapy to achieve “remission.”

**CONCLUSION:** Cushing's disease in children and adolescents is a rare illness. In this series, BIPSS was far more accurate in localizing the adenoma than CT/MRI. Transsphenoidal surgery was safe and efficacious in achieving cure in the majority of cases. The challenge of transsphenoidal surgery in this age group is the small pituitary fossa and the absence of sphenoid sinus aeration in some cases. We found the use of intraoperative neuronavigation to be an excellent aid in overcoming such anatomic difficulties.
Surgical management of pediatric Cushing’s disease: an analysis of 15 consecutive cases at Hospital of Clinics of Ribeirão Preto, University of São Paulo (1982-2006)
Ricardo Santos de Oliveira

**DESIGN:** Retrospective study of 15 consecutive pediatric Cushing’s disease (mean age: 13 years) evaluated from 1982 to 2006. Considered cured when there was clinical adrenal insufficiency and serum cortisol levels were below 1.8 μg/dL after one, two, three, or seven days following surgery. Follow-up was for a median time of 11.5 years.

**RESULTS:** Clinical and biochemical cure was achieved in 9/15 patients (60%) exclusively after Transsphenoidal surgery. Hypopituitarism was observed in four patients; growth hormone deficiency, in two; permanent diabetes insipidus, in one case.

**Conclusions:** Transsphenoidal surgery is an effective and safe treatment in most of these patients. Plasma cortisol level < 1.8 μg/dL following surgery is the treatment goal and is a good predictive factor for long-term cure.
METHODS: 10 patients with Microadenoma seen in 5, macroadenoma in 3, and normal gland in 2 patients of median age 15 years. IPPS was also carried out and confirmed pituitary adenoma as source of ACTH in 2 patients. Adopted sublabial transsphenoidal (n = 9) or pterional transylvian route (n = 1) in macroadenoma. Serum cortisol level <50 nmol/L was taken as the criteria for biochemical remission.

RESULTS: Clinical remission was achieved in 7 of 10 operated patients. Remission was achieved in both patients with postoperative BSC less than 50 nmol/L and in 3 of 6 with elevated levels. Three patients had neither clinical nor biochemical remission: 2 underwent bilateral adrenalectomy and 1 received radiotherapy. Among 7 patients who initially remitted (median follow-up of 82 months), recurrence occurred in 3 patients after a median interval of 5 years.

Conclusions: In children with CD, endocrinial manifestations are more frequent than visual symptoms. Transsphenoidal route is the preferred approach, but a nonpneumatised sphenoid sinus may be present. Surgery is the first line of treatment, but constant monitoring is mandatory to pick up the relapsed cases.
Transsphenoidal surgery is a safe and effective first choice treatment for the management of CD.

However, some peculiarities are observed in the pediatric population.

Since children have smaller nasal apertures, the sublabial route provided a wider corridor to access the sellar region than the direct transnasal rhinoseptal approach;

Care should be taken not to open the blades of Hardy’s nasal speculum too wide within the sphenoid sinus, because the chances of injuring the carotid artery are greater in children, due to the thin surrounding bones and the narrower sphenoid sinus.

During sellar dural opening, especially in microadenomas, care should be taken not to injure the intercavernous sinuses at the anterior and posterior sellar dural limits or the cavernous sinuses laterally.
Normalization of ACTH and Cortisol levels
CASE -

- A 16-year old male presented with symptoms of Increase in weight and striae over abdomen
- Signs suggestive of Cushing’s disease
- with ↑ serum ACTH and serum cortisol levels
ACTH 84, ? 2 MICROADENOMAS

MRI with double micro adenomas (noncontrast enhancing)
Post Operative MRI after complete excision of both adenomas
A 12 year old girl presented with complaints of marked weight gain and intermittent headache since 2 years.

Her weight on admission was 88 kg.

Headache had increased in severity in the last 10 days.
EXAMINATION-

- On general examination, the child was obese with a moon face and showing presence of striae and acanthosis nigricans on neck & chest.
- Her visual and Rest of the neurological examination was normal
- USG Abdomen – Bilateral polycystic ovarian disease with fatty liver.
BIOCHEMISTRY & HORMONAL PROFILE

- Cortisol = 6.10 (8 am)
- Cortisol = 16.59 (4 pm)
- Prolactin = 1.13
- LH = 2.31
- FSH = 3.09
- FT3 = 0.294
- FT4 = 1.34
- TSH = 0.842
- Cholesterol = 127
- Estradiol = 26

ACTH (26.7.16) = 163
ACTH (5.8.16) = 81.90
Sodium = 141
Potassium = 3.9
T1 Coronal (03-06-16)
T1 Coronal + Contrast (03-06-16)
T2 Coronal (22.07.16)
IPSS was introduced in 1977 by Corrigan et al.

Doppman et al (1984) suggested simultaneous sampling from both inferior petrosal sinuses to avoid false-negative results. This procedure was termed bilateral inferior petrosal sinus sampling (BIPSS).¹

In a meta-analysis of 21 studies, the overall sensitivity and specificity of BIPSS were found to be 96% and 100% respectively.²

False negative results occur when there is aberrant pituitary venous drainage viz. hypoplastic IPS or incorrect BIPSS technique (inability to cannulate or dislodgement).

False positive results occur in cases of absence of suppression by normal corticotrophs, bilateral adrenalectomy, cyclical cushings syndrome


Pituitary gland --- hypophyseal veins --- plexiform venous network --- cavernous sinus
The cavernous sinus --- SPS posteriorly and superiorly, & the IPS posteriorly and inferiorly.
The IPS --- IJV after passing through the anterior jugular foramen. The IPS is the vein most proximal to the pituitary gland that can safely accommodate a microcatheter. Here, dilution due to anterior condylar vein (ACV) is minimized.
Inferior petrosal sinus sampling in the differential diagnosis of Cushing's syndrome: results of an Italian multicenter study.

**DESIGN:** Retrospective study of the diagnostic accuracy of basal and post corticotropin-releasing hormone (CRH) IPSS, MRI & CT in distinguishing pituitary from ectopic ACTH secretion in 97 Cushing's syndrome patients: 74 with Cushing's disease (CD) and 10 with ectopic ACTH secretion (EAS).

**RESULTS:** The basal ACTH IPS:P ratio was > or = 2 in 63/74 patients with CD (85%), and in 1/10 EAS patients (10%); The basal ACTH IPS:P ratio had a diagnostic accuracy of 86%. The sensitivity & diagnostic accuracy of IPSS was significantly higher than MRI(50%) & CT(40%).

IPSS was less reliable in identifying the adenoma site found at surgery than MRI or CT(65% vs 75% and 79%).

**CONCLUSION:** IPSS improved the diagnostic performance of imaging techniques. It can help in excluding transsphenoidal surgery in EAS patients.
Inferior Petrosal Sinus Sampling

- Normal ACTH Range = < 46 pg/ml

<table>
<thead>
<tr>
<th></th>
<th>IPSS (pg/ml)</th>
<th>PERIPHERAL (pg/ml)</th>
<th>IPSS/PERIPHERAL Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>RIGHT</td>
<td>&gt;1250</td>
<td>131</td>
<td>9.54</td>
</tr>
<tr>
<td>LEFT</td>
<td>221</td>
<td>70.70</td>
<td>3.12</td>
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- The diagnosis of **Cushings Disease is confirmed by a baseline IPSS/Peripheral ratio ≥2** or CRH-stimulated IPSS/Peripheral ratio ≥3.\(^1\)

The hypoplastic inferior petrosal sinus: a potential source of false-negative results in petrosal sampling for Cushing's disease.

**DESIGN:** 501 patients with surgically proven Cushing's disease and negative or equivocal MRI of the pituitary gland underwent IPSS.

**RESULTS:** 4 patients with false-negative results of petrosal sampling demonstrated a hypoplastic or plexiform inferior petrosal sinus ipsilateral to an ACTH-secreting microadenoma.

**CONCLUSIONS:** Presence of an unilateral hypoplastic or plexiform inferior petrosal sinus can result in anomalous drainage from the pituitary gland that may lead to false lateralization to opposite side.
THE LATERALIZATION ACCURACY OF INFERIOR PETROSAL SINUS SAMPLING IN 501 PATIENTS WITH CUSHING’S DISEASE.


**DESIGN:** 501 consecutive patients with confirmed ACTH adenomas and IPSS were studied to determine accuracy of IPSS in lateralization.

**RESULTS:** IPSS correctly predicted the side of the pituitary gland that contained the tumor in 273 patients (69%), whereas the tumor was located contralaterally in 123 patients (31%).

The higher frequency of right-sided predicted lateralization and the higher accuracy in left-sided predicted lateralization may be a factor of more frequent right-sided dominance of venous drainage from the pituitary.

**CONCLUSIONS:** Lateralization of ACTH to 1 side cannot be used to guide hemihypophysectomy because this series demonstrates that 31% of patients would harbor an untreated ACTH-secreting adenoma within the remaining gland if it were left unexplored.
Venous angiography is needed to interpret inferior petrosal sinus and cavernous sinus sampling data for lateralizing adrenocorticotropicin-secreting adenomas.

**J Clin Endocrinol Metab. 1996;81:475–481**

► **DESIGN:** 23 consecutive patients with Cushing's disease who underwent venous angiography of the cavernous and inferior petrosal sinuses followed by bilateral simultaneous venous sampling of ACTH

► **RESULTS:** Venous drainage was bilaterally symmetric in 14 patients (61%) and asymmetric in 9 (39%). The most common asymmetric pattern (6 patients) was for blood from both cavernous sinuses to drain into the right inferior petrosal sinus

► IPSS in all 23 patients correctly lateralized the tumor in 12 cases of symmetric drainage, but in only 4 cases of asymmetric drainage. **Overall, venous sampling correctly lateralized 70% of the tumors.**

► Incorrect lateralization in cases of asymmetric venous drainage is probably attributable to shunting of blood toward the side of dominant venous drainage.

► **CONCLUSIONS:** Illustrate the need for venography in all patients undergoing venous sampling of ACTH for an understanding of the venous drainage patterns
Pituitary gland does not behave as right and left half either anatomically or functionally.

Dichotomy in lateralization between imaging and IPSS can be explained by intercavernous venous mixing &/or dominant pituitary venous drainage (40% healthy individuals).

Another plausible explanation is the presence of epicenter of lesion on one side with extension to contralateral side.

Rarely there may be a double adenoma. The one visualized on imaging may be an incidentaloma and the functional non visualized one may be responsible for the gradient on IPSS.
PERIMETRY –

Right eye

Left eye
Trans-sphenoidal endoscopic excision of left pituitary adenoma along with right hemihypophysectomy done under navigation.

Intraoperatively necrotic (liquefied) tumour tissue oozed out on making incision in left half of the gland. Further tissue was removed from the left cavernous sinus medial wall and later hemihypophysectomy was done on the right side. Pituitary gland was fibrotic and atrophied.

Bilateral samples sent for HP evaluation.
Post operative Cortisol levels were within normal limits and she was started on tab hydrocortisone 2.5 mg three times a day.
Will my child lead a normal life after treatment for CS?

- Various studies report that one year after surgical cure of CS most children had lost weight and body mass and their height and growth velocity had increased; however final adult height is often impaired (by at least an inch or more).

- Risk factors associated with TSS for removal of a pituitary adenoma include temporary or permanent dysfunction of the pituitary gland. Therefore, it is important for the child and adolescent to be monitored on a routine basis by a pediatric endocrinologist to screen for any problem with pituitary gland function, including hypothyroidism, adrenal insufficiency, growth hormone insufficiency, pubertal delay. After TSS for CS, daily cortisol replacement is necessary, typically for a period of six to eighteen months, until the hypothalamic-pituitary-adrenal axis (HPA) recovers. Many children often experience some symptoms of steroid withdrawal during this period (e.g. fatigue, headache).
Will my child lead a normal life after treatment for CS?

Most children and adolescents who are recovering from CS are able to resume normal physical activities within several weeks to months.

Many children and adolescents recovering from CS experience changes in cognitive performance that can be stressful for both the child and the parents. The brain is affected by prolonged exposure to abnormally high cortisol levels and once the cortisol levels are normalized there is a period of readjustment. Symptoms reported by some children and adolescents include difficulty concentrating and problems with memory that may affect their academic performance for an indeterminate period.

It is important to provide appropriate educational and psychological resources for the child or adolescent during this period.
Persistent or recurrent adenoma after previous surgery with excision of an adenoma is invariably located at, or immediately contiguous to, the site of the adenoma at the original surgery, indicating that recurrence of Cushing’s disease is from growth of residual cells left in situ at the original surgery and that, at repeat exploration, the site occupied by the original tumor should be the focus of the exploration.

Lateral dural invasion involving the wall of the cavernous sinus accounts for the great majority of patients who have persistent or recurrent Cushing’s disease.

Oldfield E, Clin Neurosurg 2011
American Association of clinical endocrinologists (AACE) recommendations

- Medical therapy has been considered a transient and palliative treatment.
- Adrenal blocking agents
  - Inhibitors of Adrenal Steroidogenesis: Metyrapone Ketoconazole Aminoglutethemide
  - Adrenolytic: Mitotane
- Neuromodulatory Drugs
  - (dopamine agonist): Bromocriptine Cabergoline

*Medical therapy to lower cortisol using metyrapone or ketoconazole is a useful short-term option prior to surgery or radiotherapy but cannot be recommended as a long-term definitive therapy for CD.*
- **Bilateral adrenalectomy** has long been considered the treatment of choice for CD in childhood.

- Nowadays, it still has a role, but should be reserved for patients in whom surgery and radiotherapy fail to stop the secretion of ACTH from the pituitary adenoma.

- Although adrenalectomy is the only treatment that offers an immediate control of hypercortisolism with 100% certainty, it is necessary to consider its side effects, including potential adrenal insufficiency crisis.

- Therefore, lifelong need for glucocorticoid and mineralocorticoid replacement therapy, hyperpigmentation, elevated ACTH levels, and an enlarged sella turcica attributable to Nelson’s syndrome have been described in 12 to 67% of cases (1,2)


Pituitary radiotherapy is effective for the treatment of CD, but it is only used on patients with persisting disease after surgery.

Growth hormone deficiency seems to be an unavoidable complication after treatment with radiotherapy.

It has also been reported that high-precision stereotactic radiosurgery (1) and gamma knife surgery (2) can effectively treat persistent or recurrent CD following TSS.


LGK for Residual/Recurrent tumor

30 Gy at 50% isodose to cavernous sinus component
25 Gy at 50% isodose to remaining area
Thanks
Welcome to AASPN 2017
24-26 March in Mumbai, India