Abstract
Pituitary adenomas are common, benign tumours, that can be classified in many ways including their functionality, size and anatomical extension. Historically, larger more invasive adenomas with extension into parasellar regions were deemed untreatable. However, with increasing operative sophistication, and more precise and effective radiation options; it is no longer the case, and therefore it becomes even more important for a comprehensive classification system for these tumours. Herein, the authors present an updated review on the available classification systems for large pituitary adenomas, based on their anatomic extension and invasion of adjacent anatomic structures.

Keywords: Pituitary adenoma, sellartumour, brain tumour.

Introduction
Pituitary adenomas are benign monoclonal pituitary tumours accounting for 91% of sellar and parasellar masses and 10-15% of all intracranial tumours. Microadenoma is defined as intra-sellar tumour with size less than 10 mm in maximum diameter, and macroadenoma with size greater than 10 mm in diameter. Giant pituitary tumours as defined by Symon et al., are tumours having an extension of more than 40 mm from the midline of the jugum sphenoidale. Although histologically benign, the invasion of important anatomic structures causes a variety of symptoms depending on the structures involved. Invasion of adjacent structures also makes its surgical resection challenging, and with high morbidity. The current review highlights how different authors have tried to classify pituitary adenomas on the basis of its extent and invasion of critical anatomic structures.

Review Of Evidence
The earliest account of pituitary adenoma extending into supra-sellar and para-sellar regions was elucidated by Jefferson et al., in 1940 and 1955, and earliest anatomic classification of intra-sellar, supra-sellar and para-sellar extension of pituitary adenoma was proposed by Hardy et al., in 1976 which they later modified in 1990. Hardy’s grading of supra-sellar extension (SSE) is such that grade A is within 10 mm above the jugum sphenoidale, filling the chiasmatic cistern, grade B is up to 20 mm, elevating the anterior recess of the third ventricle, grade C is defined up to 30 mm, filling the anterior third ventricle and grade D greater than 30 mm, above the level of foramina of Monro, or grade E with asymmetrical lateral or multiple expansions. Hardy et al., considered “giant” as those adenomas with SSE upto or more than 30 mm, with the superior margin more than 20 mm above the jugum sphenoidale, regardless of the volume of the intrasellar tumour portion. The classification considered the invasion of sella turcica, grade 1 was when the sella was mildly enlarged and asymmetrical, grade 2 and 3 were when the sella was significantly enlarged, and showing local destruction of floor, whereas grade 4 was when the sella was diffusely destroyed.

Goel et al., published a series based on his experience of 118 patients of pituitary adenoma in which he graded the tumours into four grades. Grade 1 tumours remained within the confines of sellar dura and below the diaphragma sellae and did not enter into the cavernous sinus. Grade 2 tumours showed violation of the medial wall and invaded the cavernous sinus. Grade 3 tumours showed advancement via the dura of the cavernous sinus into the various compartments of the brain. Grade 4 was when the tumour extended superior to diaphragma sellae in the subarachnoid space. Majority of the cases in his series (54 out of 118) were grade 1, followed by grade 2 (38), grade 3 (24) and grade 4, (2 cases); and most of his patients underwent microscopic trans-sphenoidal resection. Gross total resection was achieved in 52% cases in grade 1 tumors.

Knosp et al., published his series of 25 cases of pituitary adenomas invading the cavernous sinus space. Knosp classification is based on MRI (Magnetic Resonance Imaging) and classifies parasellar growth into various grades. Grade 0 showed normal findings within the
cavernous sinus space, with the tumour not encroaching the medial tangent of the supra-cavernous or intra-cavernous internal carotid artery. In Grade 1, the medial tangent of supra and intra-cavernous internal carotid artery (ICA) is passed, but the extension does not go beyond the inter-carotid line which is the line drawn between centers of the intra and supra-cavernous ICA. In grade 2, the tumour extends beyond the inter-carotid line, but does not cross the tangent on the lateral aspects of the intra- and supra-cavernous ICA. In grade 3, the tumour extends lateral to the lateral tangent of the intra and supra-cavernous ICA. In grade 4 the tumour shows total encasement of the intra-cavernous ICA. Mooney et al., conducted a study to determine the inter-rater and intra-rater reliability for Knosp score, and concluded that although the inter-rater reliability of grade 3 and 4 tumours were strong, the reliability of grade 1 and 2 were weak. The intra-rater reliability was moderate to strong, and improved with the level of experience.

The SIPAP classification combined Hardy and Knosp classifications to develop a grading system which considered extension in all directions. While it offers a quality work describing the spread of the tumour to give an idea to the surgeon regarding the difficulty of the surgery, the complex numbering system makes it difficult to use with no clear correlation between grading and extent of resection that has been shown. Wang et al., suggested a 3-dimentional model for pituitary adenoma and classified them into intra-sellar (13.8%), supra-sellar (20.7%), infra-sellar (17.2%), and lobulated adenomas (48.3%).

Understandably, except for the earlier classifications, most of the popular anatomy based classifications of pituitary adenoma are based on imaging. With the development of better microscopic and endoscopic technology, it may be a good idea to develop classification systems based on actual intra-operative findings. Ceylan et al., recently shared their 20 years experience of 1849 patients of pituitary adenomas with cavernous sinus invasion. They proposed an intra-operative endoscope based classification describing cavernous sinus invasion. Four compartments were described, superior, lateral, antero-inferior and posterior and cavernous sinus invasion was proposed to take place via two corridors, medial and lateral. The authors suggested endoscopic trans-sellar approach for tumour invasion in all compartments except lateral compartment for which they preferred trans-pterygoid para-sellar approach. The authors achieved gross total resection in 54.3% and near total resection in 21.8% of the cases.

Conclusion
Various grading systems for large pituitary adenomas exist, which characterize the tumour according to its...
anatomic extent and invasion.

References