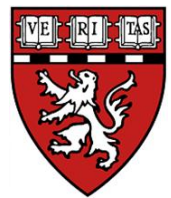# Pituitary Adenoma Segmentation Using the Medical Image Computing Platform 3D Slicer

Jan Egger, Ph.D., Ph.D.[a,b,c], Tina Kapur, Ph.D.[a], Christopher Nimsky, M.D., Ph.D.[c], and Ron Kikinis, M.D.

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Purpose

Tumors of the sellar region, mainly pituitary adenomas, represent 10% to 25% of all intracranial neoplasms, with adenomas comprising the largest portion with an estimated prevalence of approximately 17% [1, 2]. These adenomas can be classified according to many criteria including size, histological characteristics, and hormone secretion (hormone active and hormone-inactive). Microadenomas are less than 1 cm in diameter, whereas macroadenomas measure more than 1 cm. Typically for macroadenomas with mass-effect, transsphenoidal surgery is the treatment of choice [3]. By contrast, hormone-inactive microadenomas are closely monitored using endocrine and ophthalmological evaluations as well as magnetic resonance imaging (MRI). Microsurgical excision is performed if the tumor volume increases over time. Image analysis that includes segmentation and registration of these successive scans is beneficial in the accurate measurement of tumor progression.

Methods

We performed segmentation of pituitary adenomas on T1- and T2-weighted images acquired on a MAGNETOM Sonata 1.5 T MRI scanner (Siemens Medical Solutions, Erlangen, Germany) equipped with a standard head coil. The segmentation method we used is the GrowCut implementation [4] in 3D Slicer (or Slicer) which is freely downloadable from the website http://www.slicer.org. GrowCut [5] is an interactive segmentation algorithm based on the idea of cellular automata. The algorithm achieves reliable and fast segmentation of moderately difficult objects in 2D and 3D using an iterative labeling procedure resembling competitive region growing. After trial of the various segmentation facilities available in Slicer, we determined that the use of GrowCut by initializing it on sagittal, axial, and coronal

Figure 1

cross-sections provides the most efficient segmentations. In this initialization step, parts of the tumor and parts of the backg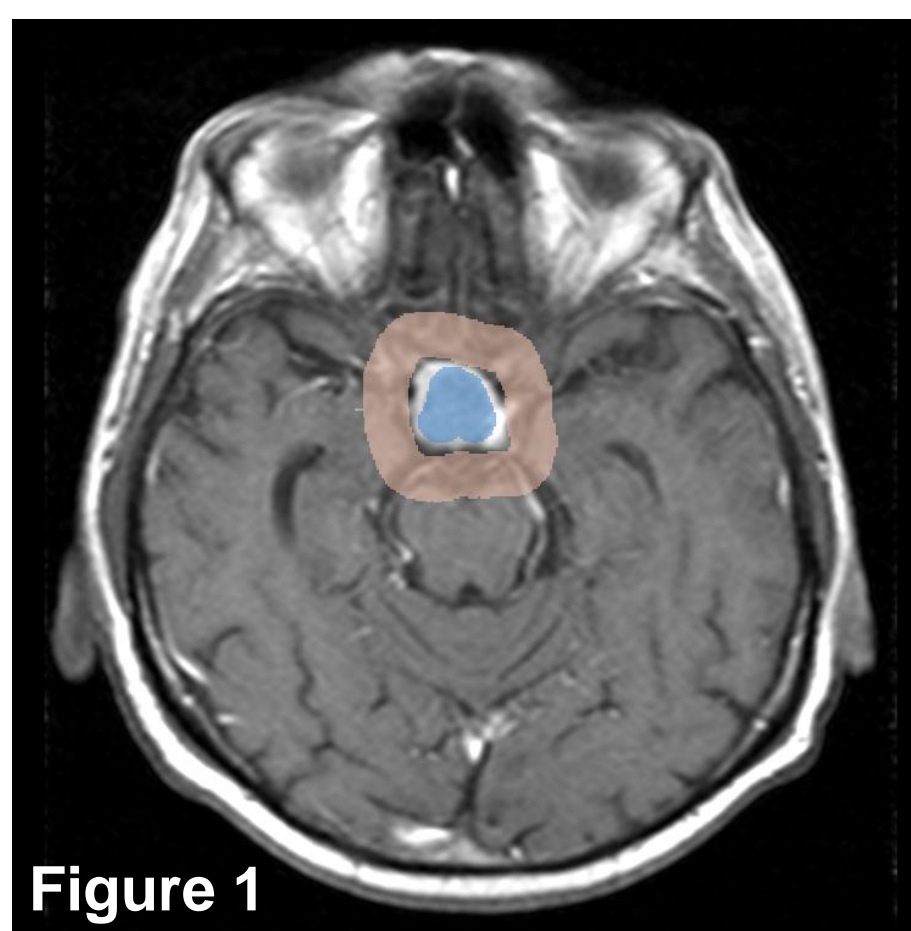round are marked on the image with the Slicer brush tool. Figure 1 shows a typical initialization of a pituitary adenoma (blue) and the background (brown) on an axial slice.

Results

The goal of this study was to evaluate the utility of Slicer for segmentation of pituitary adenomas. To evaluate the utility of Slicer, ground truth was provided by manual slice-by-slice segmentation of five pituitary adenomas by neurological surgeons with several years of experience in resection of pituitary adenomas. These manual segmentations were compared with the Slicer segmentation results of the proposed method via the Dice Similarity Coefficient (DSC) [6]. Briefly, the DSC measures the relative volume overlap between M and S, where M and S are the binary masks from the manual slice-by-slice (M) and the Slicer (S) segmentation. The average DSC for all data sets was 81.71%±4.78% and shows that the two are comparable. Figure 2 present segmentation results on a sagittal (upper row) and an axial (lower row) slice for the manual segmentation (middle images, yellow) and the Slicer segmentation (right images, magenta).

Figure 2
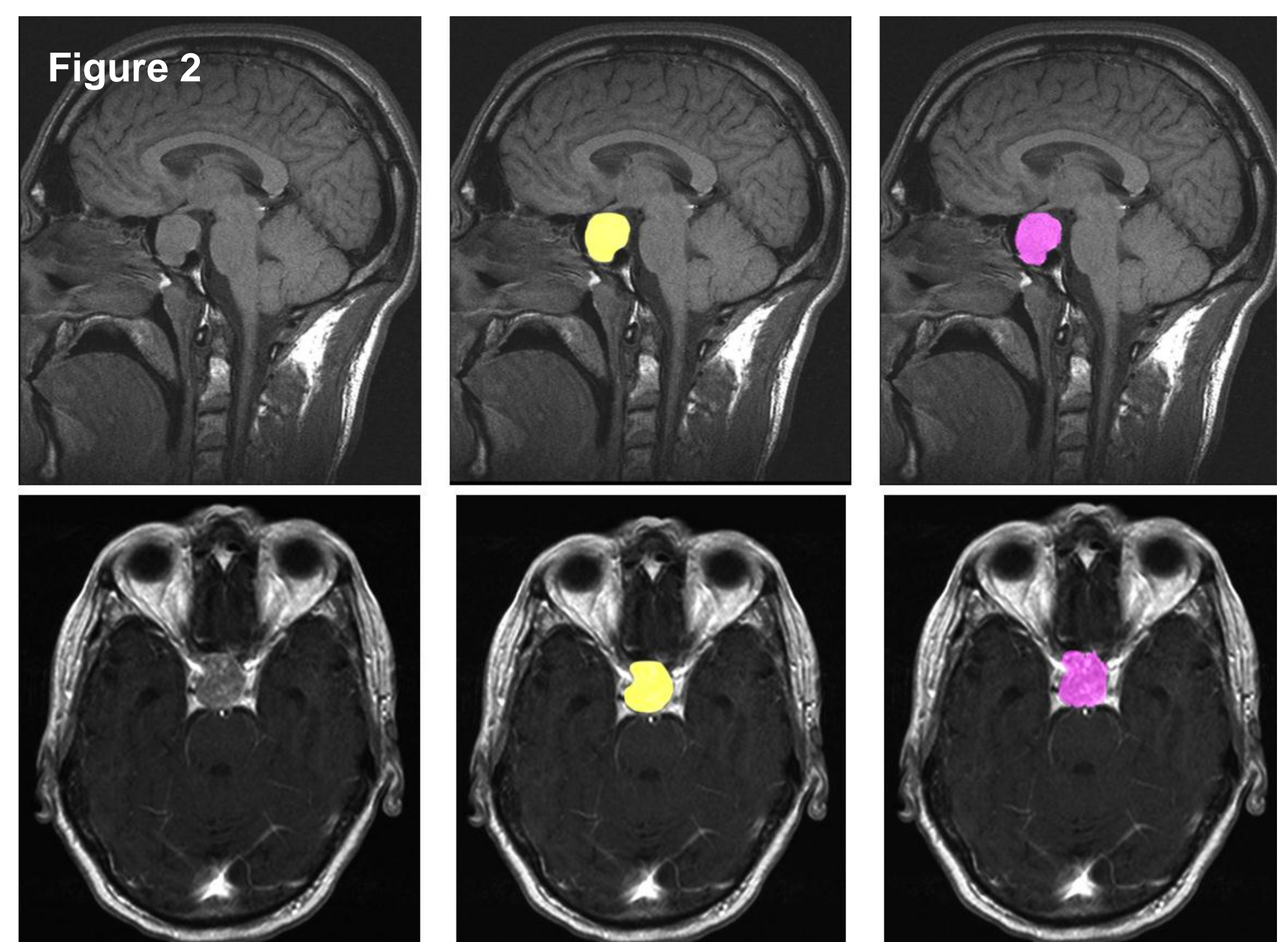
Conclusion

In this contribution, we present segmentation results for pituitary adenoma in MRI data using the medical platform 3D Slicer and showed that it is valuable to support the time-consuming process of volumetric assessment. The time and user effort required for GrowCut segmentation was on an average 50% compared to pure manual segmentation. There are several areas of future work including comparison with graph-based based segmentation methods such as [7, 8].

References

1. http://www.cancer.gov/cancertopics/pdq/treatment/pituitary/HealthProfessional/page1/AllPages#1 (last accessed: July 2012)
2. M.- A. Weber, et al., Sellar tumors (in German), Der Radiologe; 47(6):492-500. Springer Berlin / Heidelberg, 2007.
3. M. Buchfelder and S. Schlaffer, Surgical treatment of pituitary tumours, Best Pract Res Clin Endocrinol Metabol; 23(5):677-92, 2009.
4. GrowCut-Module under 3DSlicer http://www.slicer.org/slicerWiki/index.php/Modules:GrowCutSegmentation-Documentation-3.6
5. V. Vezhnevets and V. Konouchine, GrowCut - Interactive multi-label N-D image segmentation, in Proc. Graphicon, pp. 150-156, 2005.
6. K. H. Zou, et al., Statistical Validation of Image Segmentation Quality Based on a Spatial Overlap Index: Scientific Reports, Academic Radiology, 11(2):178-189, 04.
7. J. Egger, et al., Pituitary Adenoma Segmentation, Proc. of International Biosignal Processing Conference, Berlin, Germany, 1-4, 2010.
8. J. Egger, B. Freisleben, C. Nimsky, T. Kapur, Template-Cut: A Pattern-Based Segmentation Paradigm, Nature - Scientific Reports, Nature Publishing Group (NPG), 2(420), 2012.