Purpose:
To develop an auto-segmentation approach using multiple atlases to improve the quality of target delineation for low-risk CTV of unilateral tonsil cancers.

Methods:
Sixteen unilateral tonsil cancer patients received IMRT treatment for their left tonsil tumors. These patients were treated by a total of 8 oncologists, who delineated all contours manually on the planning CT. We chose 6 patients as atlases, and used deformable image registration to map each atlas CTV to the rest of 10 test patients. In each test patient, the final contour was produced by fusing 6 individually deformed contours using the Simultaneous Truth and Performance Level Estimation (STAPLE) algorithm. In addition, we also identified the best single atlas which best matched physician's contour on each test case. The auto-segmented contours were evaluated by comparing against the physician delineated contours using slice-wise Hausdorff distance (HD) and Dice coefficient (DSC), and a total volume overlap index.

Results:
Evaluation results showed that not a single atlas could produce reasonably good results in all 10 testing cases. The multi-atlas method achieved much better agreement than the single best atlas method. The multi-atlas method produced the median slice-wise HD of 7.35mm, the median slice-wise DSC of 80.2%, and the total volume overlap of 77.8%. For radiation oncologists who contoured both the test case and one of the atlas cases, the best atlas almost always came from the same radiation oncologist, indicating that inter-observer variation is dominated in target delineation. Our multi-atlas result confirms that the use of multi-atlas and STAPLE algorithm automatically reduces the inter-observer variability.

Conclusions:
We developed and validated a multi-atlas based auto-segmentation method to improve the quality and usability of low-risk target volume delineation for unilateral tonsil cancer radiotherapy.