

Computer-assisted, minimally invasive transforaminal lumbar interbody fusion: one surgeon's learning curve

Wei Tian, M.D.^{1*}, Yun-Feng Xu, M.D.¹, Bo Liu, M.D.¹, Ya-Jun Liu, M.D.¹, Zhao Lang, M.D.¹, Shuo Feng, M.D.¹

¹ Department of Spine Surgery, Beijing Jishuitan Hospital, No. 31, Xijiekou East St, Xicheng District, Beijing 100035, China

*Corresponding author

Wei Tian, M.D.,

Department of Spine Surgery, Beijing Jishuitan Hospital,
No. 31, Xijiekou East St, Xicheng District, Beijing 100035, China

Tel: 86-10-15600356091

Fax: 86-10-58516934

E-mail: drtianweia@163.com

Abstract

Study Design. A retrospective study of prospectively collected clinical data.

Objective. To evaluate the learning curve of using the computer assisted navigation minimally invasive spine surgery (CAMISS) and transforaminal lumbar interbody fusion (TLIF) technique for the surgical treatment of lumbar degenerative diseases.

Summary of Background Data. Minimally invasive (MI) transforaminal lumbar interbody fusion (TLIF) is technique challenge and long learning curve, as complex procedure performed through tubular tractor with high complications compared with open TLIF. Intro-operative navigation could provide real-time 3 dimension anatomic structure of spine, could make the complex surgery accuracy and safety. We combined computer assisted navigation and minimally invasive spine surgery (CAMISS) to treat lumbar degenerative disease. However, the learning curve of the combine technique is unknown.

Methods. Seventy-four consecutive patients with lumbar degenerative disease underwent CAMISS TLIF between March 2011 and January 2013 by a single surgeon. All patients were followed up at least 24 months, and the average follow-up time was 38 months. The learning curve was assessed via a logarithmic curve-fit regression analysis. According to the plateau of asymptote, initially 25 patients was divided as early group and remain cases were the later group. The clinical evaluation data included operative time, anesthesia time, intraoperative blood loss, day for ambulation, post-operative hospital stay, visual analog scale (VAS) leg and back pain scores, the Oswestry disability index (ODI) value, Macnab outcome scale scores, complications, radiological outcomes and rate of conversion to an open.

Results. The complexity of cases increased over the series, and the complication rate decreased. There were significant different between two groups on average duration of anesthesia ($p < 0.001$).

The operative time showed a significant decrease ($p < 0.001$) as the case number increased, as indicated by the equation $y = -18.26 \ln(x) + 219.23$ (x , case number; y , operative time [min]), with a coefficient of determination $R^2 = 0.6435$. There was no significant difference with intraoperative blood loss, day for ambulation, and post-operative hospital stay in the two groups ($p > 0.05$). The improvement of VAS leg and back pain scores and ODI in each group was similar: there was a significant improvement ($p < 0.05$) at 3 months, 12 months and 24 months after surgery when compared with preoperative scores, but there was no statistical difference ($p > 0.05$) in the VAS leg and back pain scores and ODI between two groups 3 months, 12 months and 24 months after surgery. The complication rate was 12.00% for early group, 6.82% for later group, with no statistical difference ($p > 0.05$) between groups. No significant difference was found between two groups in Macnab outcome scale scores and solid fusion rate. There was no need for conversion to an open procedure for both groups.

Conclusions. Our study showed a plateau asymptote of CAMISS TLIF was reached after 25 operations. The latter patients were during shorter operative time and anesthesia duration. CAMISS TLIF is an effective and safety option in the surgical treatment of lumbar degenerative disease.

Keywords: learning curve; computer-assisted navigation; minimally invasive spine surgery; transforaminal lumbar interbody fusion; degenerative lumbar disease

Abbreviations:

CAMISS, computer-assisted minimally invasive spine surgery; MI, minimally invasive; TLIF, transforaminal lumbar interbody fusion; ODI, Oswestry disability index; VAS, visual analog score

Key Points.

Operative time for CAMISS TLIF gradually declined with the series conducted, and a plateau asymptote was reached after about 25 cases.

Pedicle screw insertion and manipulation inside the spinal canal are key steps in the steep learning curve of MI TLIF.

Computer-assisted navigation and suitable initial patient selection can help shorten the learning curve and decrease the complication rate. After the initial stage of the learning curve, the scope of eligible candidates may be broadened.

CAMISS TLIF is an efficacious and safety technique for the treatment of lumbar degenerative diseases.

Figure 1. Scatterplot of the learning curve. The curve depicts the results for one surgeon, based on total operative times. The figure represents the total time from skin incision to skin closure for the initial 74 cases. As the number of cases increased, the operative time decreased as a result of

improved efficiency; steady state occurred at approximately patient 25.

