Posterior cervical fixation using screw-guide template system

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Introduction

Posterior cervical fixation using pedicle/lateral mass screws (PS/LMS) is a standard procedure for the treatment of the instable spinal disease, however, accurate screw placement is required to avoid the injury to the adjacent structures, such as vertebral artery and nerve roots.

We recently developed intraoperative navigation method using patient-specific screw guide templates and verified the accuracy of the procedure.
PS and LMS can cause injury to the adjacent structure

Incorrect insertion of PS (3-29%) can cause injury to the vertebral artery (0.2-1%) or dural sac.

Incorrect insertion of LMS can cause nerve root injury (4-10%) or LM fracture (6-7%)
Previous Intraoperative screw navigation

1. C-arm (Realtime, but 2D navigation. Difficult for severely deformed spine.)

2. Computer navigation (Inaccurate. Not realtime, just virtual navigation.)

3. Intraoperative CT navigation (Realtime 3D navigation, but time-consuming for scanning. Hardware is expensive. High radiation exposure.)
Methods

1. DICOM CT data is analyzed using 3D/multiplanar imaging software and screw trajectories were planned.

2. Screw guide templates were designed.

3. Transparent screw guide templates were created by 3D printer.

4. Spine models were also created.
Methods

5. Templates were examined to fit the models.

6. Preoperative screwing simulation was performed.

7. Operation was performed using screw guide template system and C-arm.

8. Screw placement was examined by postoperative CT.
Patients
AAD, Spinal degenerative disease, tumor
C1-C2 fixation 3 cases
Cervical LMS fixation 3 cases
Cervico-thoracic PS fixation 2 cases

8 cases

Illustrative case
64 y.o., female with 1–year–history of gait disturbance

flexion  neutral  extension
Screw trajectories were planned by 3D/multiplanar imaging software.

High-riding VA: C2 pars interarticularis screw

C1 lateral mass screw
② Screw guide templates were designed.

③ Preoperative simulation of screwing.
Results

All (40) screws were placed at the planned trajectories.
Discussion

Advantages of the screw-guide template system
1. Templates are made for each lamina and this system is not susceptible to alignment change of the spine.
2. Preoperative simulation is possible.
3. It does not require expensive navigation computer/machines.

Disadvantages
1. It takes 1-2 days to generate templates. (not for spine injuries?)
2. It is not a realtime navigation and C-arm or other realtime navigation should be used.
Conclusions

Efficacy of our screw guide template system is confirmed.

This system is especially useful for the screw insertion that requires high accuracy (especially cervical spine PS) and for the cases of severe spine deformity.