

Comparative analysis of radiologic outcomes of C1-2 fusion spine surgery between intraoperative CT image based navigation guided operation and fluoroscopy guided operation

Dong Wuk Son; Geun Sung Song MD, PhD; Sang Weon Lee; Jun Seok Lee M.D.

Pusan National University Yangsan Hospital

Click To Add Logo

Introduction

Atlantoaxial junction is highly complicated and specialized region
Highly variable pedicle anatomy and vertebral artery anomalies

Fixation of C1-2 is challenging surgical procedure because of the complex anatomy and the need for a high degree of accuracy to avoid complication.

Vertebral artery injury in C1-2 fixation
Transarticular screw fixation : 4.1 – 8.2%

C2 pedicle screw : 5.3% - 21%

Intraoperative 3D image(O-arm) based navigation system reduced the kind of complication, providing greater accuracy in instrument-assisted technique

In this study, we compared the surgical outcomes during the cervical fixation with and without intraoperative navigation if surgery with navigation is superior in either regard

Methods

Retrospective study

From January 1, 2009 to December 31, 2016

Total 26 patients has underwent posterior C1-2 fusion operations
fluoroscopy guided operation : 15 cases

intraoperative CT image(O-arm) based navigation guided operation : 11 cases

Patient characteristics

male : female 15 patients : 11 patients

Mean age : 54.8 years old (ranged from 17 to 80)

Disease criteria

Trauma (15 cases)

Fall down : 5 cases, Traffic accident : 5 cases, Slip down : 4 cases, Exercise : 1 cases

Degeneration (11 cases)

RA, Atlanto-axial subluxation

Operation technique

C1 : lateral mass screw (Harms technique)

C2 : isthmic-pedicle screw fixation (Harms technique)

translaminar screw, short pars screw

Results

Characteristics of patients

	C-arm group (N = 15)	Navigation group(N = 11)	P-value
Age	49.9±18.08 yr	60.9±13.77 yr	0.105
Gender (male : female)	11 : 4	4 : 7	0.109
Disease criteria (Trauma : degeneration)	10 : 5	5 : 6	0.426
HRVA	9 / 30 (15 patients)	3 / 22 (11 patients)	0.200
Median shifting	3 / 30 (15 patients)	0 / 22 (11 patients)	0.253
Pedicle size	Rt : 4.17, Lt : 4.93	Rt : 5.0, Lt : 4.66	0.323
Numbers of narrow pedicle size (<4mm pedicle size)	8 / 30 (26.7%)	3 / 11 (27.3%)	>0.999
EBL	797±462 cc	691±659 cc	0.634
Operation time	372±73.53 min	325±55.43 min	0.085
Transfusion rate	6/15	3/11	0.683
Fusion rate	15/15	10/11	0.423

Classification of screw position

Grade 0 : screw inside the bone

Grade I : perforation of the cortex by up to 2mm

Grade II : perforation of the cortex from 2 to 4mm

Grade III : perforation of the cortex more than 4mm

Accuracy of screws at each group

• Accuracy of all screws at each group

	Grade 0	Grade I	Grade II	Grade III
C-arm group (15 cases)	57 screws (90.5%)	4 screws (6.3%)	0 screws (0%)	2 screws (3.2%)
Total 63 screws				
Navigation group (11 cases)	42 screws (95.5%)	1 screws (2.3%)	1 screws (2.3%)	0 screws (0%)
Total 44 screws				

• Accuracy of screws at each group (in C2 isthmic pedicle screws)

	Grade 0	Grade I	Grade II	Grade III
C-arm group (15 cases)	23 screws (85.2%)	3 screws (11.1%)	0 screws (0%)	1 screws (3.7%)
Total 27 screws				
Navigation group (11 cases)	19 screws (90.5%)	1 screws (4.8%)	1 screws (4.8%)	0 screws (0%)
Total 21 screws				

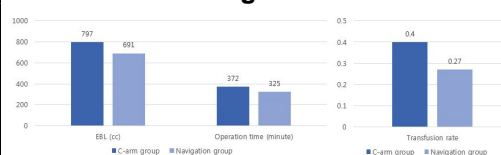
• In difficult C2 pedicle patients, Accuracy of screws at each group

	Grade 0	Grade I	Grade II	Grade III
C-arm group (9 cases)	14 screws (93.3%)	0 screws (0%)	0 screws (0%)	1 screws (6.7%)
Total 15 screws				
Navigation group (5 cases)	8 screws (88.9%)	1 screws (11.1%)	0 screws (0%)	0 screws (0%)
Total 9 screws				

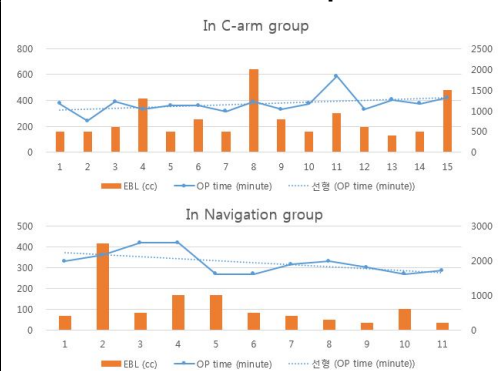
The accuracy of the screw was relatively high in the O-arm group, especially in the C2 pedicle patients with vertebral anomaly
O-arm group had no screw with a Grade II, III malposition, and showed a higher accuracy rate.

The O-arm group prevailed in the index of EBL, operation time, and blood transfusion

Effect of navigation guided operation on surgical data



Change of operating result according to accumulation of experience



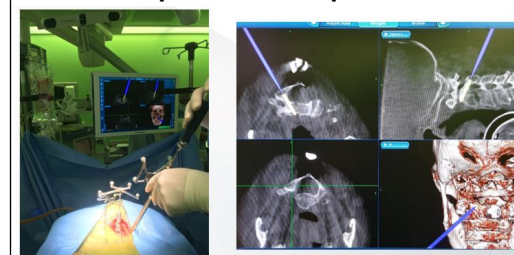
Review of literature on C1-2 fixation

Author	Year	No of patients	Level	No of CPS	No of screw perforation	Percentage of misplacement	Technique
Ling	2013	21	C1-2 OC fusion	41	3	7.3%	Intraoperative CT based
Kim	2015	18	C1-2	58	6	10.3%	Preoperative CT based
Czabanka	2017	12	C1-2	24	1	2.1%	Intraoperative CT based
Francesco	2015	17	C1-2	67	5	7.5%	Intraoperative CT based
Our cases	2017	11	C1-2	44	2	4.5%	Intraoperative CT based

The operation time was decreased, particularly in the O-arm group, according to the accumulation of experience.

In several articles, misplacement rate was reported from 2.1% to 10.3%. In our study, misplacement rate was 4.5%.

Operative field photo



Equipment set-up



Conclusions

-C1-2 fusion was successfully accomplished with O-arm system
-Accuracy of the screws was slightly higher in the navigation group.
-Procedure length with navigation system can reduced the operation time