Free hand C1-C2 screw placement in CV junction anomaly: Does anatomical complexity matters

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Background

- Conventionally, C1-C2 / Occipito-cervical fixation is gold standard for CVJ anomaly
- To minimize the associated complications, there have been several tools like intra-operative C-arm, navigation systems etc.
- However, these gadgets have been associated with -
  - High operating cost
  - Increased operative time
  - Availability at limited centres
  - Radiation exposure to both the patient and healthcare personnel

To overcome with similar challenges, techniques of freehand screw placement is well described for sub axial cervical, dorsal and lumbar regions.Unlike other areas of spine, CV junction region harbors many anatomical landmarks which are really helpful for free hand screw placement

This study highlights description of the anatomical landmarks and other surgical nuances of free hand technique for CV junction.

Methods and Materials

- Retrospective study on CVJ anomaly from Jan 2020 to Dec. 2025
- The patient's demography, clinic-radiological details, post-operative outcome, post op CT details and complications noted

Inclusion criteria

- Cases of CVJ anomalies underwent for C1- C2 or occipito-cervical instrumentation.
- Patients with minimum 1 year follow up

Exclusion criteria: Patients-

- With acute trauma of CVJ
- Whom fluoroscopy used
- With purely sub-axial instrumentation

- For comparative evaluation, patients were divided in two groups-
- **Simple CVJ group-** Mobile or fixed atlantoaxial dislocation with symmetrical C1-C2 joints with normal course of vertebral arteries and
- **Complex CVJ Group-** AAD with BI with asymmetrical C1-C2 joint and anomalous vertebral artery course

Figure 1. Simple CVJ Radiology.

Figure 2. Complex CVJ Radiology

Screw's accuracy evaluation

C1 Transpedicular, C1 lateral mass, C2 pars and C2 pedicle screws were evaluated on post op CT scan based on **Yoshihara Hojo criteria-**

Grade 0 (G-0): Correct placement
Grade 1 (G-1): Malposition by less than half screw diameter
Grade 2 (G-2): Malposition by more than half screw diameter

Results

SEX

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	MALE	146	66.1	66.1	66.1
	FEAMLE	75	33.9	33.9	100.0
	Total	221	100.0	100.0	

AGE

N	Valid	221
	Missing	0
Mean		27.84
Median		24.00
Mode		16[a]
Std. Deviation		15.541
Minimum		3
Maximum		70

DURATION OF COMPLAINTS

N	Valid	221
	Missing	0
Mean		3.154
Median		2.000
Mode		1.0
Std. Deviation		3.6579
Minimum		.2
Maximum		30.0

Chart 1. Demography.

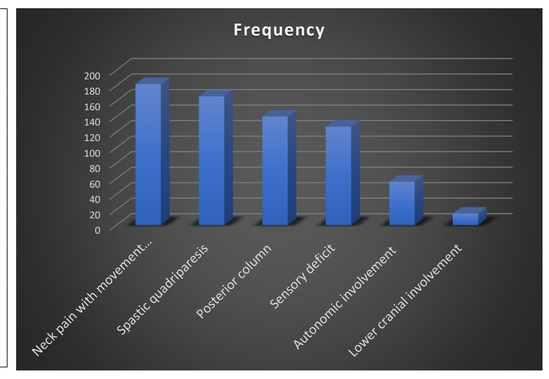

Chart 2. Clinical symptoms.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	AAD	25	11.3	11.3	11.3
	AAD WITH ACM	1	.5	.5	11.8
	AAD WITH BI	116	52.5	52.5	64.3
	ACM	2	.9	.9	65.2
	ACM WITH AAD	7	3.2	3.2	68.3
	ACM WITH AAD WITH BI	10	4.5	4.5	72.9
	ACM WITH BI	14	6.3	6.3	79.2
	FIXED AAD WITH BI	1	.5	.5	79.6
	ODONTOID TYPE 2 FRACTURE	1	.5	.5	80.1
	OS ODONTOIDEUM	1	.5	.5	80.5
	OS WITH AAD	31	14.0	14.0	94.6
	RECURRENT AAD	5	2.3	2.3	96.8
	TYPE 1 BI	1	.5	.5	97.3
	TYPE 2 ODONTOID FRACTURE	3	1.4	1.4	98.6
	TYPE 2C ODONTOID FRACTURE	1	.5	.5	99.1
	TYPE 3 ODONTOID FRACTURE	2	.9	.9	100.0
	Total	221	100.0	100.0	

Chart 3. Spectrum of cases.

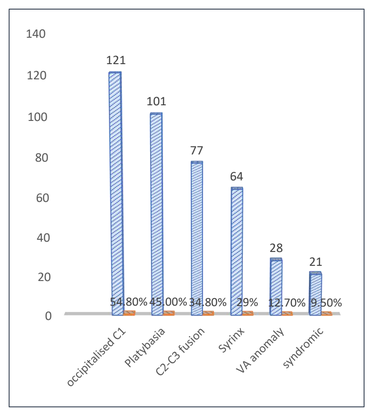

Chart 4. Radiological details.

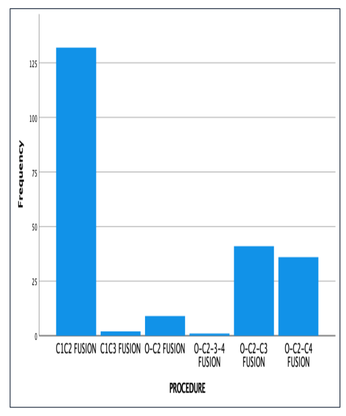

Chart 5. Procedural details.

	FREQUENCY (C1 SCREWS)	PERCENTAGE (C1 SCREWS)	FREQUENCY (C2 SCREWS)	PERCENTAGE (C2 SCREWS)	P Value
Grade 0	230	(86.47%)	366	83.18%	
Grade 1	30	(11.27%)	60	13.63%	
Grade 2	6	(2.25%)	14	3.18%	
TOTAL	266	(100%)	440	100%	
OVERALL MALPOSITION (G1+G2)	36/266	13.53%	74/440	16.82%	0.326

Chart 6. Postop CT details of Screw

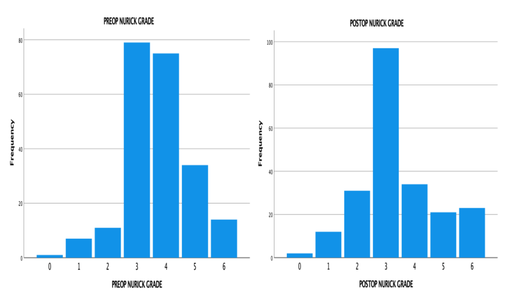

Chart 8. Clinical outcome

	FREQUENCY (SIMPLE CVJ GROUP)	PERCENTAGE (SIMPLE CVJ GROUP)	FREQUENCY (COMPLEX CVJ GROUP)	PERCENTAGE (COMPLEX CVJ GROUP)	P Value
GRADE 0	184	83.64%	412	84.77%	
GRADE 1	32	14.55%	58	11.93%	
GRADE 2	4	1.82%	16	3.29%	
Overall malposition (grade 1+2)	36/220	16.36%	74/486	15.35%5%	0.7007

Chart 7. Screw accuracy comparison in Simple vs Complex CVJ groups.

MAJOR POSTOPERATIVE COMPLICATIONS	SIMPLE CVJ ANOMALY PATIENTS (FREQUENCY)	COMPLEX CVJ ANOMALY PATIENTS (FREQUENCY)	P value
Power deterioration	4 (6.34%)	11 (6.96%)	0.97
Respiratory complication	2 (3.17%)	6 (3.79%)	-
Wound complications	4 (6.34%)	10 (6.32%)	-
No major complication	53 (84.12%)	131 (82.91%)	-

Chart 9. Complications

Discussion

- Overall accuracy of screws placement by freehand technique was 84.83% (85.2% under fluoroscopy by Hojo et al)

Shifting from the fixed anatomical landmarks to tailored one

- Adhering to the basic technique of visualisation of C1 lateral mass and C2 pars/pedicle and defining the lateral, medial, superior and inferior limits is very much helpful to identifying the entry point and trajectory of screws

Is it really effective?

- The malposition rate is comparable or even less (15.23%) in complex CVJ group than simple CVJ group (16.82%)
- Here free hand technique was utilized in abnormal anatomy whereas the study quoted by Hojo et al and others have mixed cases and they have utilized fluoroscopy as well

Free hand technique: A need of hour for CV junction

- The accuracy rate with free hand technique was more than 84% in our study stringently observed in all the three planes justifies its accuracy

Conclusions

In free hand technique-

- **Anatomical complexity is no more contraindication**
- **Can significantly cut down the fluoroscopy hazards**
- **Free hand C1-C2 instrumentation is safer, accurate and time saving as well as cost effective method.**

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