

# C1 C2 FUSION INDICATION TECHNIQUE AND COMPLICATION

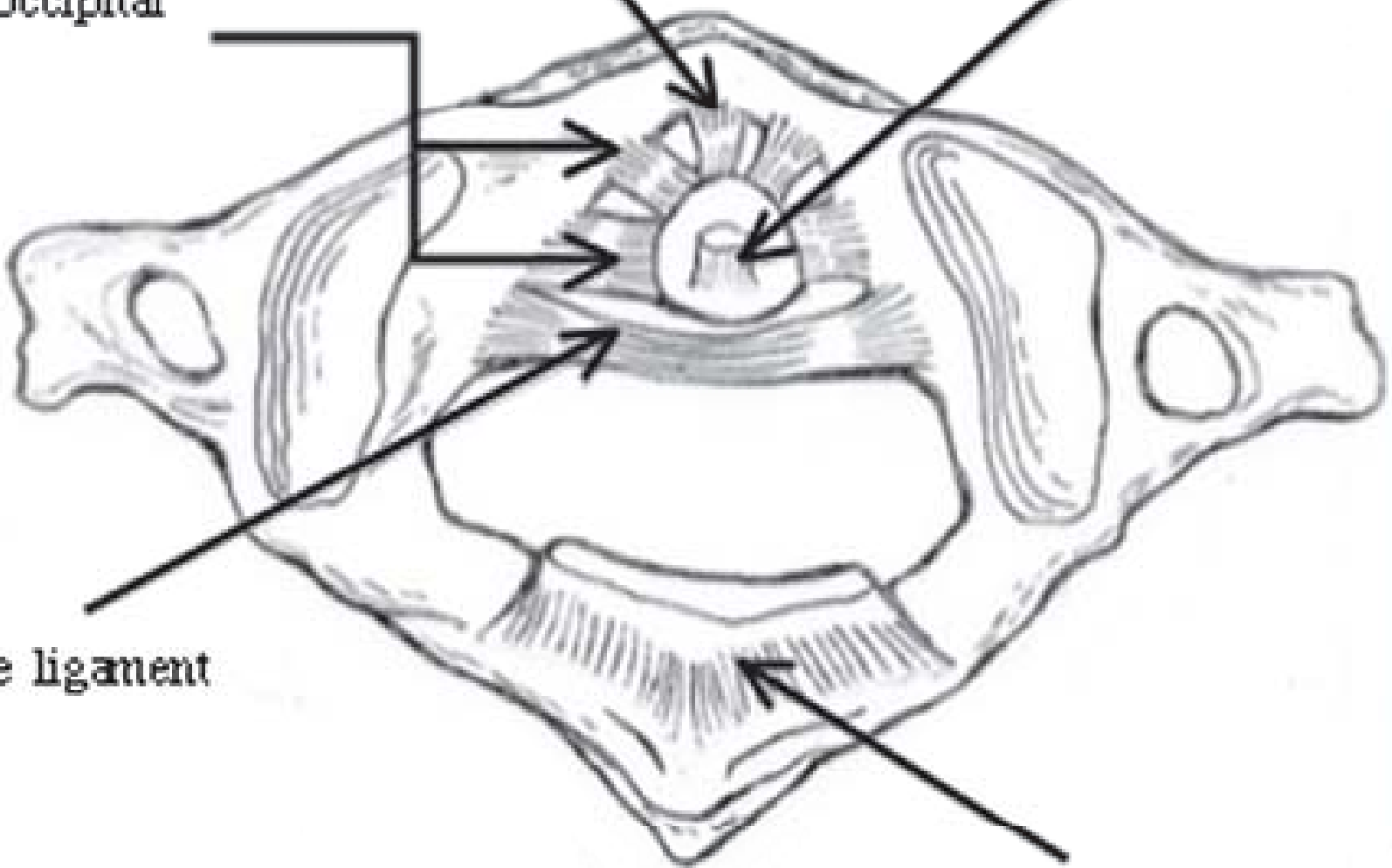
MODERATOR DR S S KALE

**C**

alar ligament  
anterior, occipital  
portions

anterior atlantodental  
ligament

apical  
ligament



transverse ligament

atlantooccipital  
membrane

posterior atlantooccipital  
membrane

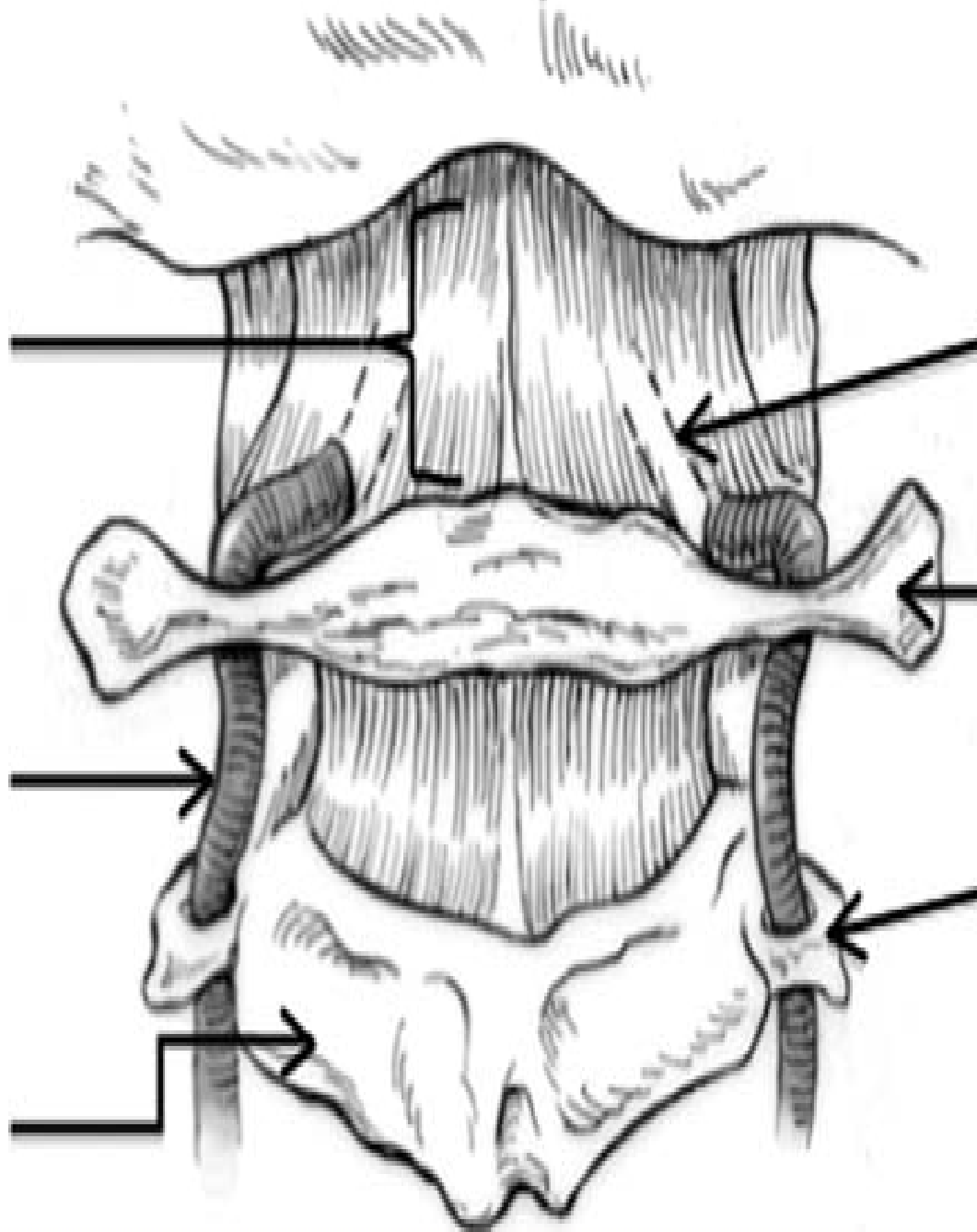
vertebral  
artery,  
intradural  
segment

atlas

vertebral artery

C2 transverse foramen

lamina of C2



# C1 C2 WIRE FIXATION

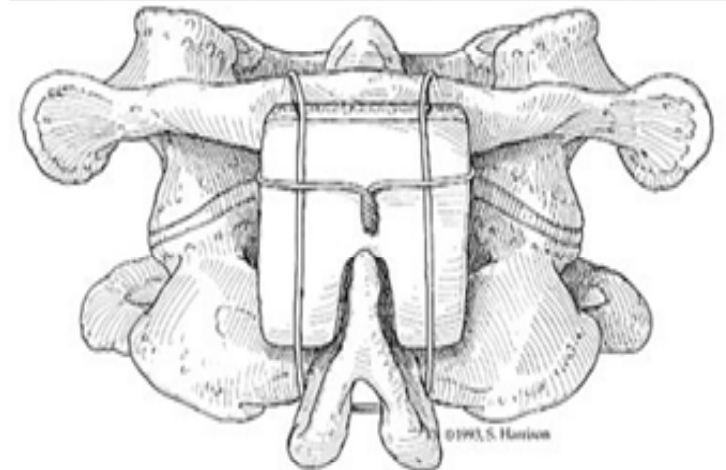
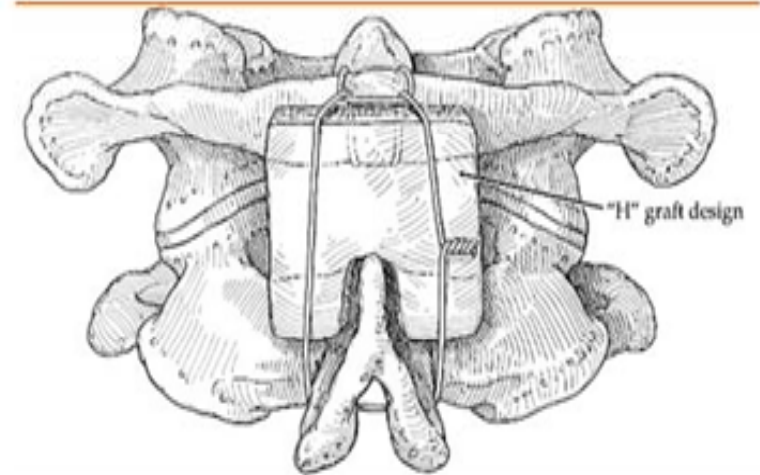
- FIRST DESCRIBED BY HADRA IN 1891
- MODIFIED BY CONE IN 1937
- THREE BASIC CABLE WIRE FIXATION
  - GALLIE
  - BROOKS
  - SONNTAG -DICKMAN

# C1 C2 WIRE FIXATION

- INDICATED IN AAD WHEN POSTERIOR ELEMENT OF C1 C2 ARE INTACT
- CONTRAINDICATION
  - ABSENT POSTERIOR ELEMENT
  - SEVERE OSTEOPOROSIS
  - NARROW CANAL DIAMETER

# GALLIE

- 20 GAUGE WIRE UNDER C1 ARCH
- INFERIOR PART NOTCHED OVER SPINOUS PROCESS OF C2
- H SHAPED GRAFT PLACED IN BETWEEN DECORTICATED C1 AND C2 ARCH
- NOTCH INFERIORLY IN THE MIDLINE
- OFFER LITTLE ROTATIONAL OR EXTENSION STABILITY
- HIGH RATE OF NON UNION

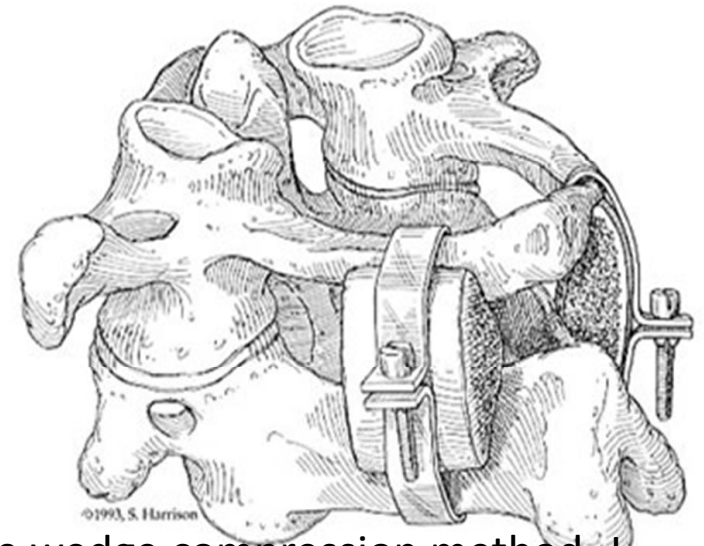
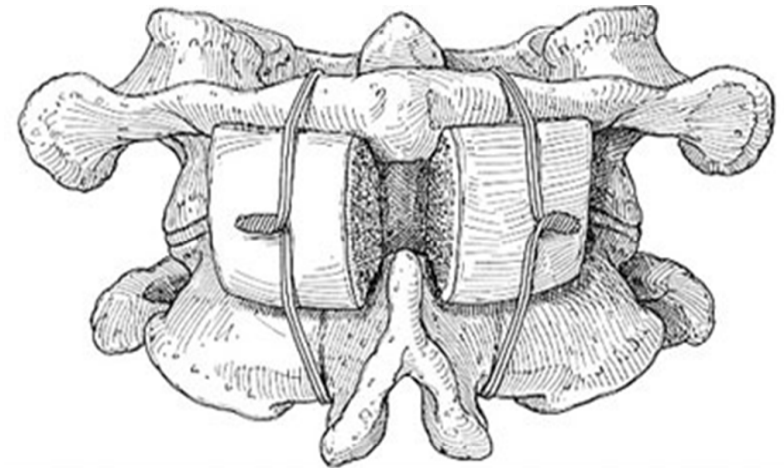


. Gallie WE. Fractures and dislocations of cervical spine. Am J Surg. 1939;46:495–499.

Coyne TJ, Fehlings MG, Wallace MC, Bernstein M, Tator CH. C1-C2 Posterior Cervical Fusion: Long Term Evaluation of Results and Efficacy. Neurosurg 1995; 37:688-693.

# BROOKS

- SUPERIOR TO GALLIE IN BIOMECHANICAL STUDIES ESPECIALLY ROTATION
- CARRIES RISK OF PASSING ADDITIONAL WIRE BENEATH TWO LAMINA
- TWO RECTANGULAR BONE GRAFT FASHIONED TO WEDGE BETWEEN C1 AND C2

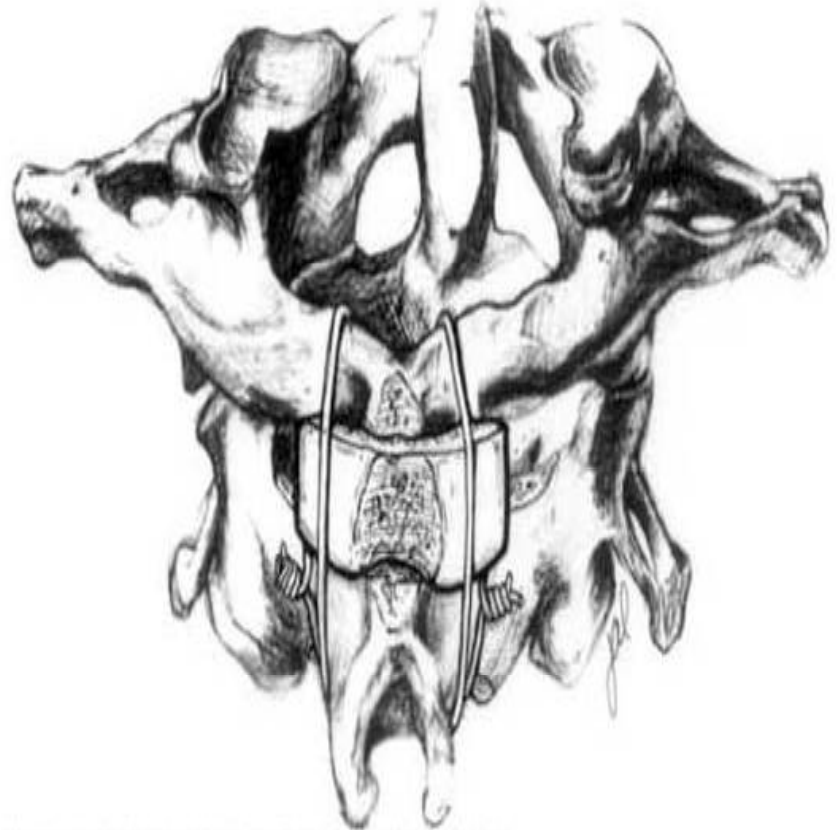


Brooks AL, Jenkins EB. Atlanto-axial arthrodesis by the wedge compression method. *J Bone Joint Surg Am.* 1978;60(3):279–284

Smith MD, Phillips WA, Hensinger RN. Complications of Fusion to the Upper Cervical Spine. *Spine* 1991; 16:702-705.

# SONNTAG DICKMAN

- ONE BICORTICAL GRAFT WEDGED BETWEEN C1 AND C2
- SINGLE SUBLAMINAR WIRE PASSED UNDER C1
- WIRE LOOPED BELOW C2 SPINOUS PROCESSES TRAPPING THE GRAFT BETWEEN C1 C2
- AVOIDES PASSING SECOND SUBLAMINAR WIRE



Dickman CA, Sonntag VK, Papadopoulos SM, Hadley MN. The interspinous method of posterior atlantoaxial arthrodesis. J Neurosurg. 1991;74(2):190–198.



# C1 C2 WIRE FIXATION

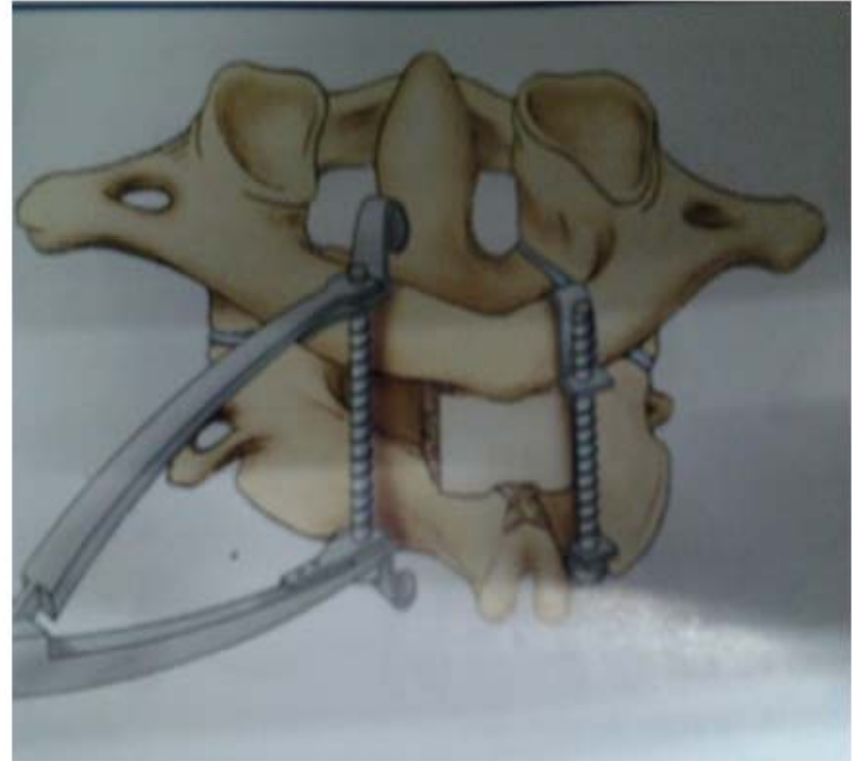
- FUSION RATES INCREASE WHEN EXTERNAL ORTHOSIS IS USED
- NEUROLOGICAL COMPLICATION INCLUDING QUADRIPARESIS CAN OCCUR IN UPTO 5 TO 7 % OF CASES
- BREAKAGE OF WIRE MIGHT OCCUR

GEREMIA GK, KIM KS, CERULLO L, CALENOFF L. COMPLICATION OF SUBLAMINAR WIRING. SURG NEUROL 1985;23; 625-229

GROB D, GASCOJJ, PANJABI MM, WARG P, DVORAK J. BIOCHAMICAL EVALUATION OF FOUR DIFFERENT ATLANTOAXIAL FIXATION TECHNIQUES. SPINE 1992; 17;480-490

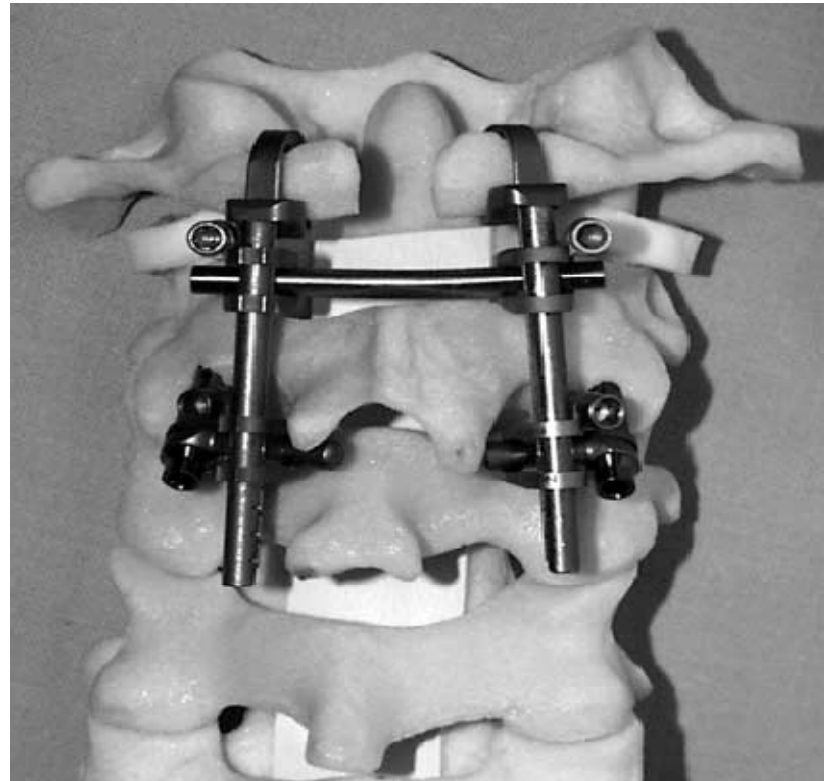
# INTRALAMINAR CLAMPS(HALIFAX)

- OFFERS POSTERIOR LAMINAR FIXATION WITHOUT PASSING SUBLAMINAR WIRE
- UPPER CLAMP PLACED ABOVE LAMINA OF C1
- INFERIOR CLAMP PLACED BELOW C2
- SEQUENTIAL TIGHTENING OF CLAMPS TO ENSURE ENGAGEMENT OF LAMINAE



# INTRALAMINAR CLAMPS(HALIFAX)

- INTERLAMINAR GRAFT MAY BE USED
- ASSOCIATED WITH IMPLANT SLIPPAGE
- HIGH PSEUDOARTHROSIS RATE
- C1 RING FRACTURE



ALDRICH EF, CROW WN, WEBER PB, et al USE OF MR IMAGING – COMPATIBLE HALIFAX INTERLAMINAR CLAMPS FOR POSTERIOR CERVICAL FUSION. J NEUROSURG 1991; 74: 185

MOSKOVICH R, CROCKARD HA: ATLANTOOAXIAL ARTHRODESIS USING INTERLAMINAR CLAMPS: AN IMPROVED TECHNIQUE. SPINE 17; 261-267,1992

# TRANSARTICULAR SCREW FIXATION

- USED WHEN POSTERIOR ARCHES INCOMPETENT
- SUPERIOR TO WIRING METHODS IN FUSION RATES
- SEVERE OSTEOPENIC PATIENTS MAY REQUIRE FIXATION THROUGH ARTICULAR FACETS
- IMPERATIVE TO DELINEATE VERTEBRAL ARTERY'S COURSE
- NOT FEASIBLE IF VERTEBRAL ARTERIES ARE TOO MEDIAL
- PROVIDES ABSOLUTELY NO MOVEMENT IN THE REGION
- PROCEDURE IS TECHNICALLY DIFFICULT
- SPINAL CORD INJURY, HYPOGLOSSAL INJURY

# TRANSARTICULAR SCREW FIXATION

- MAGERL TECHNIQUE PROVIDES STIFFEST STABILIZATION WITH LEAST AMOUNT OF ROTATION AND LATERAL BENDING
- PROVIDES THREE POINT FIXATION
- FOLLOWS MOST CLOSELY BIOMECHANICAL RULES OF INTERNAL FIXATION
- FUSION RATES BETWEEN 85% TO 98% AND WELL TOLERATED IN ELDERLY

MAGERL F, SEEMAN PS. STABLE POSTERIOR FUSION OF THE ATLAS AND AXIS BY TRANS ARTICULAR SCREW FIXATION. CERVICAL SPINE. BERLIN: SPRINGER- VERLAG; 1986: 322-327

# POSTERIOR TRANSARTICULARSCREW

- MAGERL AND SEEMANN (1979)
- TRANSARTICULAR SCREW PLACED THROUGH PARS INTERARTICULARIS OF C2 PENETRATING C1 C2 FACET INTO LATERAL MASSES OF C1
- SCREW DIRECTED 25 TOWARDS MIDLINE AND 25 CRANIAL
- THREE POINT FIXATION CAN BE OBTAINED





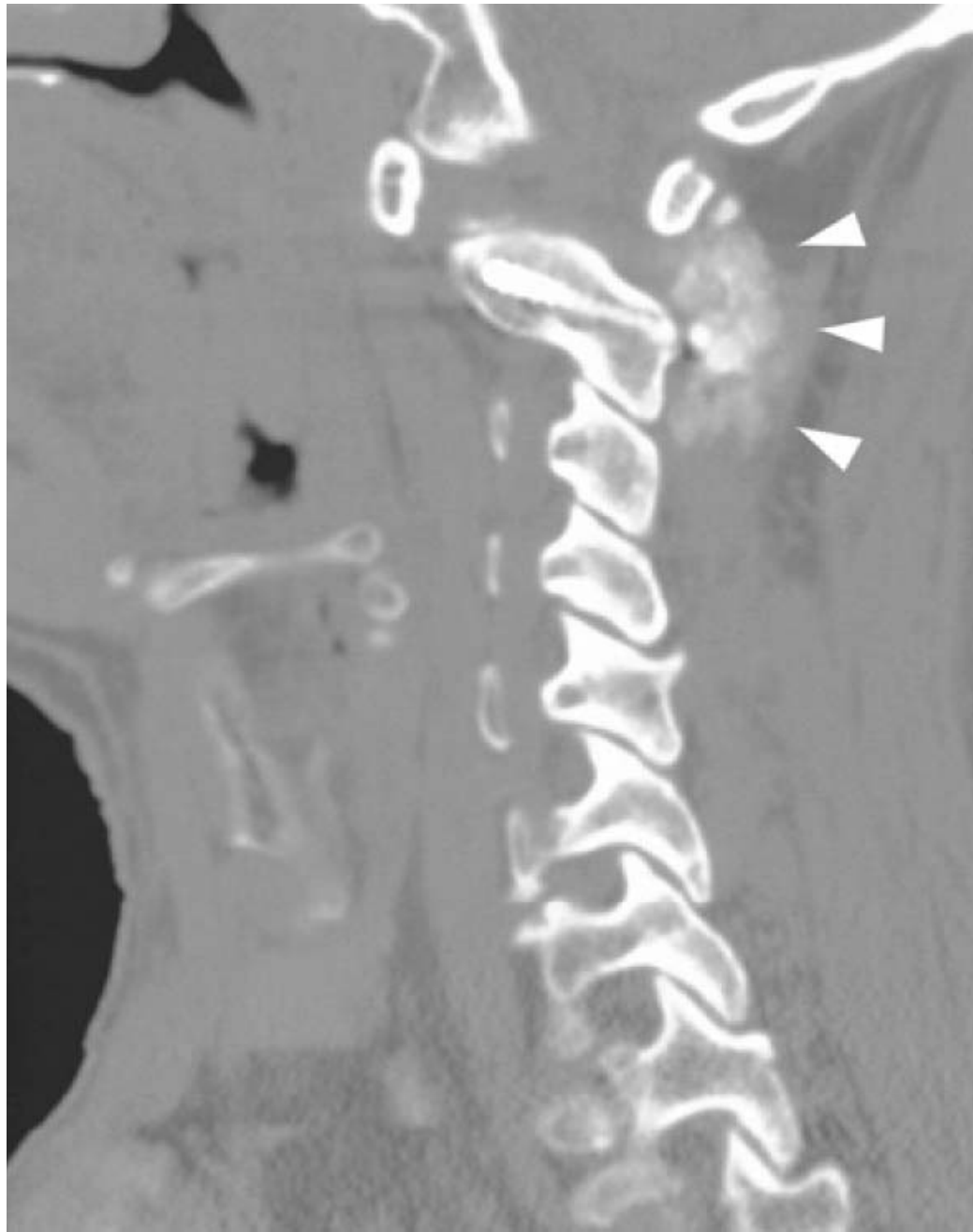


# LATERAL MASS SCREW FIXATION

- JURGEN HARMS TECHNIQUE OF C1 C2 FIXATION
- C1 LATERAL MASS SCREW AND C2 PEDICLE SCREW WITH ROD RECONSTRUCTION
- REDUCTION OF C1 C2 CAN BE ACHIEVED USING ROD AS A LEVER ARM
- CAN BE USED IN PATIENTS WITH COMPROMISED POSTERIOR ELEMENT
- EASIER THAN PLACEMENT OF TRANSARTICULAR SCREWS

HARMS J, MELCHER RP, POSTERIOR C1 C2 FUSION WITH POLYAXIAL SCREW AND ROD FIXATION. SPINE 2001; 2467-2471





# C1 LATERAL MASS WITH C2 PEDICLE SCREW

- ACHIEVED 100% FUSION RATE
- ANATOMIC ALIGNMENT NOT NECESSARY
- TECHNICALLY DEMANDING



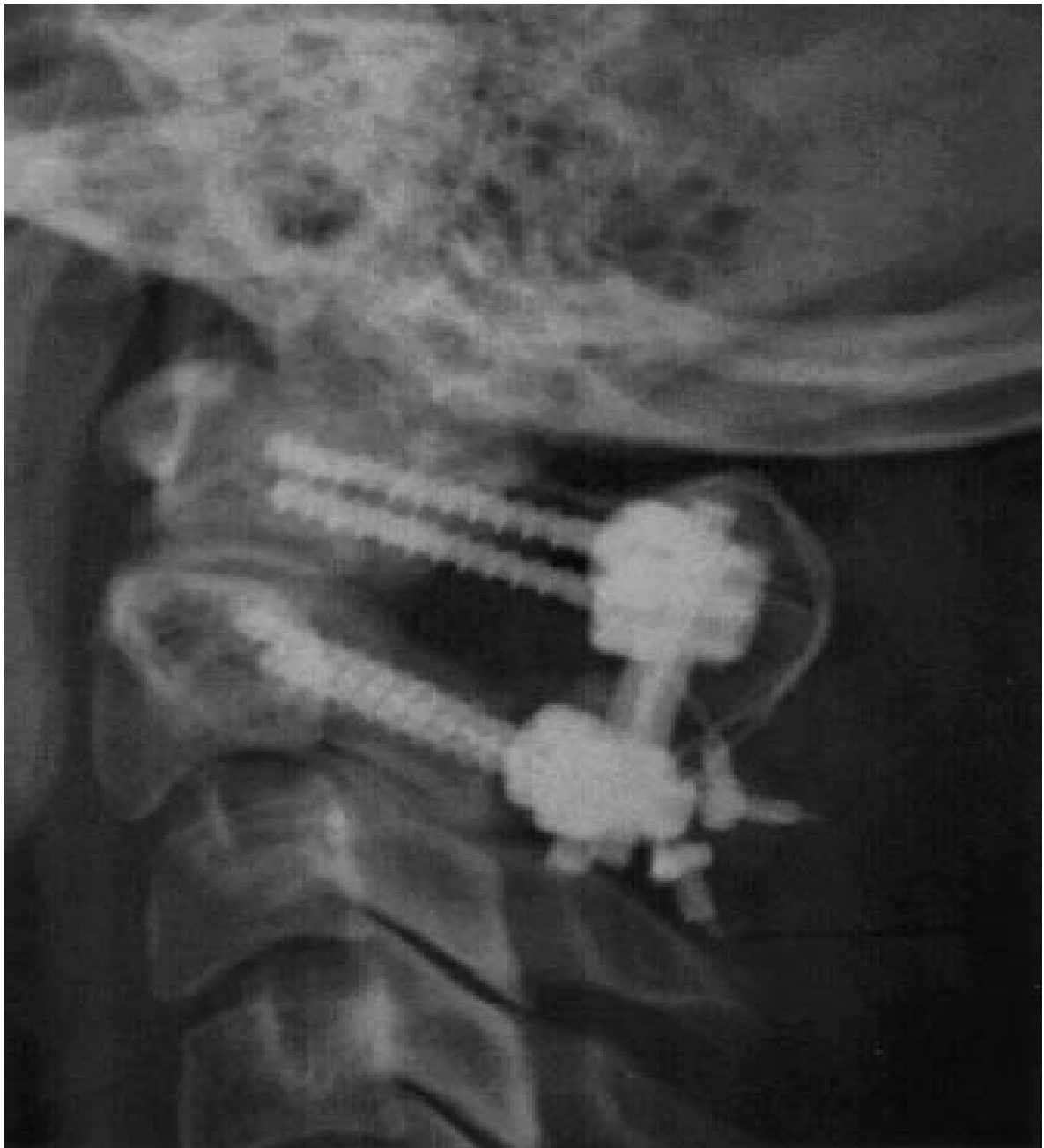
Goel A, Laheri V. Plate and screw fixation for atlanto-axial subluxation. *Acta Neurochir (Wien)* 1994; 129:47-53.

7.

Goel A, Desai K, Mazumdar D. Atlantoaxial fixation using plate and screw method: a report of 160 treated patients. *Neurosurg* 2002; 51:1351-1356.

# C2 PARS SCREW

- C2 PARS SCREW AVOIDS TRANSARTICULAR PLACEMENT OF SCREW
- AVOIDS OPERATIVE RISK BUT COMPROMISE HOLDING STRENGTH
- USE SAME ENTRY POINT AS MAGERL
- SCREW ANGLED 10 TO 15 MEDIALY AND 35 DEGREE SUPERIORLY



# OCCIPITO CERVICAL STABILIZATION

- INDICATED IN PATIENT WITH AAD,  
OCCIPITALISED HYPOPLASTIC OR BIFID ATLAS
- POSTERIOR DECOMPRESSION OF FORAMEN  
MAGNUM AND C1 ARCH REQUIRED  
ESPECIALLY ARNOLD CHIARI
- FIXED AAD WHERE EXTENSIVE  
OSTEOLIGAMENTOUS EXCISION REQUIRED

# OCCIPITO CERVICAL STABILIZATION

- WIRE AND BONE GRAFT FUSION BY ARTIFICIAL ARCH OF ATLAS
- BONY RIDGE OF OCCIPITAL BONE AND OCCIPITALIZED ATLAS CREATED
- ARTIFICIAL ARCH AND C2 DECORTICATED AND ONE MIDLINE AND TWO LATERAL NOTCH FORMED
- WIRE PASSED THROUGH THE NOTCH
- GRAFT OF ILIAC CREST WEDGED BETWEEN C2 AND ARTIFICIAL ARCH AND WIRE IS TIGHTENED



# OCCIPITO CERVICAL FUSION

## ADVANTAGES

- CORRECTS AP AND ROTATIONAL MOVEMENTS OF ATLAS PROVIDING THREE DIMENSIONAL REDUCTION
- STABLE INTERNAL FIXATION WITH EXCELLENT BONE TO BONE CONTACT
- SIMPLE TECHNIQUE

# OCCIPITO CERVICAL FUSION

## DISADVANTAGE

- CANNOT BE USED IN PATIENT WITH LARGE DISTANCE BETWEEN OCCIPITALIZED ATLAS AND C2 C3 AND NARROW CANAL
- CANNOT BE USED IN PATIENT WERE POSTERIOR DECOMPRESSION IS UNDERTAKEN

# OCCIPITO CERVICAL FUSION

- CONTOURED RODS
- C1 ARCH REMOVED
- ROD IS PLACED OVER OCCIPITAL BONE AND C2 AND C3
- ROD FIXED OVER OCCIPITAL BONE BY THREE BURR HOLES AND WIRES PASSED THROUGH IT
- ABSOLUTE BONY CONTACT IS REQUIRED TO PREVENT VERTICAL MOVEMENTS

# ANTERIOR C1 C2 FIXATION

- DESCRIBED BY GOEL
- Harms and colleagues have recently used transoral technique
- technique is performed with the use of a “T-plate
- horizontal portion of the plate is placed over the C1 lateral masses anteriorly and screws are placed through the plate apertures into the anterior C1 lateral mass
- vertical portion of the plate rests on the body of C2 inferior to the base of the dens

- THANK YOU