INTRODUCTION

Poster trans articular screw fixation in the management of Atlanto-axial instability: A retrospective study

The atlanto-axial complex is a structurally and functionally important part of cervical sine with about 50% of axial rotation occurring at atlanto-axial articulation[1]. The orientation of C1-C2 facet complex does not provide adequate mechanical support to prevent instability, should damage to dens or transverse ligament occur.

The wide spectrum of conditions that can result in atlantoaxial instability include trauma, psedoarthrosis of dens[5], rheumatoid arthritis[2,3] congenital anomalies like os odontoideum[4], incompetent posterior elements, infections[6], tumours[7], and ligament laxity as in Down's syndrome.

Atlanto-axial instability is characterized by pain in the neck, difficulty in movement of neck, radiculopathy (C2 root injury), quadriparesis or quadriplegia with or without bowel bladder involvement.

Radiographic evaluation of these patients is done by taking X-rays of the cervical spine in full flexion and extension in lateral projection and open mouth view in antero-posterior projection. CT Scan and MRI Scan further help in studying bone and soft tissue structures including extent of cord compression. Clinical instability of atlantoaxial joint involves abnormal

translation and rotation. An Anterior Atlanto Dental Interval (ADI) of more than 3mm or Posterior Atlanto Dental Interval of more than 13mm represents anterior translational instability[8]. Posterior translation is rare and usually the result of injury, destruction or congenital absence of dens. Rotational displacement between C1-C2 can be unilateral anterior or unilateral posterior with rotation around an axis centralized on the contra lateral joint and unilateral combined anterior and posterior with axis of rotation in dens.

The treatment for atlantoaxial instability is predominantly surgical which is aimed at stabilization, bony union, improvement of pain and neurological status and restoration of normal anatomy of atlantoaxial joint.

The present study is aimed at studying the role of posterior trans-articular screw fixation in management of fracture of C1 C2.

REVIEW

OF

LITERATURE

ANATOMY

Atlantoaxial joint is formed by two different sets of articulations. Tile first articulation is between the convex inferior articular process of the atlas with the superior convex articular process of the axis. The second articulation is between the anterior arch of the atlas and the odontoid process of the axis[9].

The architecture of the atlantoaxial joint allows flexion, extension, lateral bending and rotation. The atlantoaxial joint accounts for 50% of the rotation in the cervical spine[10]. An average of 43° of rotation normally occurs at the atlantoaxial joint, with more than 50° representing hyper-mobility, and more than 65° suggesting atlantoaxial dislocation[11,12].

The overall diameter of the atlas is quite large in relation to the space necessary for the spinal cord[13]. The central point of ligamentous stability in the atlanto-axial complex is the odontoid process[9]. Attached to the odontoid are various ligaments: transverse, alar, apical and accessory ligaments. The transverse ligament provides stability to the atlantoaxial joint in flexion and also prevents anterior translation of the atlas on the axis[15]. Axial rotation of

the upper cervical spine is limited by the alar ligaments and damage to these ligaments increases rotation to the contra-lateral side[16]. The capsules of the atlantoaxial joint also have a significant role in providing stability to the complex. They function to limit rotation and translation at the C 1-C2 level[17].

The vertebral artery typically enters the foramen transversarium at C6 and ascends rostrally. After exiting the foramen on the superior aspect of the axis, the artery courses laterally to pass through the foramen of the atlas. There is a sulcus arteriae vertebralis behind each superior articular process of the atlas which serves for transmission of the vertebral artery and also the first spinal nerve. The vessel then courses posteromedially to enter the dura in the midline to further enter the foramen magnum[18].

In a majority of people (40.8%), the right and the left vertebral arteries are equivalent. The left vertebral artery is dominant in 35.8% of people. However, the right one is dominant in only 23.4% of population[19,20]. The position of the vertebral artery in relation to the isthmus of C2 is anomalous in up-to 20% population[21].

Corner in 1907 in his classical account of rotatory dislocation of the atlas emphasized that the laxity of the atlanto-axial joint allowed considerable movement without dislocation and that the muscles of the neck provide considerable protection against injury[22].

Watson Jones in 1943 considered that atlantoaxial joint dislocation alone was more serious than fracture dislocation because if the odontoid process is intact, the spinal cord is in danger of being crushed against it[23].

Jackson in 1950 radiographed 50 normal adults and 50 children and found that the distance between the anterior arch of the atlas and the odontoid process is 2.5 mm average in adults and varied upto 4.5 mm in children[24]

McRae in 1953 said that neurological signs were always present when the antero-posterior diameter of the canal at the level of dens was19 mm or less[25].

In 1956, Wolf, Khilnani and Malis found that the canal at the atlas ranges from 16 to 33 mm in sagittal diameter in adults[26].

As described by Steel in his "rule of thirds", the internal antero-posterior span of the ring of the atlas measures approximately 3 cms and the spinal cord and the odontoid process each are about 1 cm thick, therefore allowing I1g 1 cm of free space for some degree of displacement[13]

In the presence of intact atlanto axial ligaments, the normal joint space between the odontoid process and the anterior arch of the atlas does not exceed 3mm in adults and is usually unchanged during flexion and extension[24,27,28,29.]

Jauregui in 1993 concluded that the atlantodental interval and the C1 Mal diameter have accelerated growth during the first 4 years of life, and the rule of thirds" by Steel remains valid throughout life[30.]

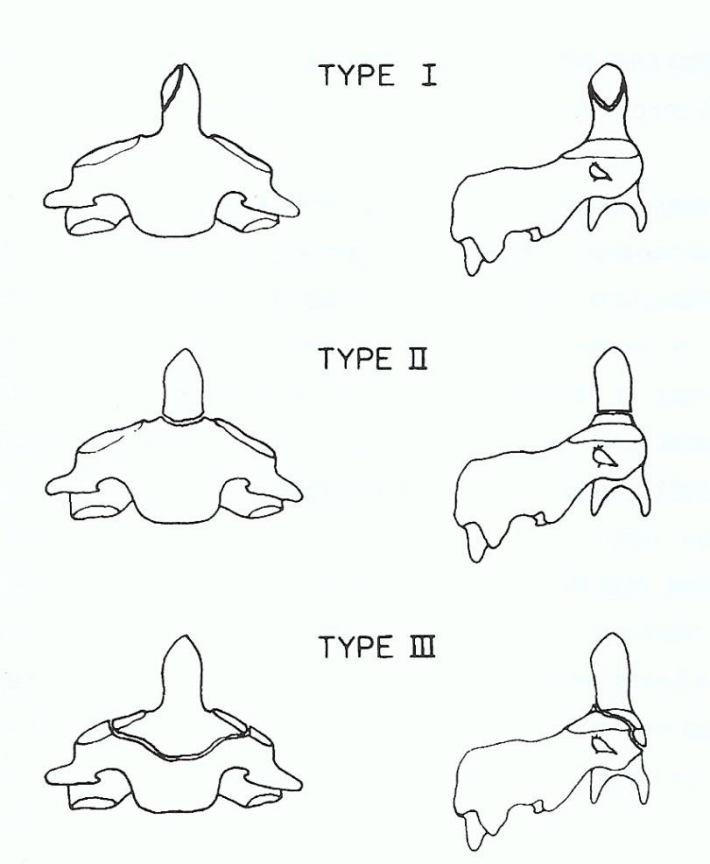
PATHOPHYSIOLOGY

Atlantoaxial instability may occur secondary to trauma, psedoarthrosis of dens, rheumatoid arthritis, congenital anomalies, infection, tumors, or Down's syndrome [2,3,4,5,6,7.] Trauma is a major cause of atlantoaxial instability associated with a fracture of the odontoid process or rarely isolated rupture

of the transverse ligament[15]. The most common traumatic injury of the atlantoaxial complex requiring stabilization is the fracture of the dens[32].

Anderson and D'Alonzo divided the dens fracture into 3 types:

- Type 1 fractures involve fractures through the upper dens.
- Type 2 fractures occur at the junction of the dens and the body of C2.
- Type 3 fractures extend into the body of C2[33].



Traumatic atlantoaxial instability can of two types: One is where there is flexion instability with anterior translation of the atlas on the axis resulting from rupture of the transverse ligament and the second type is

rotatory instability resulting from both bony and ligamentous injuries.

A maximum of 3 mm of anterior translation of the C1 on the C2 can occur with an intact transverse ligament in adult. Within the range of 3-5 mm of translation, catastrophic failure occurs usually within the midsubstance of the ligament[15].

Bell in 1830 described the association of inflammatory processes with atlantoaxial subluxation[34.]

Mixter and Osgood in 1910 emphasized that redislocation and myelitis from late injury to the cord may occur, and they described a case of one year old boy who fell from a tree and developed severe occipital neuralgia 6 months after injury[35].

JS Grogono in 1954 concluded that injuries to the atlas and the axis may occur at any age, and spontaneous rotatory dislocation is the commonest type of lesion in children, while fracture of the odontoid process is more common in adults[27]

Haid RW et al in 2001 reviewed causes of atlantoaxial instability and found trauma as a major cause in 37 % cases, rheumatoid arthritis in 22% cases and congenital anomalies in 12 % cases[36.]

CLINICAL FEATURES

Cone and Turner in 1937 noted the usual absence of spinal cord symptoms after injuries to the upper cervical spine, and recognized the possibility of sudden death or later paralysis if the injury was not recognized and treated[37].

Colsen in 1949 described fracture dislocation of the atlas on the axis

after manipulation -under anesthesia, resulting in paraesthesia of the forearms and hands with no abnormal neurological signs[38].

NA Rana et al. in 1973 found pain in 76% patients of rheumatoid arthritis with atlantoaxial subluxation in the upper cervical or the suboccipital areas with variable radiation to the mastoid, occipital, temporal or frontal regions and few had paraesthesias or pain in the hands or fingers, and one complained of bouts of "uselessness" of the upper limbs. One also suffered vertigo on extension of the neck[39].

Fielding et al. in 1976 in a study of 57 patients with atlantoaxial instability found that neurological complaints were present in twenty-four patients, cord compression in 6 patients, while 4 had nerve-root irritation. Pain and limitation of motion of the neck were present in 29 patients. 14 patients were asymptomatic[40].

Charles Clark in 1989 studied 41 patients of rheumatoid arthritis. In 9 patients, the chief complaint was pain in the neck and in 9 it was occipital aches or dysaesthsias. 9 patients had no appreciable pain and instability was diagnosed on screening radiographs. Additional symptoms included subjective cervical crepitus in 13, weakness of upper extremities in 5, clumsiness in 1, progressive muscular weakness in 2, feeling of impending doom in 2, radicular pain in 8, stiff neck and limited range of in 3, severe spasms in neck in 1, paraesthesias of upper extremity in 8, transient quadriparesis in 1, weakness of lower extremity in 1, and dysphagia in 1[42]

Monu J and Bohrer SP in 1975 stated that the posterior arch of the atlas can be found at any position between the occiput and the spinous process of C2 in all positions of the head and neck. Hence fanning or widening of the C1-C2 interspinous distance on radiographs is not a reliable indicator of ligamentous injury in upper cervical spine[44].

In 1988, Petterson et al. published a paper stating that MRI imaging along with conventional radiographs was necessary for localizing soft tissue lesions, vertebral dislocation and narrowing of the spinal canal in patients with severe rheumatoid arthritis[45].

RA Swinkels and RA Oostendorp in 1996 concluded that conventional X-rays fail to give adequate information about atlantoaxial instability however CT scan and MRI scan can visualize much more information but neither is an absolute standard. They also concluded that there is no correlation between the measure of hypermobility and the presence of clinical symptoms[46].

H Ostensen et al. in 1998 studied 20 patients of rheumatoid arthritis for instability of the occipito-atlanto-axial joints and cranial migration of the odontoid process. While conventional radiographs were useful in only 8 patients, all bony structures could be well demonstrated on CT examination and the degree of cranial migration of odontoid process quantified[47].

Significantly though, as recently as 2005, Karhu et al. evaluated patients with rheumatoid arthritis and concluded that conventional radiographs with flexion and extension views should be the first imaging modality [49].

MODALITIES OF TREATMENT

CONSERVATIVE METHODS

Though conservative treatment in the form of external immobilization with brace, Minerva jacket, cervical collar etc. has always been in vogue, a review of the literature reveals unsatisfactory results with the same.

Schatzker and associates in 1971 reported that of 37 patients with fractures of the odontoid process managed conservatively, non union developed in as many as 23 (63%)[50].

Roberts and Wickstorm in 1972 reported a series of 50 fractures of the odontoid Process, out of which 40 were treated conservatively. 8 developed non union (20%) [51.]

SURGICAL STABLIZATION

Surgical attempts at stabilization of the atlantoaxial complex date back to 1910 when Mixter and Osgood first described securing posterior elements of the atlas and the axis with heavy silk threads in case of traumatic atlantoaxial instability. It was however associated with high failure rates[35].

NA Rana et al. in 1973 studied 41 patients of rheumatoid arthritis with atlantoaxial subluxation and concluded that extent of neurological involvement did not correspond with the degree of subluxation. Further they said that fusion of the atlantoaxial complex was indicated only in patients with progressive neurological signs and in those suffering from acute neurological episode[39].

Although Type I odontoid fractures were classically considered stable fractures not requiring stabilization[51], recent reports raise doubt over this and suggest further evaluation to rule out instability and need for surgical stabilization[53].

Lewis 0 Anderson and Richard T D'Alonzo in 1974 concluded that fractures of the body of the dens were most prone to non union and surgery is commonly required in this group. They also concluded that fusion of the

first cervical vertebrae to the second is adequate in the vast majority of patients with fractures of the odontoid process or non union of fractures of the process[33].

Read and Mennen in 1983 recommended that in rheumatoid arthritis atlantoaxial instability should be sought and the joint be routinely fused before anesthesia is undertaken for another surgery, for fear of cord damage during intubation[54].

A W B Heywood et al. in 1988 studied 30 fusion operations in 26 rheumatoid arthritis patients with cervical spine instability and concluded that neurological compromise in an unstable but mobile rheumatoid cervical spine can usually be brought to remission by immobilization alone without need for decompressive procedures in the first instance[55].

ANTERIOR FUSION

Transarticular screws by anterior approach are placed in selected cases like anterior decompression, irreducible atlantoaxial subluxation, C1-C2 neoplastic lesion, locked atlantoaxial joint and when posterior transarticular screw fixation has failed[56].

Anterior stabilization for internal fixation of the odontoid is considered gold standard for the fractures of the odontoid requiring surgical stabilization. However this is contraindicated or not feasible when there is disruption of the transverse atlantal ligament, associated comminuted fracture of the atlantoaxial joint (one or both), unstable type 3 fractures, atypical type 2 fractures with comminution, irreducible fractures, associated thoracic kyphosis and pathological fractures [32,57,58].

The indications of dorsal fusion in the setting of odontoid fractures include

an associated fracture to one or both of the atlantoaxial joints and/or an associated Jefferson fracture of the atlas[59].

GALLIE'S FUSION

In 1939, Gallie introduced C1-C2 interspinous fusion by passing a steel wire around the posterior arch of C1 and then looped around the spinous process of C2 and tightened around onlay graft providing one point fixation. Gallie's fusion is the simplest of the posterior wiring techniques employing bone grafting. Gallie's technique provides stability to antero-posterior translation in flexion comparable to other techniques; it however provides only minimal stabilization in rotation and is overall biomechanically a poor construct[60]

These limitations of the Gallie's technique necessitate use of prolonged external immobilization postoperatively till fusion is achieved, and the technique has been noted to result in very high non union rates of upto 25%. As with other posterior wiring techniques, Gallies fusion requires an intact posterior arch of atlas.

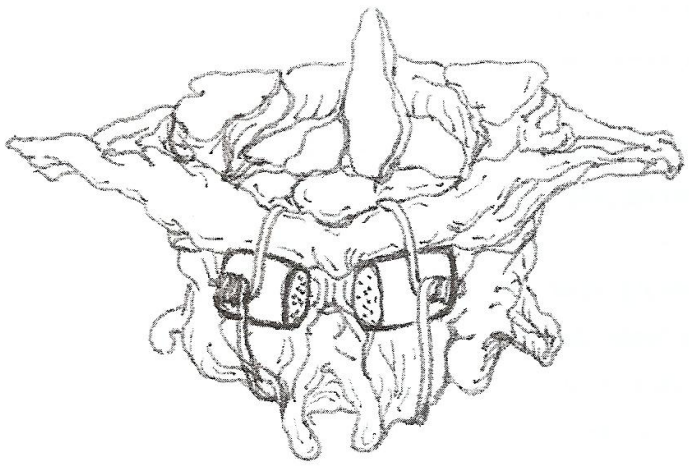
Fielding et al. in 1976 studied 57 spine fusions for atlanto axial instability. The average age of patients at time of fusion was 30 years. Out of 46 fusions by Gallie's technique, non union was reported in 1 and of 11 occipito cervical fusions, non union was reported in 2[40].

Chen XS et al. in 2004 reviewed 138 patients with surgical treatment for atlantoaxial instability. The average follow-up period was 3 years and 5 months. They concluded that Gallie's fusion technique is an effective method to manage atlantoaxial instability. However, for a successful outcome, careful wiring or cable traversing, decortication of the posterior arch of C1 and maintaining the physiological height between the C1 and the C2 posterior arch are mandatory [61]

BROOKS - JENKINS FUSION

In 1978, Brooks and Jenkins described atlantoaxial arthrodesis by wedge compression method where double twisted wires were passed under the arch of C1 and the laminae of C2, and twisted down over onlay graft giving two point fixation. They treated 15 patients with this technique out of which successful arthrodesis was achieved in 14. There was nonunion in 1 and in 1 patient, due to fracture of the posterior arch of the atlas, the fusion had to be extended from occiput to the 3'd cervical vertebra. The operation is only indicated when the posterior arch of the atlas is intact. They, however, recommended restricted use of this procedure in long standing rheumatoid arthritis or severe osteopenia[64].

The two wire construct described by Brooks and Jenkins provides better rotational stability compared to the Gallie's technique[62].



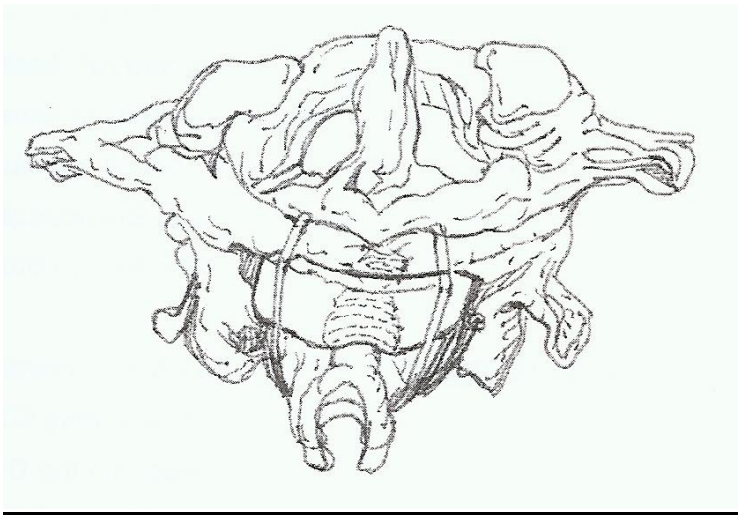
However, the Brooks and Jenkins technique of using 2 sub laminar wires is more technically demanding and has potential for cord compression after application[65].

OM Griswold et al. in 1978 studied 59 patients treated for atlantoaxial instability by various methods of fusion, 19 by plaster jacket and brace, 11 by single midline wiring and onlay one grafts and 30 by wedge compression method as described by Brooks and Jenkins. They concluded that modified Brooks procedure produced most satisfactory results with good fusion rates and less need for post op immobilization[41].

MODIFIED GALLIE'S FUSION

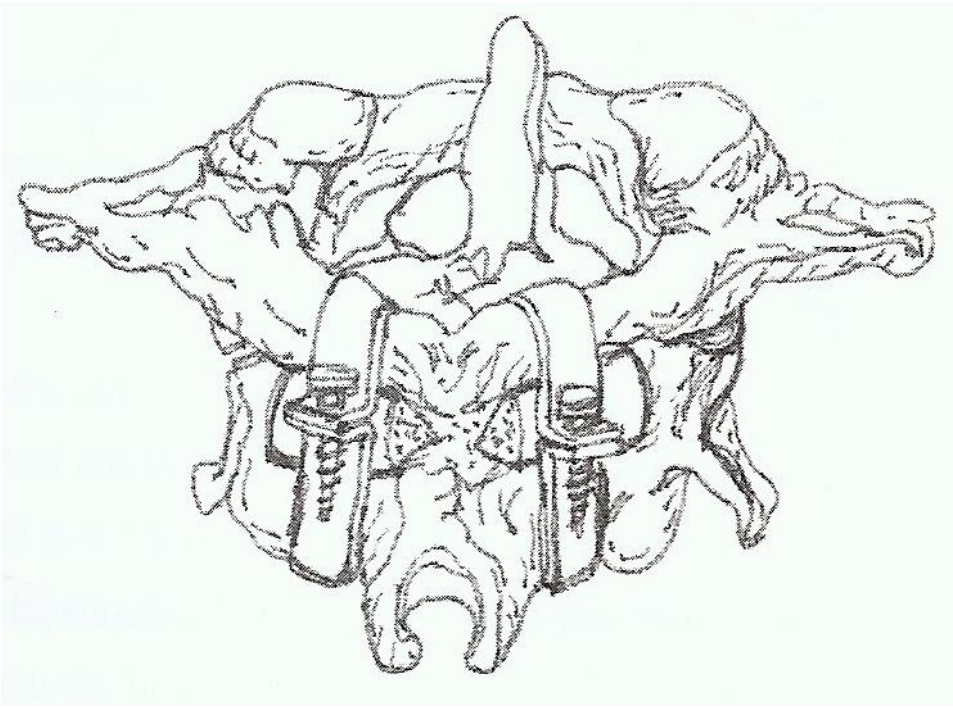
Sonntag described a modification of the Gallie's technique wherein a single bi-cortical graft is fit into the inter laminar space between the atlas and the axis and fixed with two wires passed around the posterior arch of the atlas and around the notched spinous process of the axis.

Sonntag described that this technique provided more stability compared to the Brooks and Jenkins method resulting in fusion rates upto 97 %[64]



INTERLAMINAR CLAMP TECHNIQUE (HALIFAX TECHNIQUE)

A double hook and screw construct stabilizes the laminae of C1 and the 82 bilaterally and secures bilateral interlaminar bone grafts[67].



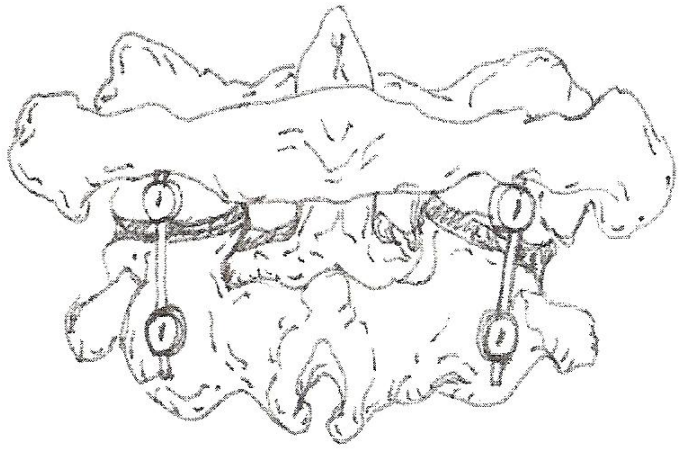
This technique has been proved biomechanically to be very efficient

in providing anteroposterior stability, though rotational stability is less than both the Gallie's and the Brooks-Jenkins method[62]

As with other posterior wiring techniques, placement of interlaminar clamps requires an intact arch of C1 and cannot be placed in case of an absent/deficient arch of C1. Interlaminar clamps required post-op immobilization with a cervical collar only; and no need for halo vest as in previous posterior wiring techniques.

C1-C2 ROD CANTILEVER TECHNIQUE

Atlantoaxial fixation using independently placed screws into the C1 lateral mass and the C2 pedicles connected with posterior rods has also been described[69,70].



As compared to the Magerl transarticular screw fixation, rod-screw fixation of the atlas and the axis is less technically demanding and obviates the risk of damage to the vertebral artery due to anatomic variations of the atlantoaxial complex.

Harms and Melcher in 2001 reported 100% fusion rates with no incidence of vertebral artery injury or dural laceration using pars screw and rod fixation. There were no instances of implant failure[67].

Stokes in 2002 reported no vertebral artery injury, C2 nerve injuries or spinal cord injuries with this technique[68].

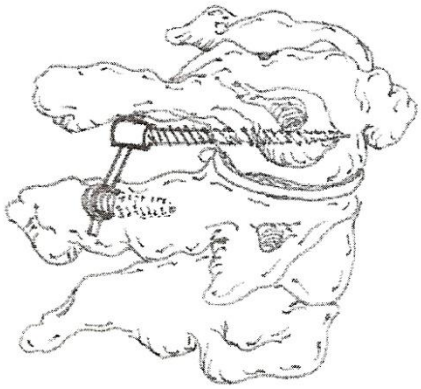
However, C2 pars screw placement cannot be used in patients with a narrow C2 pars or a medially located foramen transversarium[69].

BILATERAL CROSSING C2 LAMINAR SCREWS

An innovative technique of rigid screw fixation of the axis by using polyaxial screws inserted into the laminae of C2 in a crossing fashion has been described[70,71].

These screws are subsequently fixed to the C1 lateral mass screws creating a construct which stabilizes the atlanto-axial complex similar to the trans-articular screws[72,73].

These crossing intralaminar screws of the axis are considered safer as they are inserted away from the vertebral artery. However since intact posterior elements of C2 are required for their insertion, this procedure may not be useful in select patients having deficient posterior elements of C2.

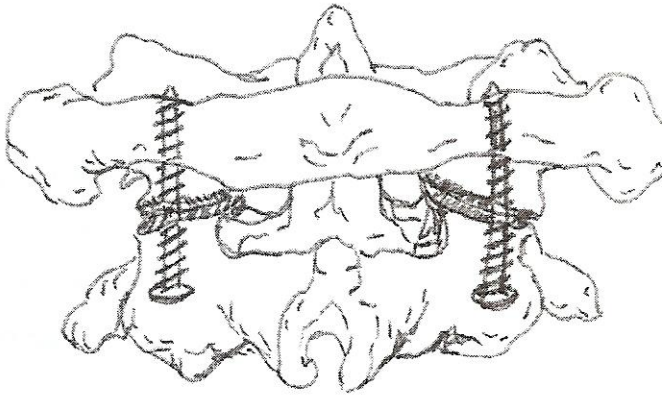


A study in 2005 has described 100% fusion rates with no neurological or vascular complication using this technique[74].

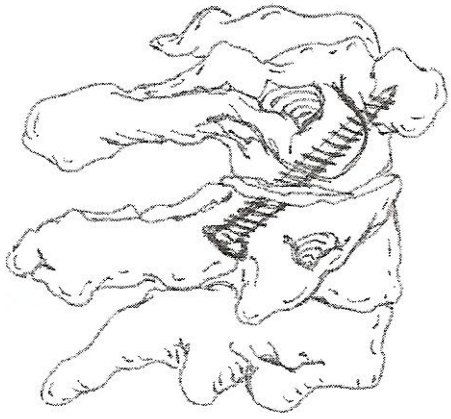
Recently in 2006, Horn et al. described a novel technique of treating atlantoaxial instability in patients who have unfavorable anatomy for transarticular screws due to anomalous course of the vertebral artery, by using C1-C3 lateral mass screw fixation[75].

TRANSARTICULAR SCREW TECHNIQUE

Magerl and Seeman in 1979 gave the concept of 3 point fixation of the C1-C2 vertebrae by posterior transarticular screws, passed from the posterior aspect of the axis, across the freshened atlantoaxial joint, into the lateral mass of the atlas[76].



The posterior transarticular screws do not rely on intact posterior elements of the atlantoaxial complex as was must in the previously used posterior wiring techniques. Hence posterior transarticular screws can be used in patients with absent or deficient posterior arch of atlas.



The transarticular screws greatly reduce rotatory movements besides the anteroposterior translation, in an unstable atlantoaxial complex and have good fusion rates. The transarticular screw is nearly 10 times stiffer in rotation than posterior wiring and improves resistance to shear stresses[77.]

Dieter Grob et al. in 1991 reviewed 161 patients who had undergone posterior fusion of the upper cervical spine with transarticular screw fixation of the atlantoaxial joints. The follow up period was a mean of 246 months. Only 5.9% of the complications were directly related to the screws. The rate of psedoarthrosis was 0.6%. There were no injuries to vertebral artery or medulla[12].

Grob et al. in 1991 reported 85% of posterior transarticular screws to be in ideal position, 8% as too lateral and 2% as too medial, in a study assessing malposition of screws post-operatively[77]. Too lateral screws cause injury to vertebral artery and too medial a position causes injury to the spinal cord.

Theiler R et al. in 1992 studied 32 patients suffering from rheumatoid arthritis and atlantoaxial dislocation who underwent atlantoaxial screw fixation and fusion to reduce the risk of cervical myelopathy. After a follow-up of average 21 months, all patients reported a significant reduction in postoperative pain and reduction of analgesic consumption[14].

In 1993, Marcott et al. reported 2 instances of dural tear in a series of 18 patients[78].

In 1993, Stillerman and Wilson reported no damage to the vertebral artery or the spinal cord after posterior transarticular screw fixation[79].

In 1994, Apfelbaum reported one incidence of bilateral vertebral artery injury leading to fatal complication, in a series of 40 patients operated upon with transarticular screw fixation[80].

In 1995, Curtis A Dickman et al. reported the use of cannulated screws in 37 patients. None of the cannulated screws bent or broke during surgery or follow-up. Only once, guide wire broke during drilling but was easily retrieved. No instance of intradural penetration or vertebral artery injury occurred. All 37 patients developed osseous union[81].

There were further reports that mention the use of cannulated screws for fixation of C1-C2 instability under the guidance of K wires[82,83].

Madawi et al. in 1997 reported an 87% fusion rate in 61 patients (37 rheumatoid arthritis) using transarticular screw fixation 18. They further reported that 14% screws were malpositioned with an 8 % rate of vertebral artery injury, although only one patient was symptomatic[84].

In 1998, a survey involving 847 neurosurgeons regarding 1318 patients treated with transarticular screws revealed a rate of vertebral artery

injury of 4.1% per patient. Most arterial, injuries were asymptomatic, and only 0.2% of all patients suffered a neurological deficit[21].

Farey ID, Nadkaim S, Smith N in 1999 compared 12 patients with atlantoaxial instability using the modified Gallie's technique and 15 patients treated using the Magerl transarticular screw fixation. Those treated by the modified Gallie's technique had good fusion in 58% and psedoarthrosis with recurrent instability in 33%. Those treated by transarticular screw had good fusion arthrodesis in 100% cases. However, one sustained vertebral artery injury[50].

GG Vecil et al. in 2001 described a modification of the Brooks posterior wring technique supplemented with transarticular screws for C 1-C2 instability. This method was used in 30 patients with no radiological failures[85].

S Panjaisee in 2001 studied 10 patients of atlantoaxial instability treated by transarticular C1-C2 screw fixation and concluded that the C1-C2 transarticular screw fixation is the best surgical treatment for C1-C2 instability. No complication was encountered. No screw or bone graft slipping was noted[86].

Naseer R, Bailey SI in 2001 reported results of treatment of 11 patients with atlantoaxial instability using transarticular posterior screw fixation and lateral bone grafting. The results showed good reduction and a stable fixation[87].

Reilly TM in 2003 studied 67 patients of atlantoaxial instability in whom 8 had traditional posterior C1-C2 wiring (group 1) whereas 33 were managed with transarticular screw fixation (group 2). In group 1, there were 7 psedoarthrosis and 4 fibrous unions. In group 2, there were no

psedoarthrosis and 2 fibrous~, unions. In group 1, there were 12 complications as compared to 4 in group[88].

Toussaint P in 2003 studied 4 patients of atlantoaxial instability treated by. 2 transarticular C1-C2 screws without any posterior interspinous graft. They concluded that the risk of screw malposition and vertebral artery or neural injury is minimal[89].

Taqqard DA et al. in 2004 studied 27 patients who had undergone atlantoaxial arthrodesis. Successful fusion was achieved in 13 of 14 patients treated with transarticular screw technique as compared with 5 of 13 patients who underwent posterior wiring techniques[90].

Fountas et al. in 2004 performed a retrospective analysis of 23 patients treated with C1-C2 transarticular screw fixation. The position of screw was judged as satisfactory in 21 patients (91.3%). Solid osseous union was detected in 19 patients (82.6%)[91].

Klaczl Z et al. in 2004 studied 41 patients with rheumatoid arthritis with instability of the upper cervical spine treated surgically. Out of these, 24 underwent the Magerl transarticular screw fixation. They recommended use of transarticular screws in younger patients. However, once destruction of the atlantoaxial joint, lateral subluxation or cranial migration of the dens is present, occipitocervical fusion is indicated[92]

Wang YQ et al. in 2004 studied 19 patients who underwent bilateral C1 C2 transarticular screw fixation, 8 of which had an incompletely reduced atlantoaxial dislocation. They concluded that for patients who have an atlantoaxial dislocation that could not be reduced completely, if there is enough bone to contain the screw, performing bilateral transarticular screw fixation is still feasible and safe[93].

Suchomel P et al. in 2004 Studied 80 patients of transarticular screw fixation over a 9 year period. They found optimal placement of screws in 68.7% and misplacement of screws in 2.7%. They had 6 screws broken in 4 patients. Vertebral artery injury was reported in 4 cases, and there was 1 case of dural tear. They had osseous fusion in 87.3% patients at 12 months[94].

AIMS

AND

OBJECTIVES

1. To evaluate in patients with atlanto axial instability, the efficacy of posterior transarticular screw fixation in achieving:

    - ❖ Relief of pain
    - ❖ Improvement in neurological status
    - ❖ Achieving bony fusion
    - ❖ Post operative neck motion

2. To see for any complication arising from the above procedure.

MATERIAL

AND

METHODS

STUDY PROTOCOL

The presents study was conducted on patients who presented in the orthopedics clinics at Government Medical College and Hospital, Chandigarh.

Inclusion Criteria:

- Patients with post traumatic atlantoaxial instability
- Patients with atlantoaxial instability secondary to rheumatoid arthritis
- Radiological evidence of Atlanto Dental Interval of > 3mm was considered mandatory for inclusion in the study.

All the included patients underwent posterior transarticular screw fixation at Government Medical College and Hospital, Chandigarh,

Exclusion Criteria:

- Short neck
- Concomitant thoracic kyphosis.
- Barrel chest deformity Congenital anomalies like absence of posterior elements of C1 with atlantoaxial instability.

Each patient was evaluated clinically with X-rays of the cervical spine in lateral projection and open mouth view in antero-posterior projection. The evaluation was done as per the proforma included (appendix). The follow-up was done at 3 months, 6 months and 1 year. At each follow-up, each patient was evaluated as per the Grab et al classification.

Grob et al. Classification of results[77]

Objective rating

- Good (no pain, solid fusion)
- Fair (Moderate pain, solid fusion
- Bad (non union, severe pain)

Subject rating

- Good (no serious pain, no restriction of activity)
- Fair (periods of pain, working capacity reduced)
- Bad (permanent severe pain, disability)

The following was the surgical procedure adopted for posterior transarticular screw fixation of the atlantoaxial complex:

SURGICAL PROCEDURE

Anesthesia: General anesthesia

Position: The patient was positioned prone, with skeletal traction applied through tongs, and with the head in a cervical rest in position of slight flexion, to allow good posterior access to the cervical spine.

Steps of Surgery: After painting and draping, skin and subcutaneous tissue was infiltrated with 1: 500000 adrenaline solution to aid in hemostasis. Standard posterior midline exposure of the cervical spine was performed from the occiput as far as distally as deemed appropriate for the proposed guide wire trajectory or screw insertion, up to C6 or C7. By sharp dissection using electro-cautery, posterior aspects of C1-C3 vertebrae were subperiosteally exposed. The attachments of the more distal vertebra were released only to the extent as considered absolutely essential for the guide wire insertion. The C1-C2 and the C2-C3 facet joints were identified bilaterally. The starting point for the ~I transarticular screw is located in the central third of the inferior articular process of the axis. Under fluoroscopy control and using a drill, a guide wire was inserted from this starting point directed cranially across the C 1-C2 facet joint, and towards the lateral mass of the atlas. A straight paramedian trajectory with no medial or lateral angulation was used. The required length of screw was then determined using a guide wire of similar length. A 2.5 mm cannulated drill bit was then used to drill over the guide wire. The drill bit should perforate the cortex of lateral mass of C1. After tapping with 4.0 mm cannulated tap, a 4.0 mm partially threaded cannulated cancellous screw was advanced over the

guide wire across the C1-C2 facet joints, taking care to maintain a straight paramedian trajectory. Aiming medially results in a smaller area of C1 lateral mass engagement, whereas aiming laterally can lead to a vertebral artery injury. Bone graft harvested from posterior iliac crest was placed at the decorticated facet joints and the inter-laminar space. It was ensured that the head is not rotated to either side during the surgery.

After treatment: The tongs were removed, and Philadelphia collar worn for 8 to 12 weeks. The patient was permitted to sit with support and collar from the first post operative day and onwards. The drain was removed after 48 hrs and wound inspected on the third post operative day. Suture removal and discharge was done on the twelfth post op day.

Follow up: At follow-up the patients were evaluated subjectively for the severity of pain and objectively to see for improvement in neurological status. Radiological evaluation included antero-posterior and lateral X-rays to evaluate bony fusion. The patients were evaluated to see for any complications arising for the above said surgical procedure.

OBSERVATIONS

AND

RESULTS

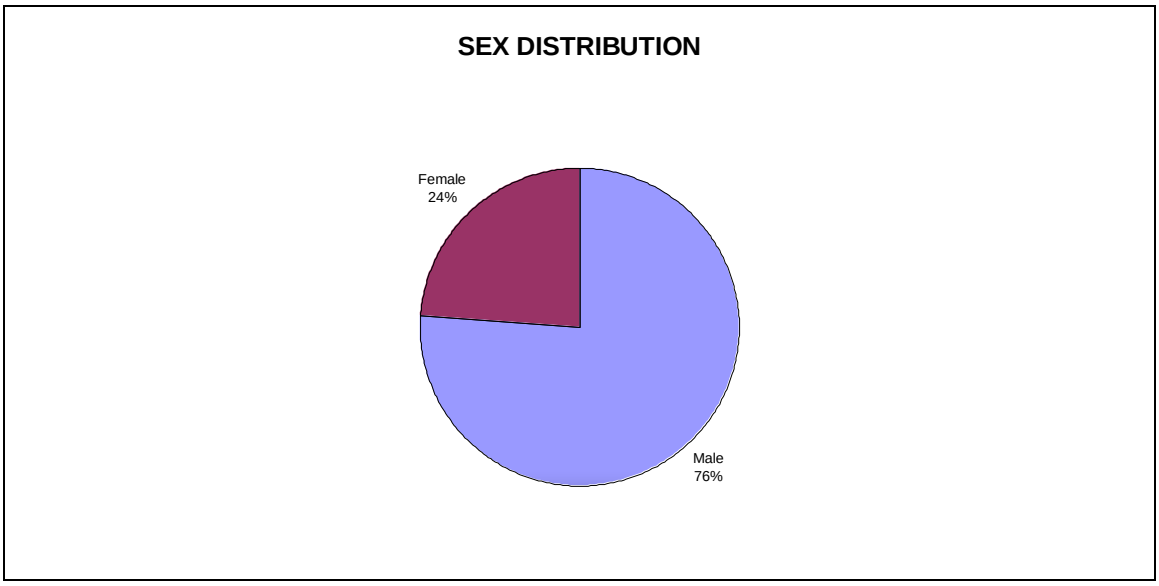
A total of 25 patients, who underwent Posterior transarticular screw fixation for Atlantoaxial instability at Government Medical College and Hospital, Chandigarh, were evaluated as part of the study.

AGE DISTRUBATION

The mean age of the patients included in the study was 34 years (34±10.704), ranging from 19 to 57 years.

SEX DISTRUBATION

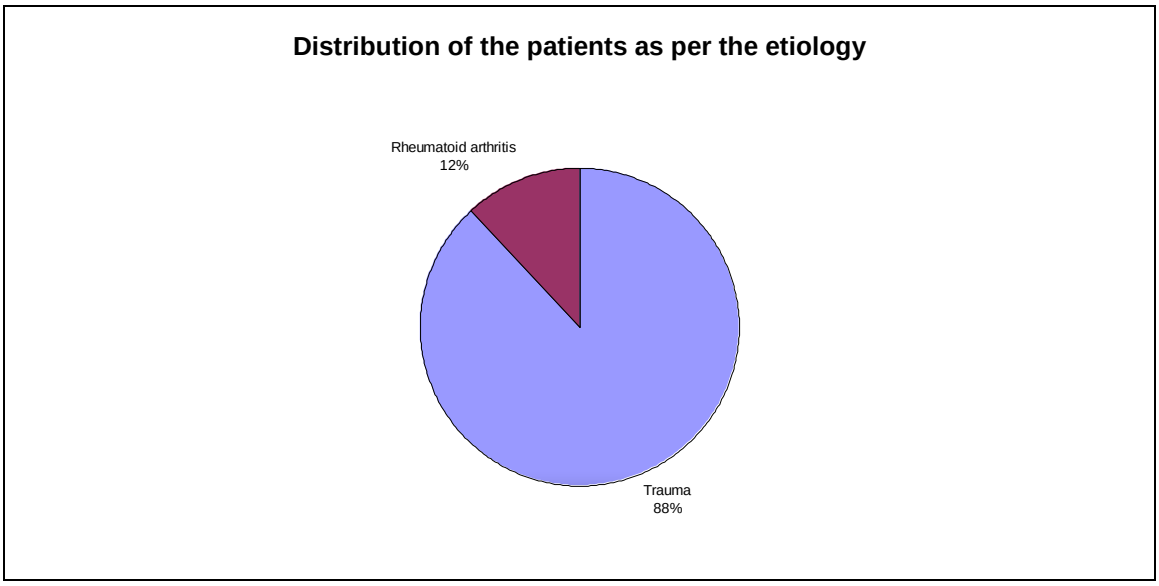
19 (76 %) of the patients included in the study were males, while 6 (24 %) were females. The mean age of the male patients was 32.16 yrs (32.16±10.925), while that of the female patients was 39.83 yrs (39.83±8.159).



DISTRIBUTION OF PATIENTS AS PER ETIOLOGY

The cause of the atlanto-axial instability among the patients included in the study was one of the following:

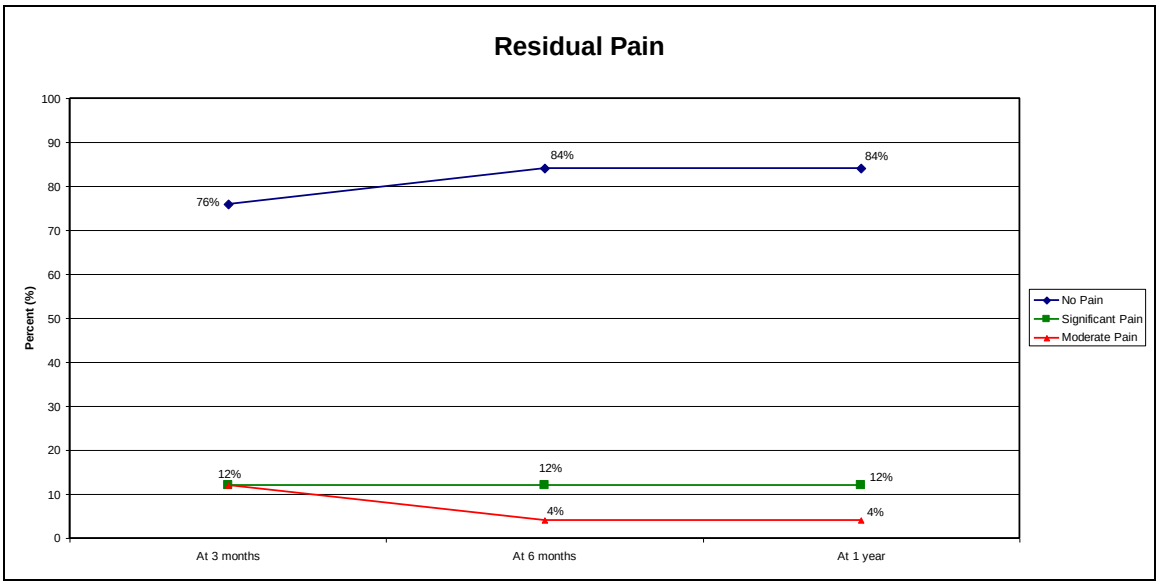
- Trauma: 22 Patients (88%)
- Rheumatoid arthritis: 3 Patients (12 %)



RESIDUAL PAIN

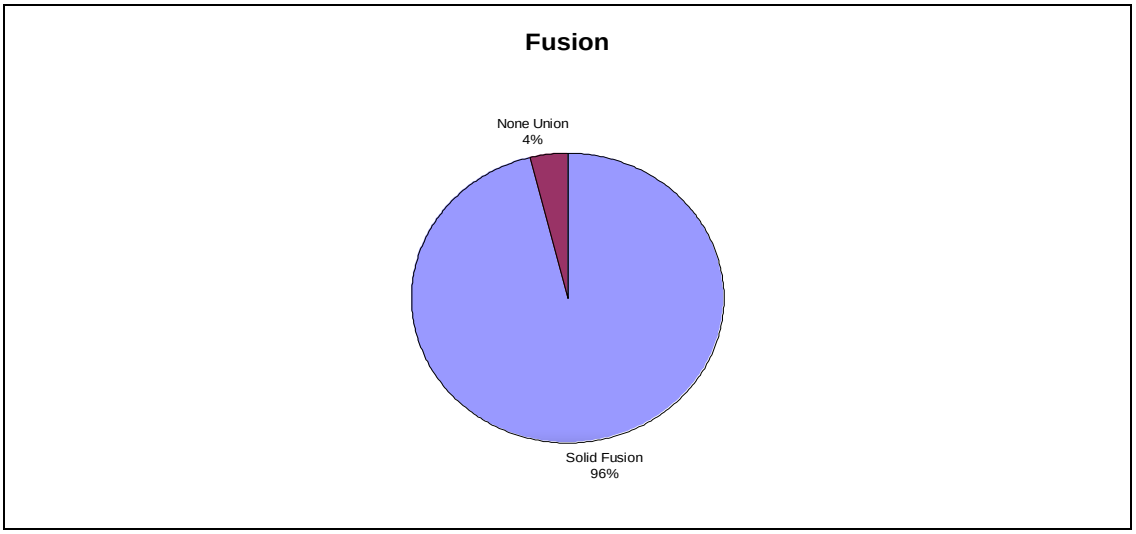
In each pt., the residual pain was evaluated at each follow up, as No pain (N), Moderate pain (M) or Significant pain (S), as described by the patient

At 3 months: N-19 (76%)
S-3 (12%)
M-3 (12%)
At 6 months: N-21 (84%)
S-3 (12%)
M-1 (4%)
At 1 year: N-21 (84%)
S-3 (12%)
M-1 (4%)



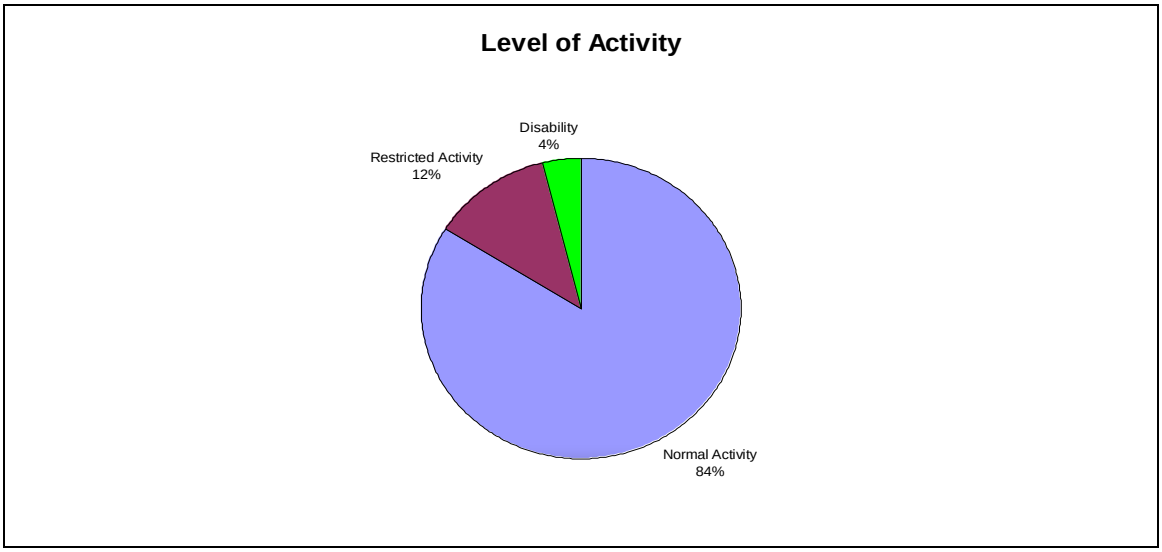
FUSION

Solid fusion was achieved in 24 patients (96%) but one (4%) of the patient showed non-union as noted on final follow-up x-rays.



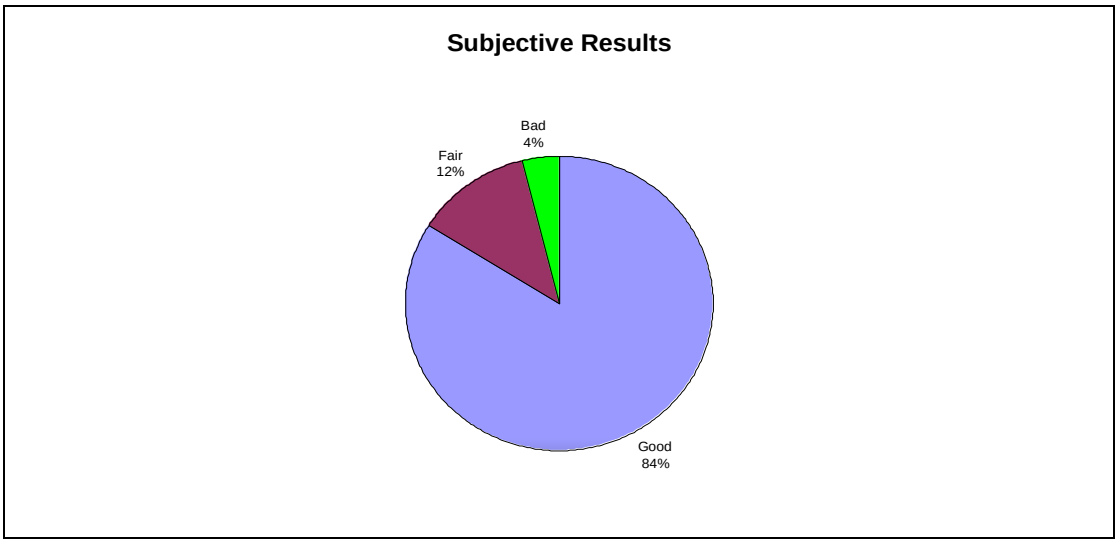
ACTIVITY

At their respective final follow-ups, 21 (84%) of the patients had normal activity levels, while 3 (12%) of the patients had restricted activity, and 1 (4%) had disability.

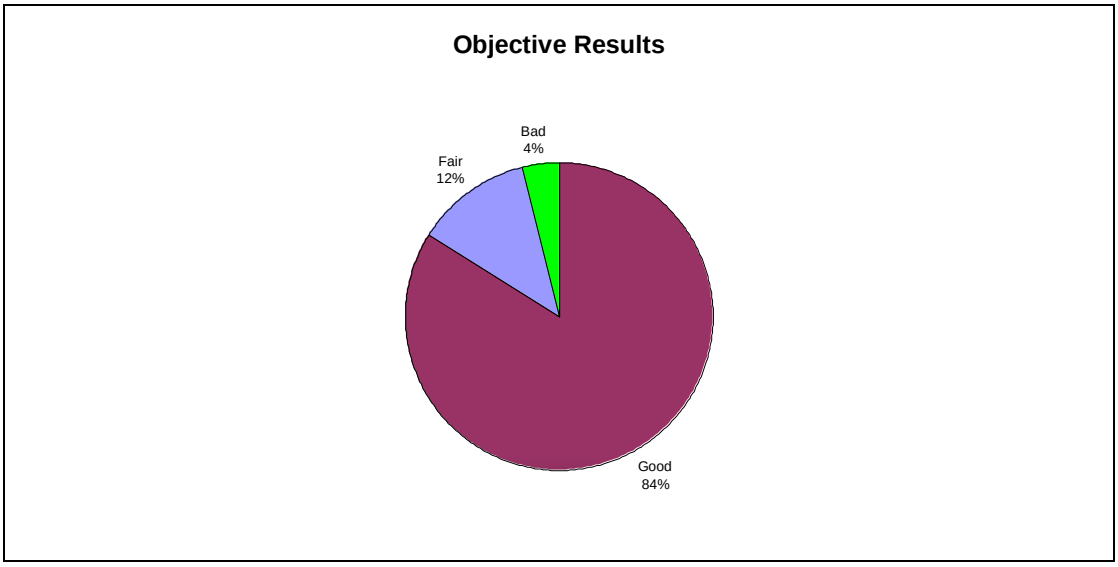


The results were evaluated based on subjective (residual pain, level of activity) and objective (residual pain, fusion) criteria.

The subjective results at final follow up were noted to be good in 21 (84%), fair 3 (12%) and bad in 1 (4%).



The objective results at final follow up were noted to be good in 21 (84%), fair in 3 (12%), patients and bad in 1 (4%) patient



COMPLICATIONS

One of the major complication noted during the study was injury to the left vertebral artery in one case (4% of the total patients), which necessitated abandonment of ipsilateral screw insertion in that case. However, the same was on follow-up not found to be associated with any dysfunction, and fusion occurred satisfactorily.

In one of the cases, the screws backed out, and though fusion occurred satisfactorily in the patient, the patient continues to have some residual pain, and has been advised hardware removal though he has not consented for the surgery.

Non-union occurred in one of the patients, who however developed a stable psedoarthrosis, with pain and disability. This patient was advised repeat surgery but refused for the same.

There was no incidence of neurological injury or infection noted during the course of the study.

DISCUSSION

AGE DISTRIBUTION

The mean age of the patients included in the study was 34 years (34+10.704), ranging from 19 to 57 years.

Bohlman in 1979 studied 300 patients who were hospitalized for acute cervical injuries. Out of these, 69 had involvement of the atlantoaxial joint. The age of patients included ranged from birth (2 patients) to eighty-seven years; the average age was forty-seven years. More than half (161 patients) were twenty one to fifty years 0ld[95].

Our results as also a review of literature, suggest that no age is exempt from this problem.

SEX DISTRIBUTION

19 (76 %) of the patients included in the study were males, while 6 (24 %) were females.

In 2001. Haid RW, Subach BR and others studied results of transarticular screw fixation for atlantoaxial instability in 75 consecutive operations. The study group was composed of 43 men and 32 women, with a mean age of 44 years ranging 8 to 76 yr[36].

CAUSE OF ATLANTOAXIAL INSTABILITY

The cause of the atlanto-axial instability among the patients included in the study was one of the following:

- Trauma: 22 Patients (88%)
- Rheumatoid arthritis: 3 Patients (12 %)

RW McGraw in 1973 published a paper defining the indications for atlanto axial arthrodesis. They included congenital abnormality of dens, atlanto axial rotatory subluxation, fracture of dens and rheumatoid arthritis[52]

In a study on 161 patients in 1991, the indication for posterior fusion of upper cervical spine was trauma and post traumatic instability in 40.6 %, rheumatoid arthritis in 31.0%. congenital anomalies in 12.4%, psedoarthrosis of dens in 11.1 %, degenerative arthritis in 4.3%, infections in 1.2%, tumors in 1.2%[12].

A W B Heywood et al in 1988 studied 30 fusion operations in 26 patients ~f rheumatoid arthritis with cervical spine instability and concluded that progressively increasing pain and instability are valid indications for fusion in rheumatoid cervical spine[55].

RESULTS

In each patient, the residual pain was evaluated at each follow up, as No pain (N), Moderate pain (M) or Significant pain (S), as described by the patient

- At 3 months: N-19 (76%)
  M-3 (12%)
  S-3 (12%)

- At 6 months: N-21 (84%)
  M-3 (12%)
  S-1 (4%)
- At 1 year: N-21 (84%)
  M-3 (12%)
  S-1 (4%)

In 2004, 24 patients with rheumatoid arthritis and posterior transarticular screw fixation were evaluated according to the Functional Rating Index (FRI). 30 patients improved (14 patients by more than 10 points), 6 patients did not change and 4 worsened. The improvement after 3 and 12 months was statistically significant ($p < 0.001$)[91].

In 2006, Ronkainen et al studied 86 rheumatoid patients who had undergone transarticular screw fixation. In two-thirds of the patients there was relief or decrease of pain, and the functional capacity improved. Neurological deficits subsided in 53% of cases[96].

Solid fusion was achieved in all but one patient had no bony fusion radiologically.

In a study in 2004, Schomel P et al documented fusion in 70.8% cases at 6-months follow-up, and in 87.3% at 12 months. Segmental stability was achieved in all patients, even in cases with incomplete fusion as seen on radiograph 120.

At their respective final follow-ups, 21 (84%) of the patients had normal activity levels, while 3 (12%) patients had restricted activity, and 1 (4%) had disability.

The results were evaluated based on subjective (residual pain and level of activity) and objective (residual pain and fusion) criteria.

The subjective results at final follow up were noted to be good in 21 (84%), fair in 3 (12%) patients and bad in 1 (4%) patient.

The objective results at final follow up were noted to be good in 21 (84%), fair in 3 (12%) patients, and bad in 1 (4%) patient.

One of the major complication noted during the study was injury to the left vertebral artery in one case (4% of the total patients), which necessitated abandonment of ipsilateral screw insertion in that case. However, the same was on follow-up not found to be associated with any dysfunction, and fusion occurred satisfactorily.

In one of the cases, the screws backed out, and though fusion occurred satisfactorily in the patient, the patient continues to have some residual pain, and has been advised hardware removal, though he has not consented for the surgery.

A study in 1991, found that there was loosening and displacement of the screws, compared to their immediate postoperative position, in 3 patients. However, all 3 developed solid fusion and were free of pain[12].

Non-union occurred in one of the patients, who however developed a stable psedoarthrosis, with severe pain and disability.

In 1994, Apfelbaum reported one incidence of bilateral vertebral artery injury leading to fatal complication among 40 patients operated upon with transarticular screw fixation[83].

In 2001, a study documented osseous union in 96% patients treated by posterior transarticular screw fixation. There were no hardware failures, and 3 patients developed psedoarthrosis. No incidence of vertebral artery injury, spinal cord or hypoglossal nerve injury was noted[38].

Fountas et al in 2004 performed retrospective analysis patients treated with C1-C2 transarticular screw fixation and detected solid osseous union in 82.6% patients[94].

The results of the present study, coupled with a review of the

literature, effectively establish the procedure of posterior transarticular screw fixation as an effective and safe means of management in atlantoaxial instability.

SUMMARY

AND

CONCLUSIONS

The present study was conducted in the department of orthopaedics at Government Medical College and Hospital, Chandigarh on patients undergoing posterior transarticular screw fixation in atlantoaxial instability. The study and the conclusions thereof can be summarized as follows:

1. A total of 25 patients with an age of 19-57 years were included in the study. 19 of the patients were males while 6 were females.

2. Each patient was evaluated pre-operatively using cervical spine X-rays in anteroposterior, lateral, and open mouth view. In the post-operative period, patients were assessed clinically by Grob et al. subjective and objective criteria and radiologically.

3. The most common presenting symptoms in the patients included is the study was neck pain and difficulty in movement of neck

4. The most common cause of atlantoaxial instability was trauma (88% of the patients).

5. At the first follow-up at 3 months, 76% of patients had no residual pain. At the end of 1 year, 84% patients had no pain and 12% had only moderate pain.

6. The technique of transarticular screw fixation enabled fusion in 96% of patients.

7. 84% patients had normal activity levels after surgery.

8. At follow-up, 84% patients had subjectively good results and 12% patients had subjectively fair results. When assessed as per the objective criteria, 84% patients had good results.

9. One major complication encountered during the said surgical procedure

was injury to the vertebral artery in one patient, who however had no neurological deficit postoperatively.

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