Original Article

Recent trends in cervical stabilization

Lt Col PK Sahoo* Wg Cdr R Chaturvedi# Wg Cdr RM Sharma#

ABSTRACT

Cervical spine, like rest of the spine is a mechanical structure which transmits load, allows and protects spinal cord. A stable cervical spine will be able to undergo physiological displa without cord or root injury. An unstable spine gives rise to deformity, pain and also may damag cord and nerve roots.

Easy avilability of computerised tomography (CT) and magnetic resonance imaging (MI revolutionized the diagnostic evaluation of spinal instability by delineating the exact nature, e extent of pathology and anatomy of spine and spinal cord. This guides for appropriate mana protocol and approach for spinal stabilization.

Spinal instrumentation gives immediate spinal stability, enhances quality of bone fusion, facilitat mobilization, rehabilitation and creates an environment for neurological recovery.

Provision of modern spinal turning frames, intensive care units (ICU) with multimode ventila monitoring facilities, operation theatre with spinal tables, image intensifier, high speed pneumat operating microscope, newer anaesthetic drugs, techniques, various spinal instruments, implan surgeons own experience plays key role in spinal stabilization.

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KEYWORDS : Cervical spine stabilisation; Titanium cervical spine locking plate (CSLP); Ego head screw; Locking screw.

Cervical spine like rest of the spine is a mechanical structure, which transmits load, allows motion and protects the spinal cord. A stable spine as defined by white and Punjabi [1] is the ability of the spine, under physiological loads, to prevent (a) initial or additional damage to the spinal cord or nerve roots, (b) deformity or (c) pain from structural changes. An unstable spine gives rise to incapacitating deformity, pain and also may damage the spinal cord and nerve roots. Cervical becomes unstable due to developmental dis trauma, infections, degenerative diseases, v

* *Classified Specialist (Surgery and Neu gery) Command Hospital, AF, Bangalo 007.*

\# *Classified Specialist (Anaesthesiolog mand Hospital, AF, Bangalore-560 00*

body tumours and following surgery for spinal disorders.

Initial description of anterior approach for cervical discectomy always included stabilisation procedure by bony fusion [2]. This was advocated and popularized after the pioneering work of Smith and Robinson 1955[3] and Cloward 1958[4] to prevent the possibility of developing late kyphosis from disc space collapse or radiculopathy from foraminal narrowing. The insight provided by these approaches and basic understanding of the biomechanical principles of spinal fusion, easy availability of newer modalities of investigations like computerised tomography (CT), magnetic resonance imaging (MRI) scans, introduction of sophisticated neuro surgical equipments and implants like operating microscopes, high speed pneumatic bone drill, titanium cervical plates and screws has refined the technique of cervical spinal fusion and stabilisation.

Caspar [5] proved that the recovery from neurological deficits was better in surgically fused and stabilized patients after multiple level discectomy and Corpectomy. Basic principles of stability according to him are realignment, bone-to-bone contact, absolute immobilization and compression of fragments. These principles are the basis of plate osteosynthesis.

Anterior cervical plates and screws are manufactured from stainless steel (316L), vitallium and titanium. Stainless steel possesses structural, mechanical and physical characteristics these are not CT or MRI compatible and has risks of a compromised biological response resulting in infection. Vitallium, cervical plates and screws do not have adequate fatigue resistance, strength and exhibit low resistance to corrosion. The application of titanium plates and screws has gained worldwide acceptance because of its higher strength, resistance to corrosion, lightweight, biocompatibility and most importantly CT and MRI compatibility. Titanium cervical plates of different sizes with expansion head and locking screws indigenously manufactured by GESCO, Chennai were used for anterior cervical fusion in the present study.

This study was under taken with aim of:

1. Anterior cervical spine instrumentation by titanium plates, expansion head and locking screws for:
   (a) Acute injury to the cervical spine involving the vertebral body or disc requiring corpectomies or discectomy.
   (b) Multiple levels prolapse intervertebral disc (PID) with discectomy and bone grafting.
   (c) Following Corpectomy/discectomy for tuberculosis, vertebral body tumour.
   (d) Post surgery instability and post laminectomy kyphosis.
   (e) Any other conditions giving rise to cervical spinal instability.
2. To achieve:
   (a) Immediate stability
   (b) Good neurological recovery
   (c) Early mobilization and ambulation
   (d) Avoid rigid external cervical orthosis

Material and Methods

Twenty patients admitted, evaluated and operated at CH (AF) Bangalore from Jan 99 to Jun 2000 were the subjects of this study.

On admission patients were evaluated clinically with detailed neurological examination.

Anterior posterior (AP), Trans lateral radiographs and Magnetic Resonance Imaging (MRI) of the cervical spine was carried out in all patients to find out: -

(a) The site, and extent of the lesion

(b) The cause of the lesion like trauma, tuberculosis, tumours, degenerative diseases or any other condition.

(c) Any cord changes

Operative technique

The patient placed in supine position with cervical traction using Mayfield's clamp and shoulders taped and pulled to the foot end of the table. The approach is made from the right side with a vertical incision along the anterior border of sternocleidomastoid from angle of mandible to suprasternal notch for exposure from C3 to C7. Platysma incised in the same line. The middle layer of cervical fascia was split between sternomastoid and strap muscles. Common facial vein at C3 and omohyoid at C6 level require division depending on the level of surgery. Deep cervical fascia overlying the longus colli, the prevertebral fascia and anterior longitudinal ligament incised in the midline and retracted laterally. The longus colli muscles dissected on both sides above and below the area required for stabilisation. Caspar transverse retractors placed underneath the longus colli muscles and longitudinal retractors placed for vertical retraction to avoid injury to the soft tissues. Caspar distraction pins and distracter placed after making drill holes on the vertebral bodies above and below the level of Corpectomy\discectomy as delineated by image intensifier. Corpectomy\discectomy carried out using high-speed pneumatic bone drill under microscope. A tricortical bone graft harvested from the iliac crest was placed and Casper distracter removed. Titanium cervical plate of appropriate size was placed above and be level of bony fusion. Titanium cervical pla fixed with 14 mm size expansion head a and locking screws. AP and lateral rad of the cervical spine were taken post ope Neck was immobilized with soft cervic for a period of 7 to 10 days. Postop neurological evaluation, AP and lateral rad of cervical spine was carried out at 2 we months and 6 months. The complicatio outcome evaluated in all cases.

Results

Fourteen (70%) were in the age grou to 60 years. Three (15%) were between 2 year and another 3 (15%) were above the 60 years. Eighteen (90%)males And 2(10%) were in this study.

Seventeen (85%) had neck pain, 1 had brachialgia, 16 (80%) had myelopathy, 4 had radiculopathy. Sphincteric disturban present in 4 (20%) and one Patient compromised respiration.

One level anterior cervical cord compr due to wedge compression fracture/disc Pro due to cervical spine injury was present in 4 of patients. Two Levels anterior thecal compr in 9 (45%) and 3 level anterior thecal Compr in 7(35%) was present as per MRI scan. T (15%) had Associated Myelomalacia of th in MRI scan. Fourteen patients (70%) with m level PID, 4 (20%) with cervical spine injur 2 (10%) with post laminectomy instab underwent anterior cervical Decompr and instrumentation.

One level discectomy in 2 (10%), one Corpectomy in 2 (10%), 2 level discectomy (45%) and 3 level discectomy in 7 (35%) fol

by bone grafting and anterior cervical titanium plating with expansion head and locking screw fixation was carried out.

Two patients had temporary hoarseness of voice and in 2 other patients 2 screws perforated in the intervertebral disc space and fixed to the graft. There were no operative site complications, donor site complications, graft extrusions or implant failure.

Neck pain improved in all 17 (100%), brachialgia improved in all 13 (100%) cases. In patients with radiculopathy, 2 (50%) had excellent and the other 2 (50%) had good recovery. Amongst 16 patients with myelopathy 8 (50%) had excellent recovery, 6 (30%) had good recovery and in 2 (10%) neurological recovery were minimal but ambulatory with support. These two patients had cord changes in the form of Myelomalacia in MRI scan. Three patients became continent and one is on intermittent self-clean catheterization out of the 4 patients who had sphincteric disturbances. None of the patients deteriorated neurologically or there was any death in the operated cases. The radiological alignment was good and the plate was in situ in all the patients at 2weeks, 2 months and 6 months follow up. There was good bony fusion and excellent stabilisation at 21/2 months in all patients.

In the immediate postoperative period a soft cervical collar was put in 16 (80%). In 4 (20%) patients, with cervical spine injury, hard cervical collar were used. Eighteen (90%) patients were ambulatory on the first postoperative day and 2 (10%) with spinal cord injury and quadriparesis were ambulant with support after 2 weeks of surgery. MRI scan was carried out in 5 patients post operatively and the titanium plates and screws were found to be MRI compatible.

Discussion

Initial description of anterior approach for cervical discectomy always included fusion procedure [2], which was popularized, by Smith and Robinson in 1955[3] and Cloward 1958 [4]. This was advocated to prevent the possibility of late kyphosis from disc space collapse or radiculopathy from foraminal narrowing. Arguments in favour of fusion include the maintenance of disc space height that avoids vertebral setting and minimizes the potential for the development of foraminal stenosis. Also fusion stabilizes the spine and may prevent progressive deterioration due to instabilities [6]. The basic principle is that, the bone graft between the involved interspaces gives inherent stability and allows fusion to occur even in degenerative situations. The anterior cervical decompression and fusion is now widely accepted as a safe and effective treatment modality for cervical disc herniation. Studies for this procedure have found this to be reproducible, with a high level of patient satisfaction [4,7,8]. There are several factors affecting the fusion rate of anterior graft including the type of graft [6], surgical technique [9,10] and also the number of operative levels. By using the modified Robinson technique, the fusion rates of single level procedure can be expected to be in the low to mid-90th percentile [9]. This success rate decreases with increasing the number motion segments grafted [2,6,11].

Study by Sanford for three level anterior cervical decompression and fusion using modified Robinson technique revealed the radiological fusion rate was far less than satisfactory. The group of patients with a pseudoathrosis had a statistically significantly worse pain outcome. Most unions were not as a result by graft collapse but rather failure of one of the two-graft body interface to ossify. The reasons for decreasing fusion rate with increasing number of operative levels are not clearly defined. Intuitively the more

surfaces there to heal, the higher the pseudoathrosis rate will be per patient. Altered biomechanics probably play the largest role, which is supported by work of yoo et al sharing increasing contact stress at graft body interface, when the number of operative levels increases [12]. Therefore the authors recommended anterior plate fixation for two or three level anterior cervical discectomy. Anterior internal fixation increases the stability of the construct and is safe and effective treatment of an unstable spine segment.

The technique of cervical Corpectomy was developed initially for treatment of vertebral body fractures. Relatively poor results for operative treatment of cervical spondylotic myelopathy (CSM) by the posterior route lead to further development of multilevel Corpectomy followed by stabilisation using bone. A comparative review of CSM reveals that anterior approaches have a success rate of 75% compared to 60% for posterior approach [13]. Other indications for this surgical procedure are ossification of posterior longitudinal ligament (OPLL) [14], pyogenic or tubercular involvement of cervical vertebra and vertebral body tumours. Corpectomy has been utilized for management of intradural lesions located exclusively anteriorly on the cord. Multi segmental Corpectomy is most commonly performed in the treatment of CSM. Alternatively, multiple anterior discectomies have been described. This approach is feasible and safe for up to 3 vertebral excisions [15], although up to 4 level corpectomies have been performed. After Corpectomy stabilisation is also mandatory and is best achieved by an autogenous bone graft from the iliac crest or fibular strut graft with plating. The fibular graft is recommended when more than two level Corpectomy is performed. Fusion with autogenous iliac crest cortico cancellous graft is rapid and occurs usually within 3 months. Commonly available heterografts like surgibone have not become popular.

Anterior surgery has also been us correction of cervical kyphosis. Cervical ky arises from either a loss of posterior sk elements or loss of anterior supporting str or a combination of both. It can occur as a of extensive laminectomy, post laminec irradiation, congenital, metabolic or in conditions. The angulations can be m progressive, involve multiple levels and pr neurological manifestations. Patients with de posterior elements, secondary to ext laminectomy, are best treated by pre ope traction, followed by anterior cervical relea strut graft fusion with plating. Anterior ce fusion with iliac bone with plating has now accepted as the treatment of choice when an deficiency occurs.

Orozco in 1970 first used anterior ce plate in case of cervical trauma. Subsequ Caspar standardized the method with s operating steps and instrumentation in 19 The basic principle was based on the AO group's recommendations for metal f osteosynthesis. Fast and stable bone heali observed if there is correct realignment, good to bone contact, compression and abs immobilization by anterior cervical instrumen with metallic plates and screws. More over neurologic outcome is predicted because surgical immobilisation. Caspar's trip plate osteosynthesis technique incorporate principles, gives optimal neural ba environment because of liberal bony decompre This is safe, stable, and strong and p immediate stability.

Operative internal fixation of an unst cervical spine provides improved segm stability and reduces the need for prolonged rest and /or rigid external orthosis. Int fixation can be performed in conjunction wit appropriate neural decompression proce

Osteosynthetic plate stabilisation technique provides additional immediate internal stability resulting in an improved fusion success rate and less dependence on external orthotic immobilization. In this series 18 (90%) of patients were put on soft cervical collar only for 7 to 10 days post operatively.

The ultimate goal of spinal instrumentation and grafting is to optimise the creation of a fusion mass of the proper size and structure in the shortest period of time. This can be achieved by attending to three well-recognized principles of bone graft surgery (a) adequate preparation of the graft bed, (b) selection of the appropriate graft and (c) an adequate period of postoperative immobilization of the fusion site. Solid fusion usually occurs within 3 months when the principles are adhered to [17].

Several authors have described the use of osteosynthetic plate, the Caspar plating being widely used [5,18]. The Caspar's trapezoid osteosynthetic plate technique, though originally described for the treatment of injuries of cervical spine [5], has been successfully employed for spondylotic myelopathy [18,19], post laminectomy kyphosis [20], failed anterior body fusion and after corpectomy for infection or metastasis with fusion rate nearly 100%. The Caspar plating require a bicortical purchase to prevent screw loosening and graft slippage [5]. Placing the screws in to the posterior vertebral cortex requires biplannar fluoroscopy and is technically demanding. The advantage of the Caspar system is that the angle between the plate and screw is not fixed. They have also two rows of screw holes to prevent fixation. In a patient with short neck and in lower cervical spine, it is sometimes necessary to insert screws at varying angles.

To reduce the incidence of screw pull out and graft slippage, the locking plate system using unicortical expansion head and locking screws are available (A locking screw is inserted in to the head of anchor screw to expand the anchor screw head). This locks the screw to the plate and provided immediate rigid fixation. All are made of titanium, which are MRI compatible and minimizes CT and MRI artifact [21]. They are safer to use, as they do not require bicortical purchase, thus avoiding possible injury to the cord, roots or vascular structures. In the present series, in all 20 cases titanium plates with expansion head and locking screws indigenously procured were used.

The anterior cervical plating with screws biomechanically serves as a tension band, which is most effective in extension injury in preventing cervical spinal distraction or tension across the intervertebral disc. Hence it is most effective in reducing anterior strain as the plate and graft act as a block preventing compression. How ever it is less rigid in axial and flexural loading. Clinically it means that posterior elements can still distract apart in bilateral or unilateral facet injury. Despite this adverse in vitro biomechanical results, clinical result show more than 90% success [22].

The advantages of cervical plating with bicortical screws are unlimited options in screw placement and long-term clinical studies are available with success. The disadvantages are the operative technique is technically demanding, require intra operative fluroscopy and risk of spinal cord injury exists if not careful. The advantages of unicortical screws with cervical locking plates are easy to place and fluroscopy is not mandatory. The disadvantages are fixed screw trajectory and hard wire is expensive.

The complications of anterior cervical surgery are (a) injury to the soft tissue structures of the neck by self-retaining retractors with sharp blades, curettes and drill that can cause perforation of pharynx, trachea, oesophagus or pleura.

Oesophageal perforation can occur either at the time of surgery or in the postoperative period, which can be prevented by, radiolucent Caspar transverse and vertical retractors [5,23]. Severe laryngeal oedema with tracheal obstruction may lead to respiratory insufficiency and asphyxia. Dysphagia may occur due to Oesophageal oedema. (b) Injury to the carotid artery and jugular vein though uncommon has been reported [24]. Prolonged retraction in conjunction with atherosclerotic disease of the carotid artery may lead to cerebral ischaemia [25]. Injury to the vertebral artery usually occur during removal of lateral osteophytes at or proximal to the 5th or 6th cervical levels. (c) Drill and curettes may result in dural tears over the cord or root resulting in CSF leak. Fascial or muscle graft with fibrin glue prevents CSF leak in most cases.

The neurological complications includes injury to the recurrent laryngeal nerve resulting in transient vocal cord paralysis in 0.3 to 16% cases [26], while permanent vocal cord paresis has been described in 1 to 2% cases. Injury to the superior laryngeal nerve can result in permanent change in voice tone and quality. In the present series 2 patients had temporary hoarseness of the voice post operatively which improved spontaneously. Dissection lateral to the longus colli can injure the sympathetic chain resulting in Horner's syndrome in 0.5-4% cases [25]. Injury to the ansa cervicalis, facial nerve, hypoglossal nerve and the cervical plexus has been reported [27]. Postoperative neurological deterioration can occur in the form of transient or permanent radicular or myelopathic damage. This can occur due to improper or inadequate decompression or direct injury due to drill or posterior migration of the bone graft and instability of the spine [28]. The incidence in most series ranges from 0.2-3% of cases [25]. Neurological complications can also occur due to improper neck position or handling and prolonged intraoperative hypotension compromising spinal cord blood flow. In the present series none of the patients had any neurological deteriora

Graft related complications inclu migration or dislodgement. Bone graft e has been reported in 0.5-2% cases [29]. T may extrude anteriorly causing Oesoph tracheal compression or posteriorly caus compression.

Angular deformities are commo nommion can occur leading to pseudo a and persistent pain on neck movements present study none of the cases ha extrusion or graft related complications.

The complications of anterior instrumentations are screw pullout a slippage, which are obviated by locki system and expansion head screws. De complications include pain, haematoma, infection, osteomyelitis, lateral femoral cu nerve injury and iliac crest fracture. In the series two patients had 2 screws loosening screws went in to the graft at intervertebr space from the vertebral body. Howev patients were asymptomatic at follow u

To conclude anterior cervical instrume using Titanium plates, expansion head and l screws is an excellent modality of stabilisa cervical spine injury, multilevel PID an laminectomy kyphosis. It provides imm stability, good neurological recovery mobilisation and ambulation without rigid o orthosis. MRI scans can be perform postoperative patients, as these are MRI comp and throws less artifact.

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