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Craniocervical Abnormalities

Modern Diagnosis and a Comprehensive Surgical Approach

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Summary

A retrospective study of 41 patients operated on between 1975 and 1983 is presented including guidelines for surgical management with some alternative technique both in anterior and posterior approaches and modern diagnostic procedures. A proposed base-line inclined – 10° from Reid's base-line proved to be adequate to obtain the true shape and size of the foramen magnum on CT-scan. The normal range of the clivo-axial angle in adults is reported and its clinical significance is stressed.
Keywords: Basilar impression, craniocervical abnormalities, CT-scan, foramen magnum, NMR-scan.

Introduction

Since the craniocervical junction differs considerably from the remainder of the spine and from case to case, radiological interpretation may sometimes be difficult to achieve. However, the importance of this anatomical region cannot be over-emphasized; it serves as the conduit for the passage of structures of the central nervous system at the point between the brain stem and spinal cord. Although the interest in the craniocervical junction goes back to 1891, when Chiari reported three types of elongation of the hindbrain structures, subsequently known as the Chiari malformation [4], it was not until the advent of radiography, especially the introduction of tomography, pneumoencephalography (*Dandy,* 1919), positive contrast myelography (Sicard and Forestier, 1922), that it became possible to detect abnormalities of this area [3,5,10,12,16,22,23].
Since the advent of computed tomography and subsequent introduction of Metrizamide (Amipaque, a water-soluble CSF contrast-medium), remarkable advances are taking place in radiological analysis and in the clinical management of abnormalities of the craniocervical junction [18].

From our recent experience with 41 patients, we propose a new diagnostic base line for CT-scans of the foramen magnum and a plan for surgical management based upon the pre-operative demonstration and understanding of the craniocervical pathology.

Material and methods

The basis of this communication is a study involving 41 neurologically disabled patients with carniovertebral abnormalities operated on between 1975 and 1983 in the Department of Neurosurgery, Saitama Medical School. There were 25 males and 16 females, from 7 to 84 years of age (Tab. I), with radiological changes as summarized in Table II. Basilar impression was the most frequent (20 cases), followed by atlanto-axial dislocation (16 cases), abnormal odontoid [11], developmental narrow cervical canal [11] and assimilated atlas [7]. In practically all cases, these abnormalities were combined. Patients were subjected to neuroradiological investigations both conventional and modern procedures. Conventional procedures included routine plain and tomographic x-rays plus pneumo-encephalography,

Tab. I. 41 cases with craniocervical abnormalities.

Age	No. of cases	Male	Female
1–9	2	1	1
10–19	3	3	0
20–29	2	2	0
30–39	4	3	1
40–49	12	5	7
50–59	10	5	5
60–69	7	5	2
70–79	0	0	0
80–89	1	1	0
	41	25	16

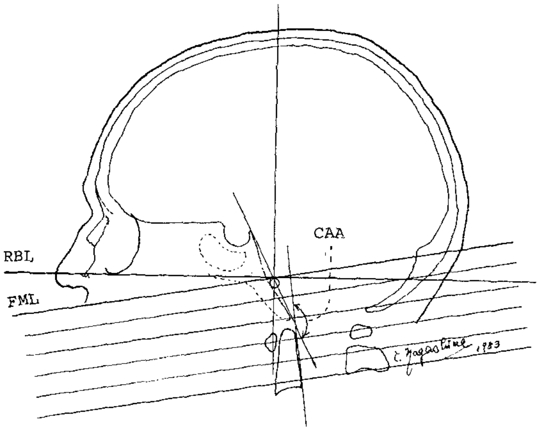


Fig. 1. Slices at each level of sections cut parallel to the foramen magnum line (FML: −10° from RBL). CAA represents clivo-axial angle.

myelography and angiography with sometimes RI bone survey. Modern procedures included plain CT, CT metrizamide myelography (CTMM) and nuclear magnetic resonance (NMR) scans. Measurement of clivo-axial angle, which is not properly evaluated even at the present time, is added.

Tab. II. X-ray findings in 41 cases with craniocervical abnormalities.

X-ray findings	Alone	In association
basilar impression	4	20
atlanto-axial dislocation	9	16
assimilation of atlas		9
developmental narrow canal		10
abnormal odontoid		10
Arnold-Chiari malformation		3
Klippel-Feil syndrome		4
others		3

Tab. III. Angle from Reid's base line (RBL) and McRae line measured on plain skull X-ray.

	Materials	Results
Male	20 cases 26–67 years of age (mean; 42.65)	mean = −9.65° standard deviation; 2.03
Female	20 cases 26–66 years of age (mean; 42.95)	mean = −9.7° standard deviation; 1.95

McRae line: in between basion and opisthion (McRae 1953)

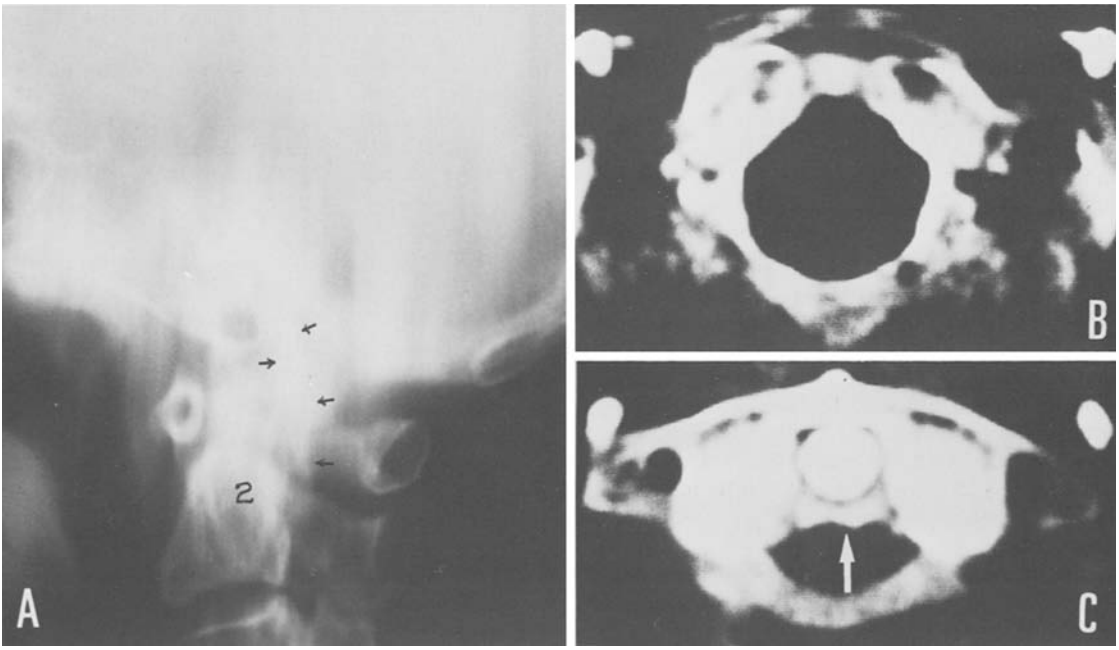


Fig. 2. Cervical spine laminogram (A) with radiopaque lesion behind the dens (small black arrows) compressing medullospinal junction in a case with spastic tetraparesis and the CT (B, C). The CT slices, 5 mm in thickness, were sectioned parallel with a line −10° from RBL. Note, in C, a hemicircular band-shaped high (EMI-unit: +445) density (white arrow) indicating ossified transverse atlantal ligament which clearly explain the lesion and the mechanism of cord compression. Margin and bone at and around the foramen magnum is well demonstrated in B.

Modern diagnostic procedures

1. Appropriate base line for "foramen magnum CT" (foramen magnum line)

Investigating craniocervical abnormalities on CT-scan, the CT-slice should include both the basion and the opisthion on the same plane with the exact shape of the foramen magnum. For this purpose, an angle between Reid's base line (RBL) and McRae line [12] – a line between basion and opisthion – was measured in 40 normal adult skull x-rays (Tab. III). The angle was approximately – 10° without sex difference. The result indicates a base line inclined – 10° from RBL may be adequate for this purpose and consecutive caudad slices may show an undeviating horizontal section of the upper cervical spine when the craniocervical axis is neither extended nor flexed (Fig. 1). Fig. 2 is an example; this patient had tetraplegia due to medullo-spinal compression of unknown radio-opacity behind the dens on tomography (Fig. 2–A). It was elucidated on this CT sectioning to be an ossified transverse atlantal ligament with +445 EMI units of the lesion (Fig. 2–C).

2. CT Metrizamide myelography (CTMM)

This examination is especially useful in diagnosis of Arnold-Chiari malformation and syringomyelia. It consisted of "primary CTMM" and "secondary CTMM"; the latter is performed after conventional Metrizamide myelography. [18]

In primary CTMM, small doses of Metrizamide are used, 6 ml in children around 10 years of age, 10 ml in a large adult, at a concentration of 170 mg iodine/ml, which is isotonic with the CSF. Metrizamide should be mixed with CSF. The patient is therefore tilted and rolled before CT examination. CT-slices are sectioned parallel with the "foramen magnum line" (−10° from Reid's base line).

In secondary CTMM, the dose of Metrizamide is that of the previously performed conventional Metrizamide myelography. We routinely use 12–10 ml Metrizamide with a concentration 250–170 mg iodine/ml. Following total Metrizamide myelography, the patient is brought to the CT-room and CTMM is done during the first four hours after the Metrizamide injection. Fig. 3 is Chiari type 1, with clear delineation of caudally displaced cerebellar tonsils to C2 level by the Metrizamide.

3. Clivo-axial angle (C–A angle)

Although Dolan [5] reviewed the craniocervical relation, the authors attempted to have detailed data in variable neck position both in male and female normal adults. Tab. IV is the normal range of the C-A angle. There was no sex difference in the neutral neck position, however, a slightly increased range of motion is noted in females compared with males.

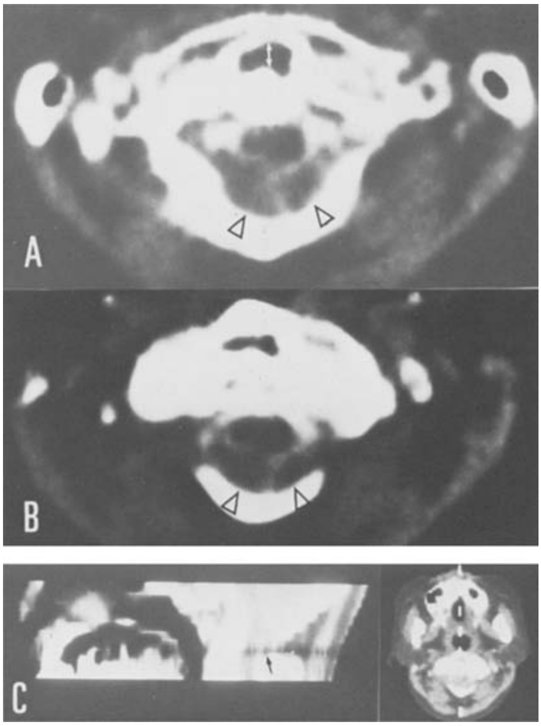


Fig. 3. CT metrizamide myelography (CTMM) of Chiari malformation at level of C1 (A), C2 (B) and its sagittal reconstruction (C). In A and B, metrizamide clearly delineates cerebellar tonsils (open arrow heads) and the cord. Anterior dislocation of anterior arch of atlas from the dens (white arrow in A) indicates atlanto-axial dislocation. The CT-slices were sectioned parallel with "foramen magnum line" (−10° from RBL). In C, elongation of cerebellar tonsils below the foramen magnum (black arrow) and basilar impression are observed (Case 38. 44-year-old female).

Tab. IV. Clivo-axial angle measured on plain X-ray.

neck position	neutral	full-flexion	full-extension
MALE 20 cases (20–63 years of age, mean: 41.3)			
normal range	139°–172°	134°–165°	152°–177°
mean & S.D.	158.2±9.8	149.1±7.6	167.7±7.1
FEMALE 20 cases (20–70 years of age, mean: 41.3			
normal range	142°–176°	121°–160°	158°–177°
mean & S.D.	157.4±7.5	147.1±7.9	169.0±2.1

Abbreviation: S.D. = standard deviation

Smaller C-A angle, less than 150° in full extension, less than 130° in neutral position may produce ventral impingement of the medulla and should be corrected to a greater angle when occipito-cervical fixation is carried out. The clivus line (line drawn along posterior surface of clivus) and the axis line (line drawn along posterior surface of axis) form the angle (Fig. 1).

4. Nuclear magnetic resonance (NMR)-scan

Three dimensional proton imaging with a 1500 Gaus NMR unit (Toshiba) offers a major advance in our ability to evaluate posterior fossa and brain stem abnormalities, particularly medullospinal juctional area and cerebellar tonsils. NMR imaging visualizes the cerebellum and identifies the tonsils without use of contrast agents, mesencephalic and hindbrain structures and position and shape of the fourth ventricle (Fig. 4). This examination is now carried out in neurosurgical and neurological patients as well as in normal subjects and normal anatomical standards for the posterior fossa structures based on NMR images are being established. In Fig. 4, normal anatomical relationship and pathologically displaced midbrain and hindbrain structures caused by the clivus chordoma are shown. It can be predicted that in the future the initial procedure for evaluation of the craniocervical abnormalities and the posterior fossa will be NMR imaging and it is likely that other modes of examination may be eliminated or modified.

Operative technique

In both the anterior and posterior approach, Crutchfield's skull traction is used throughout the operation in cases with atlanto-axial dislocation. A lateral x-ray just before starting the operation is essential for the surgeon to know the alignment of craniocervical axis. Repositioning may be indicated if malalignment is shown on x-ray.

The anterior approach involves a transoral resection of the clivus atlanto-odontoid bone complex. The operative technique used is basically similar to that described by Fang et al. [6], Greenberg et al. [8,9] but some modification is now used:

It consists of

1. no tracheostomy but transoral endotracheal general anaesthesia with transposition of the endotracheal tube to the right mouth corner with tapes,
2. no midline splitting of soft palate and uvula,
3. intraoperative use of x-ray monitoring by means of a C-arm image intensifier; the monitor is placed with operating microscope side by side which enables the surgeon to look at the screen in almost the same line with the binocular of the microscope so that little head movement is required for observing either the operating field or the screen (Fig. 5). Proper placement of instrument requiring only a few seconds of radiation greatly facilitates the accuracy of the procedure.
4. stay sutures to retract the soft tissue flaps are placed at short intervals along the flaps; we use them again on closing the wound; fine Dexon material is

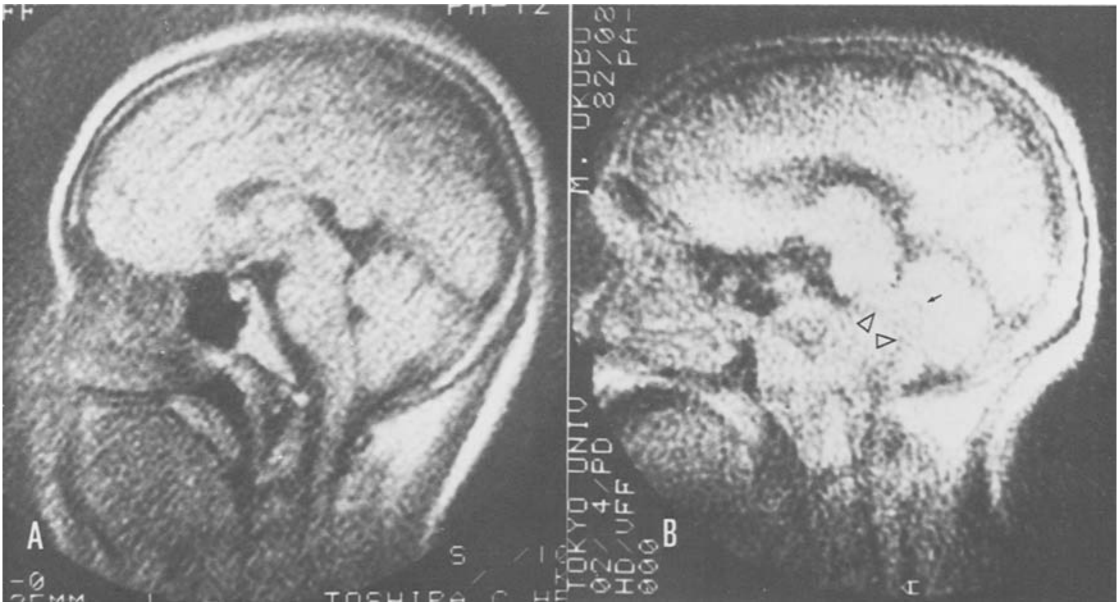


Fig. 4. NMR (nuclear magnetic resonance) scans of normal (A) and pathological (B) subjects. In A, mesencephalic, hindbrain and cerebellar configurations are clearly demonstrated. In B, brain stem compression caused by a huge clivus chordoma (open arrow heads) with deformed fourth ventricle (black arrow) and upward shift of pons and mesencephalon are well shown (by courtesy of Prof. Kintomo Takakura).

preferable. Soft tissue flaps consisting of pharyngeal mucosa, constrictor muscles, buccopharyngeal fascia and longitudinal ligament are raised with periosteum from bone as far lateral as close to the lateral border of the C1–2 joints and the flaps are retracted by numerous fine Dexon sutures.

Through the incision, the anterior arch of C1, the body of C2, and the inferior margin of clivus are exposed and removed by air drill, rongeur, Kerrison punch, or curette. The dorsal part of the odontoid is drilled away as thin as paper and is removed. Great care should be taken not to compress the already compromised medulla oblongata. The extent of decompression can be estimated by x-ray monitoring putting an instrument at the caudad or cephalad ends of defect, or tentative filling of the defect with contrast medium which is soon washed out with saline. If C1–2 fusion is requested, an exact autogenous iliac bone graft is inserted into the C1–2 joints and defect and is punched firmly home. The wound is well irrigated with saline and 20.000 X diluted Hibitane solution repeatedly. The wound is closed in layers, the first layer being the anterior ligament, the second the buccopharyngeal fascia together with the constrictor muscles, and finally pharyngeal mucosa by using the Dexon stay sutures which had been placed post-incision. Since the wound is so deep and narrow [14], the use of stay sutures greatly facilitates the closure. In our series, the indications for the anterior approach were a few, only three in 41 cases. In the tree, there were definite ventral indentations to the medullo-spinal junction, and lower cranial nerve palsies due to the high position of the odontoid (Fig. 8), requiring immediate removal of the protruded dens. It is now our policy, in such instances, that anterior decompression should be carried out first, and then by putting the patient prone, posterior decompression and fixation are accomplished within the same day. These combined anterior and posterior procedures in one session greatly facilitated alleviating symptoms and greatly shorten the hospital stay of the patient.

Posterior approach

The approach has three therapeutic purposes:

1. decompression of cervicomedullary junction, cerebellum and brain stem by means of extensive suboccipital or limited foramen magnum decompressions,
2. posterior C1–2 fixation (1) or occipito-cervical fixation [17] and
3. intradural surgery for Arnold-Chiari malformation or syringomyelia [19], both of which frequently coexist in association with the craniocervical abnormalities. In the present series, three cases of Arnold-Chiari malformation were found; two which had an

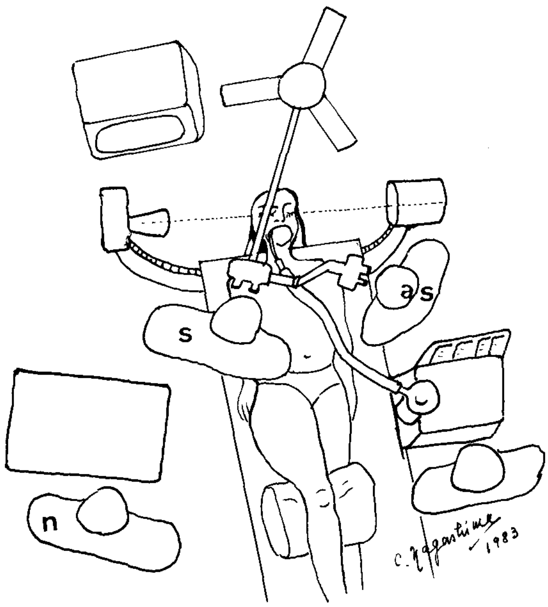


Fig. 5. Position of the attending team and equipment for transoral resection of clivus atlas-odontoid bone complex. s: surgeon, as: assistant, n: scrub nurse.

assimilated atlas improved after suboccipital decompression with posterior fixation, however, one required intradural resection of prolapsed cerebellar tonsils on account of persisting sleep-induced apnoea and tetraparesis improved with the decompression alone.

Since my first publication (C.N.) [16] about occipito-cervical fixation with or without decompression by means of wire and acrylic in 1970, some modification has been added. The most important is to make a vigorous attempt to obtain a normal C-A angle at the time of fixation, especially in cases with smaller C-A angle due to non-reducible or only partially reducible atlanto-axial dislocation. A retrospective study of our cases of basilar impression with postoperative slow aggravation of myelopathy revealed that it is due to (1) a smaller C-A angle compressing the ventral medulla, (2) inadequate decompression of foramen magnum, especially of lateral wall of the foramen, or (3) arachnoid adhesion with subsequent blockage of CSF circulation. Our new policy, therefore, includes the taking of lateral intraoperative x-rays twice in the operating room; first, just prior to making the incision to confirm that the alignment is neutral, then, just prior to fixation to confirm greater or flat C-A angle by means of forcible traction directed more upward taking a posture of extreme hyperextension. The weight is increased up to 20 kg, and the operating table ist tilted 25° to 30° head-up, so that the patient does not move upward. Under general anaesthesia, the greater C-A angle is usually obtainable by such a manoeuvre because of the complete relaxation of muscles. Although the fixation procedure may be more difficult due to the restricted operation field, it can be done since the twisted wires had already been passed underneath the laminae and burr holes in the squama occipitalis. The second modification is to use twisted wire made during the operation (Fig. 6). The third minor change is an improved technique for passing the twisted wire [7] underneath the laminae. A sharp towel clip inserted into two small drill holes on the lamina of C2 or C1 is pulled up (Fig. 6–C). It provides enough room to separate the periosteum from the inferior surface of the lamina and to pass twisted wires. Of 41 cases, occipito-C2 or C1–2 fusion was performed with autogenous bone graft in cases under the age of 13. In practically all cases over 14 years of age, it was done with wire and acrylic.

Clinical categories for treatment purposes

The pathological anatomy of the cervicomedullary junction (CMJ) can be categorized for treatment purposes into reducible and non-reducible or irreducible pathology [13,17]. Reducible lesions refer to the capacity for restoration of normal anatomical relationships of the craniovertebral junctions. This is further classified into five major categories, based on the anatomical craniocervical relationships.

Group 1. Reducible craniovertebral dislocation, requiring posterior fixation.

Cranio-vertebral (C-V) dislocation involves both occipito-atlantal and atlanto-axial dislocation and may be due to (1) the incompetence of ligaments or ligamentous structures such as the cruciform, transverse atlantal, apical, alar ligaments and the tectorial, anterior and posterior atlanto-occipital membranes and also, due to (2) the incompetence of osseous structure such as os odontoideum, ossiculum terminale, hypoplastic odontoid process, or non-union of odontoid fracture, and hypoplastic occipital condyles. The latter results in a forward gliding of the skull [13] in its relationship to the spine. Occipito-cervical stabilization in a correct position is the goal in these reducible lesions.

Group 2. Partial reducible C-V dislocation, requiring posterior decompression and fixation.

A representative case is summarized below.

Case No. 41. This 46-year-old female had a one-year history of numbness in the distal four extremities with gradual proximal spread and spastic tetraparesis. Cervical spine films in flexion and extension on admission showed an anterior dislocation of the atlas on the axis, which was non-reducible. Osteoarthritic changes in the C1–2 joints with anterior and posterior osteophytes, os odontoideum, block C4–5 vertebrae were also noted. Forcible extension (20 kg weight) with Crutchfield tongs for seven days with the neck hyperextended made it partially reducible; further forcible extension for five days was followed by posterior decompression and occipito-C2 fixation with twisted wire and acrylic (Fig. 7). Small C-A angle 131° (normal; more than 150°) on full extension became 150° after forcible extension, and fixation was done keeping with this 150° C-V angle. All symptoms disappeared at the time of her discharge 15 days after the operation.

Group 3. Non-reducible C-V dislocation with severe narrowing of sagittal diameter at C1–2, requiring posterior decompression and fixation.

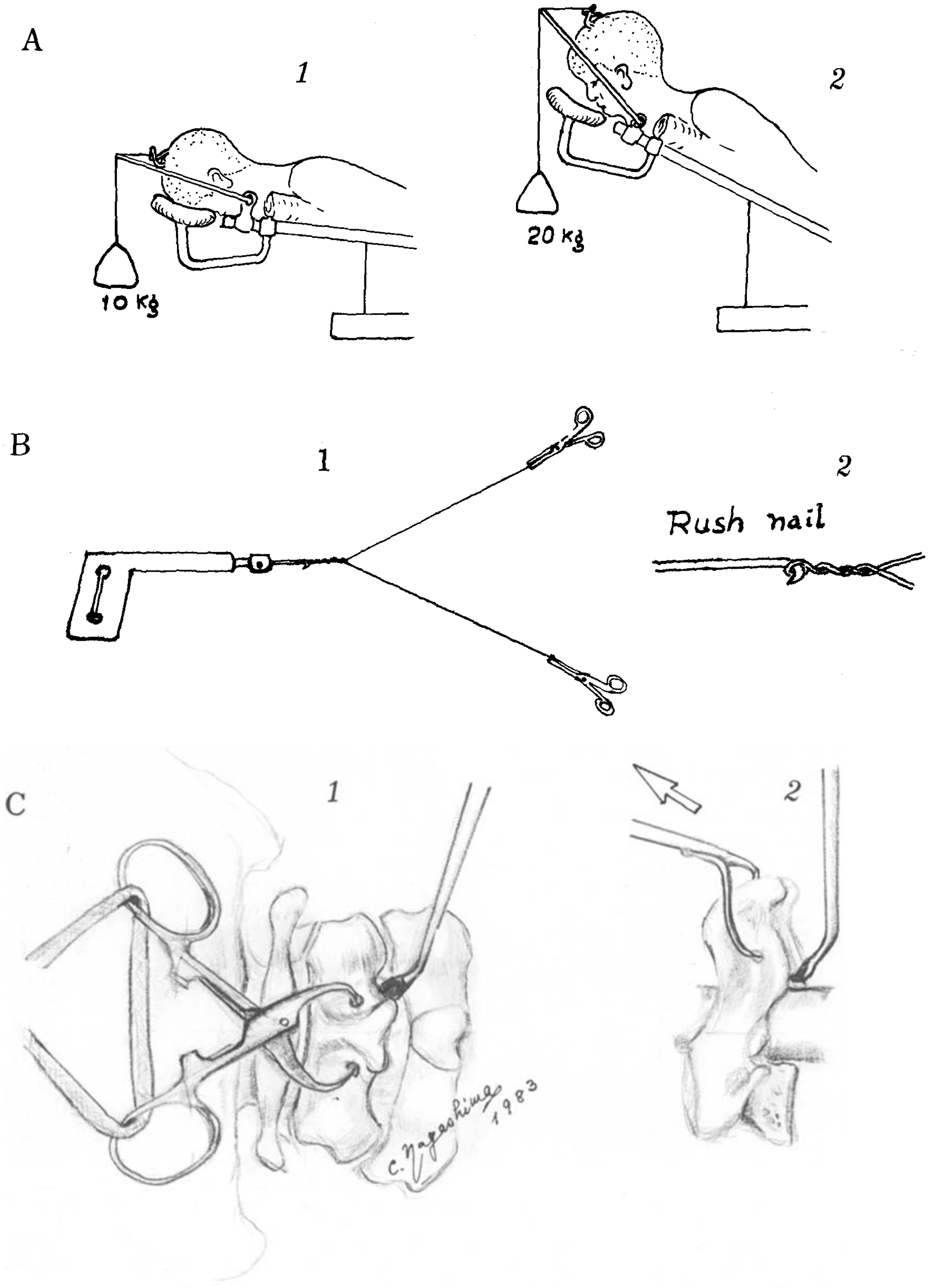
In cases similar to the one mentioned above, except the dislocation remained unreduced, even by prolonged forcible extension reported by the author (C.N.) [17], immediate posterior decompression of medullospinal junction may be preferable. The case, operated in 1971, a 52-year-old female is still doing very well as a farmer's wife 11 years after the operation. Occipito-C2 fixation done with decompression remained unchanged on x-ray and it is reported she has no trouble working on the farm.

Group 4. Non-reducible C-V dislocation with basilar impression, requiring posterior and anterior decompression and fixation.

Fig. 6. Techniques used in posterior fixation. A-1: Position of patient for exploring occipital squama, C1, 2 and for passing ▶ twisted wires underneath the C1–2 lamina and through the occipital burr holes. Just prior to occipito-cervical fixation, the neck is hyperextended by strong traction directed upward, with the weight increased from 10 kg to 20 kg in order to obtain a wider clivo-axial angle (A-2). The operating table is tilted 25° to 30° in order to prevent any upward shift of the patient.

B shows a simple method for making a twisted wire 8) (using 0.7 mm wire) with a hand drill, Rush nail (used for internal metal fixation) and Kochers.

C shows author's technique for passing twisted wires underneath the lamina providing enough room in between the lamina and the dural tube by seizing the spinous with a towel clip and pulling it up with complete separation of periosteum from the bone by a curved flat curette. C1: a view seen from above, C2: lateral view.


A
1
2
10 Kg
20 Kg
B
1
2
Rush nail
C
1
2
C. Nagashima 1983

Group 5. Non-reducible C-V dislocation with basilar impression plus lower cranial nerve paresis, requiring anterior decompression and subsequent posterior fixation.

Group 4 and 5 have a common feature being associated with C-V dislocation and basilar impression; the only exception is a lower cranial nerve paresis, which indicates damage to the medulla oblongata is in progress. A representative case is summarized below.

Case No. 38. 44-year-old female had suffered from difficulty in expectorating phlegm, on walking and vertigo for two years. Examination revealed bilateral paresis of ninth & tenth and left seventh and twelfth cranial nerves, spastic tetraparesis, downbeat vertical nystagmus, pallohypaesthesia below T4, and ataxic gait. The dens protruded 16 mm above Chamberlain's line. The atlanto-dental interval was 7 mm, and an assimilated atlas was seen (Fig. 8). CTMM revealed a Chiari type 1 (Fig. 3). The anatomical mechanisms causing neurological symptoms are ventral compression and angulation of medulla oblongata by the protruded dens and dorsal compression by elongated tonsils and the assimilated atlas. The anterior arch of the atlas, dens and the distal clivus were removed by the transoral approach. The patient was maintained in skeletal traction until the day of posterior decompression and fixation, when the assimilated C1 was removed and suboccipital craniectomy with occipito-C2 fixation were carried out (Fig. 9). Just prior to fixation, extreme upward extension by skull traction was made so that a normal C-A angle was re-established. The vertical nystagmus improved and there was no oscillopsia on the tenth postoperative day. The patient's symptoms cleared by six weeks after the operation.

In patients belonging to Group 4, the majority were treated by a posterior approach in the first place. Although patients were advised to have an anterior decompression in order to prevent future involvement of lower cranial nerves, patients eagerly asked to be discharged because of the disappearance of symptoms. Only one patient with dysphagia has undergone anterior decompression later.

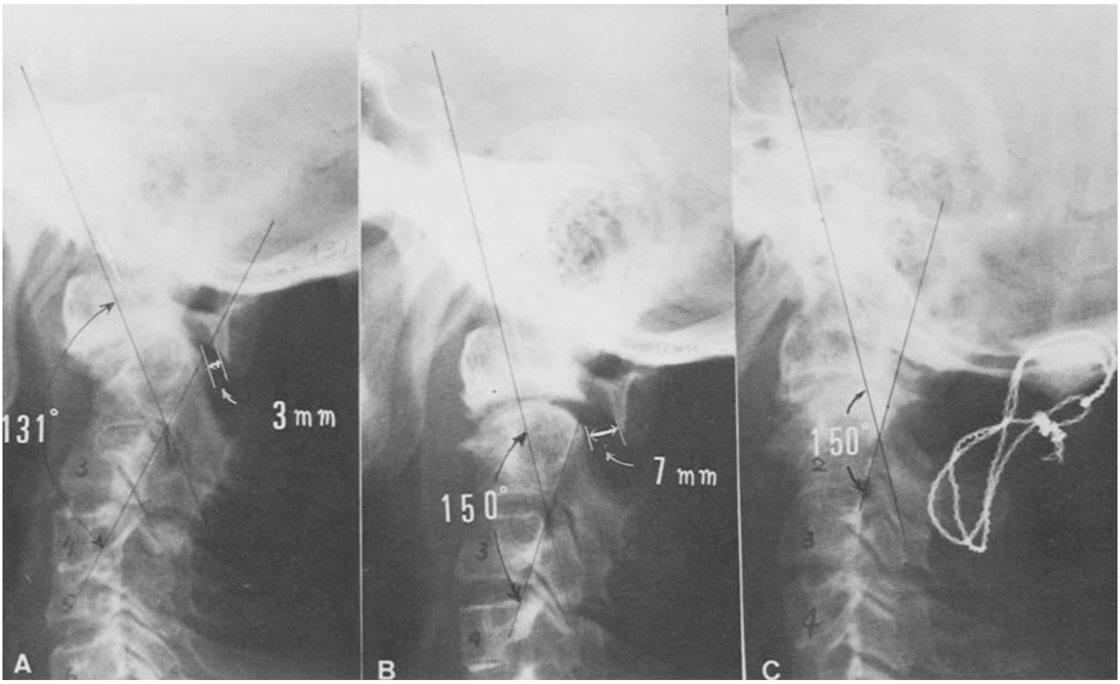


Fig. 7. Partial reducible atlanto-axial dislocation. Lateral x-rays in full-extension of the neck before (A) and after intensive skeletal traction with 20 kg in extreme hyperextension of the neck (B). Note, widening of effective A–P diameter at C1–2 of 3 mm in "A", increased up to 7 mm in "B". Acute clivo-axial angle of 131° (normal range; 158°–177°) rendered a less acute angle of 150° with slight reduction of anterior dislocation of C1 on C2. Postoperative x-ray (C) shows occipito-C2 fixation with twisted wires and acrylic done with reduced clivo-axial angle of 150°. Posterior arch of C1 is not seen (Case 41. 41-year-old female).

Results

Follow-up examinations ranged from two months to seven years. There was no death. The clinical results have been designated as follows:
Excellent. These patients showed total or subtotal relief of symptoms without functional impairment, with or without residual spasticity.
Improved. These patients had relief of some or all symptoms of intermittent discomfort but a residual spasticity and weakness.
Unchanged. These patients were unchanged from their preoperative condition.
Worse. These patients had increased or new symptoms.
Of 41 patients, 36 (87.8%) were rated excellent; 31 (75.6%) are working full time, 5 are retired due to old age, 3 (0.7%) were rated improved. Two (0.5%) are unchanged; one is an 84-year-old male with chronic rheumatoid arthritis, secondary basilar impression and atlanto-axial dislocation. Posterior decompression and fixation were performed twice; however, due to osteoporosis, the C2–C3 laminae were too weak to support skull, he is wearing a Philadelphia collar. The other is a 43-year-old female with basilar impression, atlanto-axial dislocation and assimilated atlas. Posterior decompression and fixation were done first. Two years later, dysphagia, vertical oscillopsia and trunkal ataxia was aggravated. Transoral decompression failed to improve her symptoms, which remained unchanged.

Discussion

Two main interests in this article are (1) introduction of modern diagnostic techniques and, (2) proposal of comprehensive guidelines for the surgical approach, with some modifications of surgical technique. The impact of computed tomography and introduction of Metrizamide provided remarkable advances in the diagnosis and management of craniocervical abnormalities. Of our three cases of Arnold-Chiari malformation, in one pneumographic examination failed to demonstrate it but, it was shown by CTMM. It is our policy to perform CTMM in all cases with craniocervical abnormalities after total Metrizamide myelo-

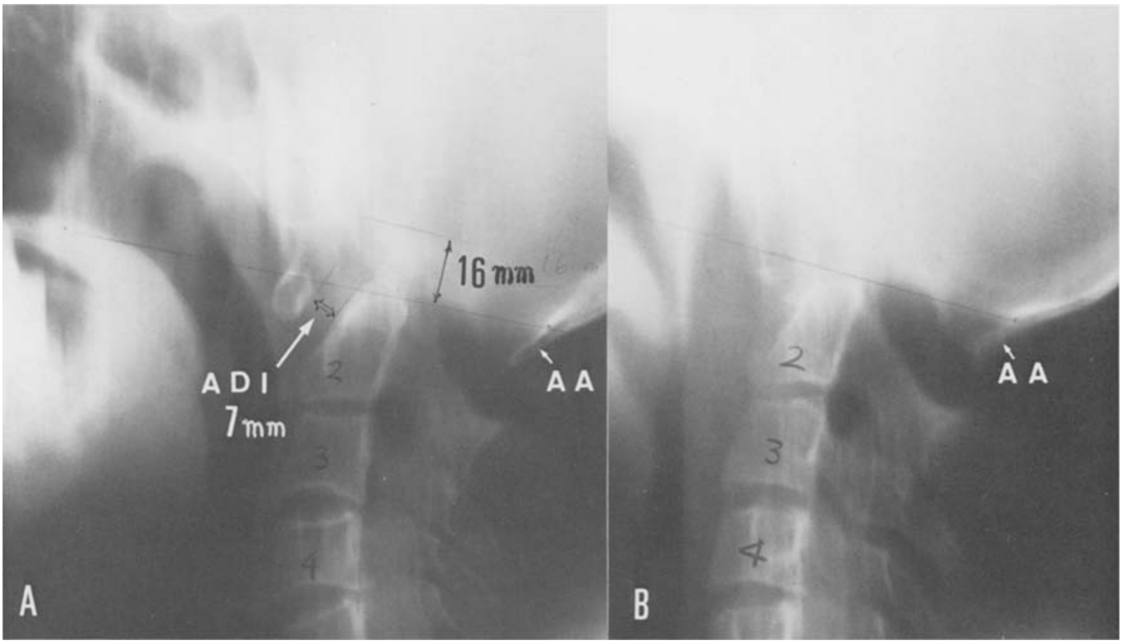


Fig. 8. Pre- (A) and posttransoral resection of clivo-atlanto-odontoid bone complex (B). In A, basilar impression with elevated odontoid 16 mm above Chamberlain's line, assimilated atlas (AA) and atlanto-axial dislocation with 7 mm atlanto-dental interval (ADI) are shown. Medulla oblongata is pushed up by the top of odontoid and ninth, tenth and twelfth cranial nerve pareses were noted. Anterior decompression was done first. In B, odontoid process, anterior arch of atlas, lower clivus are removed. AA compressing cord from behind remained unchanged. Posterior decompression with occipito-C2 fixation was done at the second procedure (Fig. 9). Skeletal traction had been carried out in between the two procedures (Case 38. 44-year-old female). (Arnold-Chiari malformation is associated in this case).

graphy during the first four hours after Metrizamide injection with a CT-scan angle of − 10° from RBL: i.e. "foramen magnum line". With the use of the "foramen magnum line" on CT-scan, the size and shape of the foramen magnum have been demonstrated accurately in all the cases. Deformity and asymmetry is often associated with an assimilated atals, occipital condylar hypoplasia, and basilar impression. Its recognition, before operation, is of great value in achieving the decompressive procedure.

In general it is well recognized that platybasia *per se* causes the angle subtended by the spinal cord and medulla as it goes through the foramen magnum to be "more acute" than is ordinarily the case [21]. However, basilar impression may exist without platybasia, and platybasia *per se* is not necessarily associated with basilar impression [21]. Therefore, Welker's basal angle used to determine the platybasia cannot indicate the acuteness of the angle formed where the spinal cord and medulla goes through the foramen magnum, in cases without platybasia. For this reason, the C-A angle was measured and a normal range was established in different positions of the neck. It may be of importance to predict the impingement of the cervicomedullary junction ventrally. As shown in Fig. 4–A, the normal anatomy by NMR imaging shows a slight backward angulation at the medullospinal junction even in a neutral neck position and the C-A angle reflects well the degree of the angulation. The acuteness of the angle is a mechanically poor arrangement for these very important structures with developing thickness of the dura or arachnoid adhesion with subsequent impaired CSF circulation [21]. With these facts in mind, occipito-cervical fixation preserving a normal or flat C-A angle seems for the authors to be of the most importance (Fig. 7,8,9).

Menzes et al. presented an excellent guideline for a surgical approach of the abnormalities based on 17 operated cases. Ventral decompression was performed in nine patients by transoral, transpalatine

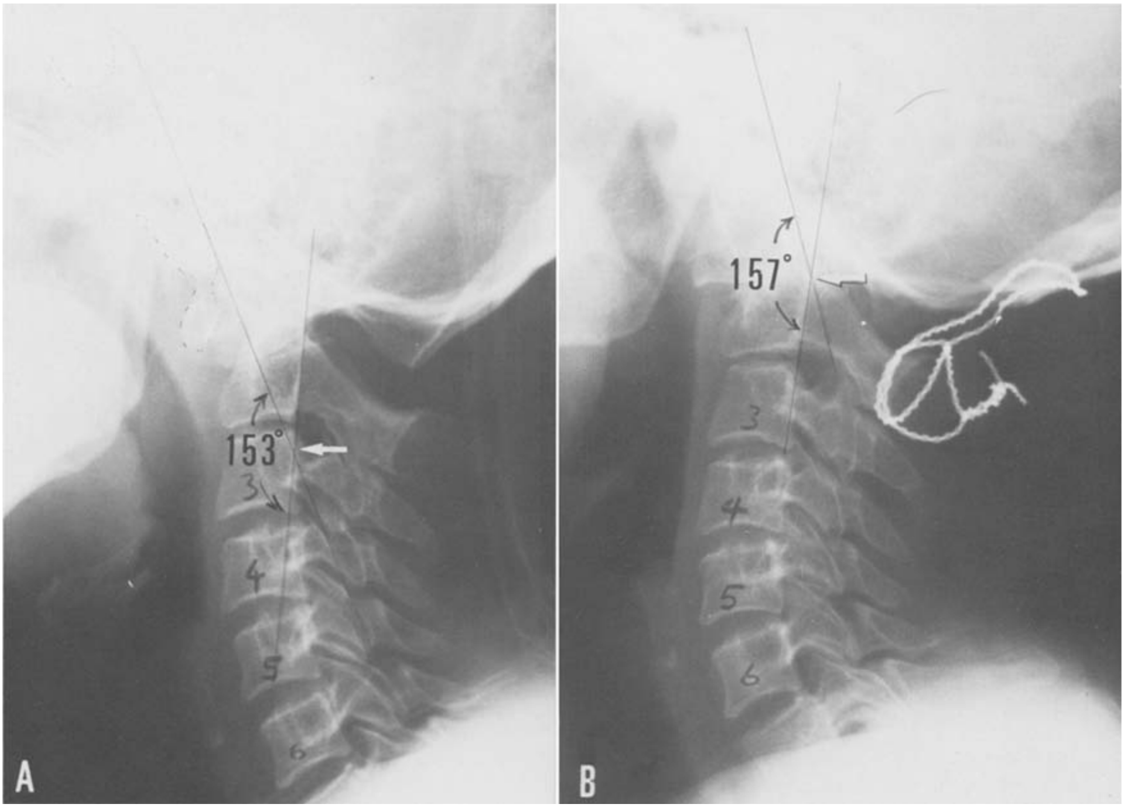


Fig. 9. Pre- (A) and postoperative posterior decompression including assimilated atlas and occipito-C2 fixation with twisted wire and acrylic (B). Clivo-axial angle is slightly improved (pre: 153°, post 157°). Note, marked "upward shift" of point of crossing (white arrows) of clivus and axis lines! This indicates reduction of the atlanto-axial dislocation with ventral shift of cervical spine axis by combined anterior and posterior procedures (Case 38. 44-year-old female).

resection of the odontoid-clivus complex [13]. In our 41 cases, only three were treated by transoral decompression in the period between 1975 and 1983. The indication for transoral decompression in patients with craniocervical abnormalities still seems to be a matter of controversy [2]. *Mosberg,* who first used the transoral approach in 1955 [14,15] stated that, during the ensuing 23 years, he used this approach in only one patient to obtain a biopsy specimen from a destroyed C2 body. He also expressed his feeling that there are four areas of technical difficulty. I must emphasize that I am not urging the use of this primitive technique. Instead, I am suggesting possible alternatives if circumstances are such that the more conventional techniques are not feasible [2,14].
In regard to the indications, the following are our principle ones. An absolute indication includes the ventral impingement on the medulla by an abnormally high odontoid with paresis of the lower cranial nerves, symptoms of compression of the medulla and high cervical cord. It corresponds to the clinical category Group 5. Relative indications include the clinical category Group 4, i.e., a similar condition to Group 5 except no symptoms of involvement of medulla, high cervical cord or lower cranial nerves.
Since the basilar impression is a result of occipital dysplasia; either ex-occipital (medial or paramedial type), or basi-occipital (anterior type) [20], or both, the aim of operation should be the decompression with subsequent increase in the capacity of the posterior fossa. Associated acute C-A angulation, if present, could be corrected with two staged forcible traction intraoperatively in the majority of the cases belonging to Group 4.
It is our conclusion, that the majority of craniovertebral abnormalities could be treated by a posterior approach and, in not many cases is there an absolute indication for transoral decompression.

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