



The surgical procedure of syringomyelia with Chiari I in adults regarding the intrapial aspiration of cerebellar tonsils: does this procedure improve symptoms with less complication?

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ABSTRACT

Introduction. Cranio-vertebral decompression remains the common denominator for the treatment of syringomyelia associated with Chiari I. On the other hand, the details of the procedure, remains controversial. The success of the surgery is to restore the circulation of cerebro-spinal fluid at the level of the foramen magnum. How is this circulation restored to the level of foramen is the question? We offer our attitude towards the treatment of syringomyelia with Chiari I.

Material and method. Consecutive series of 32/121 patients benefiting from cranio-vertebral decompression associated with intrapial aspiration of cerebellar tonsils treated for syringomyelia with a Chiari I malformation in adults.

Result. Motor deficits were present in 20 / 22 patients, representing 90% of the entire patient group. these motor deficits are improved in 16 out of 22 cases, and remained unchanged in 06cas. no motor aggravation occurred. in our study, bone decompression and intra pial aspiration of cerebellar tonsils (sub arachnoids manipulation) were found to be associated with favourable results on clinical signs and symptoms. However, sub arachnoids manipulation and intra pial aspiration of cerebellar tonsils showed a little more complication compared with bone decompression with dural plasty.

Conclusion. The bone decompression with dural graft and intradural dissection of adhesions and reduction by intra pial aspiration or resection of the tonsils is indicated on the MRI aspect of cerebellar tonsils of considerable size totally obstructing the foramen Magnum, the intraoperative finding, through the arachnoid, of the absence of passage of the cerebro-spinal fluid because of the bulging of the cerebellar tonsils.

INTRODUCTION

The understanding of the pathophysiology of the development of syringomyelia with Chiari malformation formulated in many series [1,12,20,32,34,38,54,60,67,85]. explains the use today more and more of cranio-vertebral decompression technique is therefore the common denominator of syringomyelia treatment associated with Chiari I, on the other hand the details of the procedure, the technique of closure of the dura mater, and whether a drainage system should be placed or not in the syringomyelia cavity remains controversial. The maintenance of restored cerebrospinal fluid flow, however, is often problematic.

Keywords
syringomyelia,
Chiari I,
intra pial aspiration of
cerebellar tonsils



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Many different surgical techniques are utilized to treat syringomyelia with Chiari type I malformation, and there is no consensus. Surgical technique may include bony decompression of the posterior fossa with or without duraplasty, arachnoid dissection, or shrinking of the cerebellar tonsils. The goal of any of these operations is to restore adequate cerebrospinal fluid CSF flow at the level of the foramen magnum and reconstruction of the Cisterna magna.

Is the reduction of the volume of the cerebellar tonsils by intrapial aspiration or resection of cerebellar tonsils or finally tonsillar shrinking associated with osteodural decompression the best choice of treatment. We will discuss the results of our series of intrapial aspiration of cerebellar tonsils by comparing it with the different publications cited in the literature and propose our opinion.

MATERIALS AND METHODS

Preoperative Population Characteristics

In our consecutive series of 32/121 patients with cranio-vertebral decompression associated with intrapial aspiration of the cerebellar tonsils or resection of the cerebellar tonsils treated for syringomyelia associated with a Tonsillar herniation (Chiari I malformation) in adults, 10 of them were however excluded from the study for lack of fully exploitable files. Our series therefore includes 22 patients. The mean age of the patients was 30 years. There were 13 female (59%) and 09 male (40%) patients.

Preoperative Clinical Symptoms

Signs and symptoms are summarized in Table I. Sensory disturbances were present in the upper limbs in 59%. Motor weakness was present together in the upper limbs and in the lower limbs in 90,9% of patients. Headaches were noted in 45,4%, lower cranial nerves palsy in 13,6% and Balance disorders or Gait ataxia in 08 cases.

TABLE I. Symptoms/Signs in 22 Patients

Symptom / Sign	Preoperative Status Syringomyelia+Chiari I (No. of patients)	Postoperative result (No. of patients)
Weakness & muscular atrophy	20	15

Sensory disturbance	15	13
Balance disorders, Gait problems or Gait ataxia	08	08
Pain headache	10	10
Cranial nerve dysfunction	03	03

The presence or absence of clinical signs was noted in all of these patients and motor disorders were assessed according to Mc Cormick's classification (Table II). All our patients were adults. The distribution by sex shows a female preponderance, which corresponds to what has been reported in some series [57,91,3,93,45,28 , 66,79 ,17, 51,49,14]. Motor disorders were the main symptom of the majority of patients in this series, followed by the sensory disturbances and headaches. We noted ataxia in 08 cases and cranial nerve deficits in 03 cases.

TABLE II. Mc Cormick's classification.

Functional grade	Clinical prerequisites
I	Intact neurologically, normal ambulation, minimal dysesthesia
II	Mild motor or sensory deficit, functional independence
III	Moderate deficit, limitation of function, independent w/external aid
IV	Severe motor or sensory deficit, limited function, dependent

TABLE III. Summary of Preoperative Status of motor disorders and Postoperative results Grade in 22 Patients I: motor disorders were assessed according to Mc Cormick's classification: Pré-opérative staging and after surgery.

Pré-opérative Status Chiari I+Syringomyelia (No. of patients)	Post opérative Status Chiari I+Syringomyelia (No. of patients)
09 cases Grade III	08 Grade II (improvement) 01 cases (unchanged)
08 cases Grade II	08 Grade I (improvement)
03 cases Grade IV	Unchanged

02 cases Grade I	Unchanged
22	Total

Preoperative Imaging

All patients underwent magnetic resonance imaging (MRI) studies including sagittal and axial spin-echo T1 and T2 sequences. We analyzed the size of the ventricles, studied the anatomy of the occipito-vertebral junction, namely the position of the tonsils, the posterior arch of C1, the height extension of the syringomyelia cavity. Preoperative MRI showed that the syrinx predominantly involved the cervical or the cervicothoracic spinal cord (28% and 50% of the patients respectively) and occupied from 30% to 80% of the spinal canal according to the Vaquero's index [81].

Septa were present in 30% of patients. All patients showed tonsillar herniation reaching the inferior rim of C1. None showed spinal dysraphism or basilar invagination

Surgical technique

Regarding the surgical technique, all patients of our series of 121 cases were operated in the ventral position which allows the easy visualization of the tonsils, since in the sitting position the tonsils are stretched down under the effect of the universal attraction so they will be less visible than ventral, and also the brainstem and cerebellum have a tendency to migrate downward in the sitting position. In this series, the craniocervical decompression procedure was chosen based on the different flow of the cerebro spinal fluid dynamics at the cervico vertebral junction. After a small craniectomy, opening the foramen magnum, removing the small lower part of the posterior fossa, and removing the posterior arch of C1. The extent of bone decompression is also important, if the craniectomy is too wide in height, the patient is at risk of ectopy of the cerebellum and recurrence of symptoms. Some authors suggest that the craniectomy should be wide [21] in addition to the craniectomy, Isu [47] is satisfied with the removal of the outer layer of the dura as a treatment for syringomyelia occurring with a Chiari I malformation for him is enough. and others, like us, prefer a small craniectomy in order to avoid the sagging of the cerebellum (cerebellar ptosis), which is sometimes responsible for the patient's death, as reported after a wide craniectomy [43,83,84]. Zhang et al. [92]

retrospectively analysed 132 patients in a comparison of small and large craniectomy. As noted above, the success rate was 78.2% in the large craniotomy group, with nearly half of patients developing complications, the most common of which was cerebro spinal fluid fistula (11.5%), whereas in the small craniotomy group, the success rate was 82.5% with only three cases of complications. This study demonstrated the superiority of smaller craniotomies.

But according to Ellenbogen [29] a limited craniectomy can lead to inadequate decompression and persistence or recurrence of symptoms, I totally agree with Ellenbogen if we do not realize an intrapial aspiration of cerebellar tonsils. In 2003, Milhorat and Bolognese reported a good result in their experience in tailoring the craniectomy based on the extent of the compressed subarachnoid space on pre-operative magnetic resonance imaging.

We advocate a suboccipital craniectomy limited to enlarging the occipital foramen and allowing both decompression and maintenance of the cerebellum in the posterior fossa. For some authors occipito-vertebral decompression alone is enough Di Lorenzo N [26]. then the opening of the dura with keeping the arachnoid intact and an intraoperative exploration that will show if there is a good passage of the cerebro spinal fluid by visualization or observation of the bulge of the arachnoid or not (Figure1). If there is a bulge of the arachnoid it means that there is a good passage of the cerebro spinal fluid so this procedure is sufficient. according to this finding the decision of the realization of the intrapial aspiration of the cerebellar tonsils will be taken. all of the 21 patients in our series have benefited from the intrapial aspiration of the cerebellar tonsils, the extent of intrapial aspiration or resection was ended when the tonsils were reduced and Magendie foramen with the obex of the fourth ventricle are seen.

So even in our therapeutic attitude the decision to use either bone decompression or sub arachnoid manipulation was routinely made intraoperatively, before the dural opening was made. at last duraplasty was also done to all patients using fascia lata graft (Figure2).

During the whole procedure, careful hemostasia is performed with bipolar forceps under saline irrigation to keep the field bloodless, to prevent adhesions that can be induced around the spilled blood.

RESULTS

Immediate postoperative result and Complications

In our series no mortality was seen, this are similar to those reported by [7,5,16,93] who reported no mortality in their series. But we noted, some cases of postoperative complications, such as cerebro spinal fluid leakage (04/22, 18.1%) who were treated with the use of repeated lumbar puncture with complete closure of the cerebro spinal fluid leakage, three patients 13.6% have intracranial infection who were treated medically. We have noted, hiccups in one case, who was treated only with the use of a synthetic drug as a tranquilizer, sedative, and antiemetic (chlorpromazine). The most serious complication was aseptic meningitis (02/22, 9.09%) with cerebro spinal fluid leakage (04/22, 18.1%).

Based on the results of this series, headache responds very well to decompression surgery with intra pial aspiration of cerebellar tonsils, on 10 of 22 patients with preoperative headache experienced relief complete immediately after surgery. Motor deficits were present in 20 / 22 patients, representing 90,9% of the entire patients. No motor and sensory aggravation occurred. but the follow-up of the patients shows us that the motor improvement

occurs slowly. Other symptoms, such as ataxia in 08 cases and cranial nerve deficits in 03 cases, are improved in immediate postoperatively in our series, similar with findings reported by other authors. [14,17,30,33,37,16] series, which adopts the same surgery technique of craniovertebral decompression with tonsillectomy used in this study.

MRI Follow-up

On the neuro-radiological level, the MRI was performed successively at one month, six months and 12 months then every 02 years, found a normalization of the position of the cerebellar tonsils in all cases with a reconstruction of a new large cisterna magna. The syrinx cavity was clearly or markedly regressed in 09 case, and slightly regressed in 13cas.

Syrinx cavity clearly regressed in 09 case Fig2 Figure 3. Preoperative MRI scan reveals syrinx cavity with tonsillar herniation extending below the foramen magnum (Chiari I). Post op Postoperative MRI scan reveals the regression of the syrinx cavity and absence of cerebellar tonsil herniation. (A) Slightly regressed in 13cas Fig3:

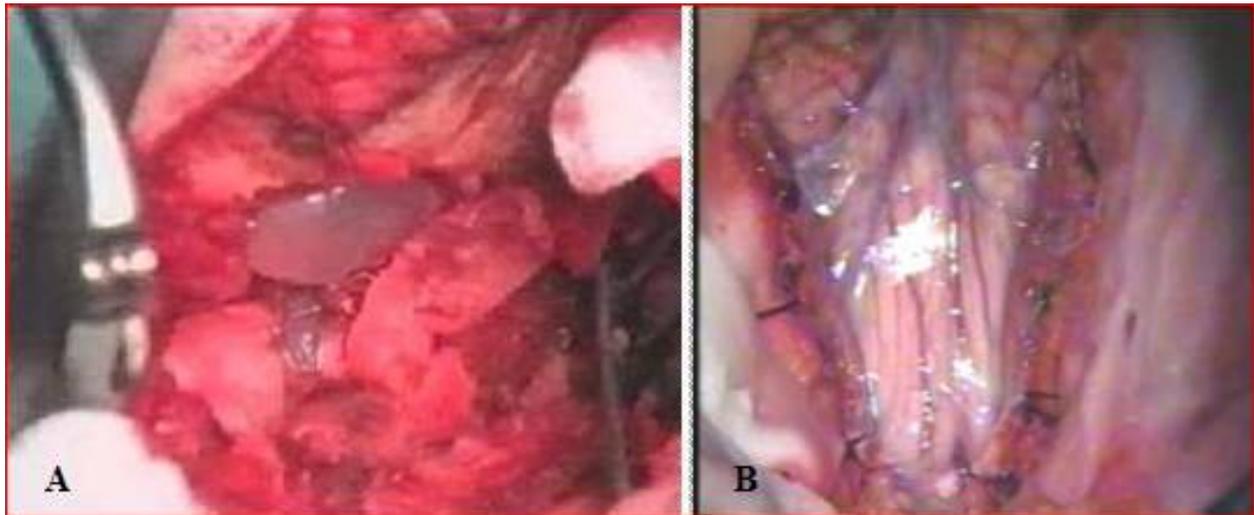


FIGURE 1. Preoperative picture of Dural opening with preservation of intact arachnoid (A) showed a bulge of the arachnoid which confirms the good passage of the cerebro spinal fluid (B) shows the large tonsils that occupy a large space and prevent the normal passage of the cerebro spinal fluid

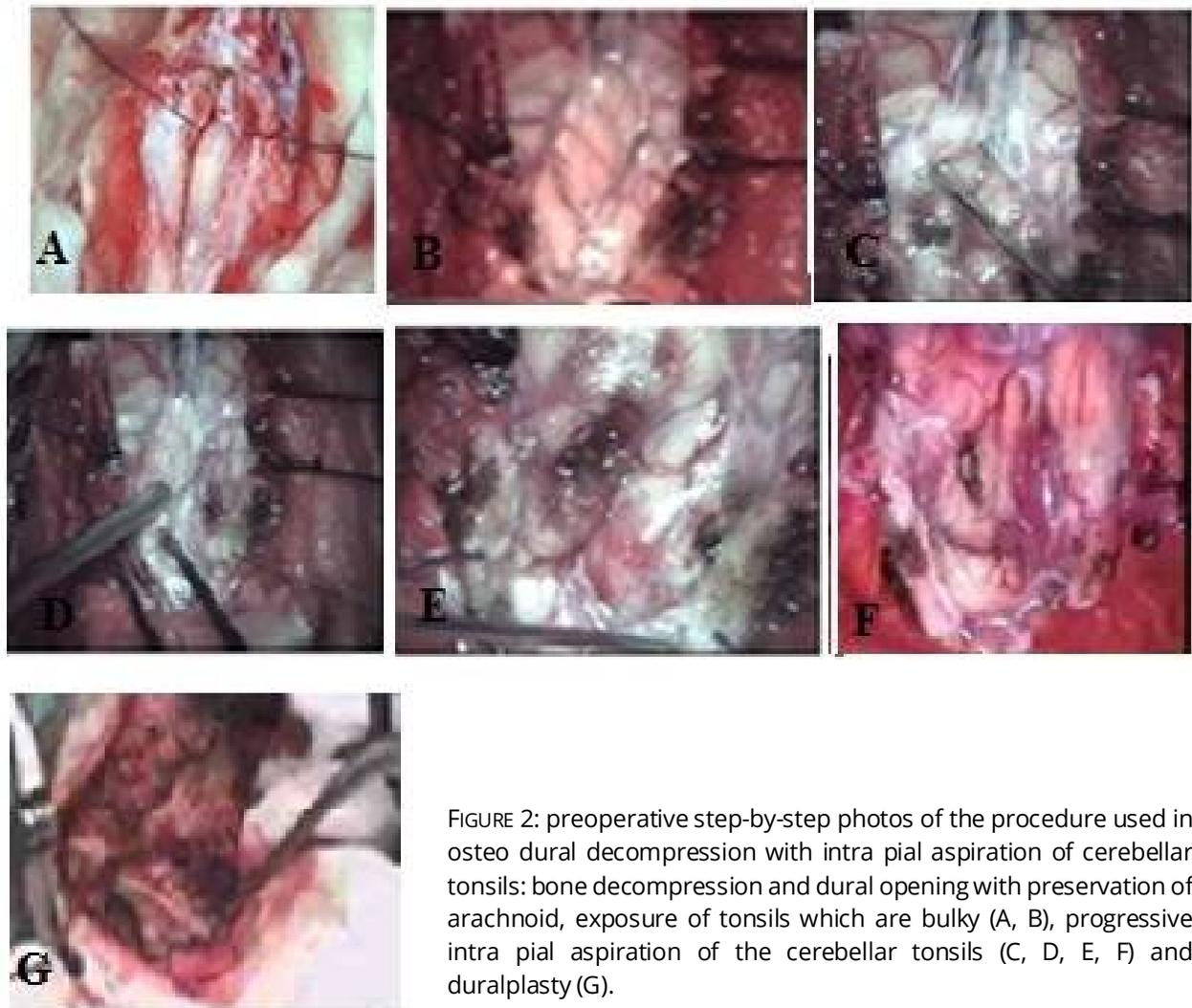


FIGURE 3.
Pre-operative (A) syringomyelia cavity with Chiar I
Post-operative(B) clearly regression of the
syringomyelia cavity

FIGURE 4.
Syringomyelia cavity pre op with Chiar I (A) Slight
postoperative regression of the syringomyelic cavity
(B)

The reoperation was not performed in our series because the result of long-term follow-up of our patients showed an improvement especially on the motor level. among patients who improved 15.79% remained stable in their initial improvement with an average follow-up over 8 years. These are similar to those in the series of reports on the best prognosis of the literature summarized and reported by Nozar Aghakhani [2].

Literature review

A literature review was performed with the PubMed search engine of the National Library of Medicine of the National Institutes of Health (<http://www.ncbi.nlm.nih.gov/pubmed>) and on the research gate site, using the following Keywords "Chiari malformation," "Chiari malformation type I with syringomyelia," "posterior fossa decompression with or without duraplasty," and "Craniocervical decompression with duraplasty and cerebellar tonsillectomy." The search was restricted to English-language publications without date limitations.

DISCUSSION

First, we will say what are the circumstances that led us to opt for this method.

Secondly, we analyse the various publications through the literature, is this method seen our retreat is effective or not, based on the following parameters: the immediate postoperative and the long-term results.

Third is that this method can be proposed in some patients.

To discuss the first issue, as you know that the key point of surgery in syringomyelia with Chiari malformation is to allow a flow of cerebrospinal fluid at the level of Magendie foramen and foramen magnum. For our part, we have opted for the 22 patients a osteo-dural decompression associated with intra pial aspiration of the cerebellar tonsils for several reasons:

- when the opening of the dura with maintenance of the arachnoid intact and an intraoperative exploration will show us intraoperatively, through the arachnoid, the absence of passage of cerebrospinal fluid due to the large volume of the cerebellar tonsils. As there is no bulge of the arachnoid, this means that there is not a good passage of cerebrospinal fluid in sufficient quantity.

- it has not been demonstrated that the resection of the cerebellar tonsils does not lead to neurological disorders. the function of which is not yet clearly determined.
- Visualization or appearance of large cerebellar tonsils and considerable size completely obstructing the foramen Magnum causes neurological disorders. depending on the presence of these 03 parameters, the decision to perform intrapital aspiration of the cerebellar tonsils will be taken.

In our experience, the intra pial aspiration or resection of the tonsils does not lead to a noticeable neurological deficit. according to Asgari S and al [9] during removal of the cerebellar tonsil, the integrity of the pia mater of the cerebellar tonsil should be preserved to reduce postoperative adhesions, causes aggravation or reappearance of neurological disorders. we take into account the analysis of the literature publication and the study of Arnautovic A [6], and Aghakhani N [2] ,Royo Salvador [71] to evaluate of surgical treatment options in the Chiari Malformation Type I with syringomyelia and concerning the occurrence of complications during the realization or not of the intrapial aspiration of the cerebellar tonsils, we found that the debate still exists as to whether, once the dura mater is open, arachnoid dissection should be performed or not and if the cerebellar tonsils are resected or retracted or not?. for some neurosurgeons the manipulation of the tonsils can lead in the long term to arachnoid adhesions between the cerebellar tonsils and the dura mater which prevents or hinders the subsequent flow of the cerebro spinal fluid at the foramen Magnum, with worsening of syringomyelia and symptoms according to Asgari S [9]. to avoid this postoperative arachnoiditis Sindou et al [76] and others authors such Hyun Seok L [44], Lee HS [56], Oldfield EH [67], Perrini .P[69] advocated or suggested opening of the dura with preservation of the arachnoid membrane and adding duraplasty, and reported favourable results. while in our series on an average of 8 years of follow up , we did not have this type of problem since we did not have any post-operative neurological aggravation in medium and long term (after minimum 1 year of follow-up) which eliminates the eventual arachnoiditis following intra pial aspiration of cerebellar tonsils which is confirmed in the study of Junpeng Ma1[49]and Zuev A.A[93] that the Cerebellar

tonsillectomy with suboccipital decompression and duraplasty can provide long-time cure for most Chiari I malformation cases, and some authors reported, the good results with this procedure [55, 91] and they have good results. Williams also recommended to remove part of the tonsils to ensure that the pathways are maximally opened. Many papers have supported arachnoid opening and/or tonsillectomy [5,16,7,93]. However, a successful surgical outcome (100% normalization of hindbrain herniation) was reported without arachnoid opening by Heiss et al [39] what was mentioned also by Royo Salvador [71] in his article. Klekamp [52] and Lee HS [56] showed that combined arachnoid pathology was a strong risk factor for symptom recurrence, because any operation undertaken to improve a problem related to arachnoid scarring may create new arachnoid scars, the lesser the extent of dissection and the lesser the contamination of the surgical field with blood, the better the chance of achieving good long-term results

Alden [4] in his article explains that, tonsillar shrinkage or resection has been advocated "as a way to improve the volume mismatch and to increase communication between the fourth ventricle and the spinal compartment". Fisher [30] recommends subpial resection of the cerebellar tonsils, While Batzdorf U [16] and others many neurosurgeons recommend tonsil shrinkage by coagulation or other means. and other authors Gonçalves da Silva J, Arruda J AM [7], Galarza M [30], Raftopoulos C [70] have another way to achieve sub arachnoid manipulation, and claim that this technique improves decompression in the region of the foramen magnum. In his article José Alberto Gonçalves da Silva and al [22], observed a Blockage of the foramen of Magendie in 55 (52.8%) patients, mainly caused by the presence of a dense membrane or adhesions between the cerebellar tonsils. In our opinion this is a valid argument for the exploration of the cerebellar tonsil and foramen of Magendie. On the other hand, some of the neurosurgeons [63,21, 39. leave them intact, performing especially the opening of the fourth ventricle. On the other side, Batzdorf [16] recommends lightly diathermying the pia mater over the surface of the tonsils. for Raftopoulos [70] it is enough just to open the arachnoid and then remove the adhesions.

Secondarily in the past, decompression treatment of the occipito cervical junction has been a dangerous operation, with a significant mortality rate [Di Lorenzo]. With the development of neurosurgery, occipito vertebral decompression has become a relatively low-risk procedure. In our series, there have been no cases of death, or serious infections requiring revision of the wound, Badie et al. [10] retrospectively evaluated 20 cases treated via decompression technique with duraplasty and tonsillectomy. The success rate was 85%, with no mortality. Complications were not described. The 04/22 cases of cerebro spinal fluid leakage in our series is slightly high but if we take all our series of 121 patients who have benefited from occipito cervical decompression with dural plasty, the leak rate of cerebro spinal fluid is similar to that reported in other series [28,35,40,46,48,49]. The incidences of CSF-related complications and hydrocephalus in studies about occipito cervical decompression with dural plasty were 4–10% and 3–4% respectively [79].

No appearance of a a pseudomeningocele in our series because we use a small suboccipital decompression, this makes it possible to avoid the appearance of a a pseudomeningocele. Recently, Jeffrey S et al [17], performing a small bone decompression report in his article on minimally invasive subpial tonsillectomy for Chiari I decompression significantly reduced the risk of pseudo-meningocele formation.

The incidence of Motor deficits and sensory disorder in our series is higher than in other series [8,10,68]. In our series, these motor deficits are improved in 16 out of 22 cases after functional rehabilitation, and remained unchanged in 06 cases, we agree with Bălașa. A, Gherasim.D.N.[11] who believes that preoperative longtime neurological deficit is a predictor of poorer outcome, making early surgery. this explains why in our series we had 06 patients who remained unchanged postoperatively and this is probably due to late diagnosis in our patients who only consult at the late stage.

Depreitere et al. [25] retrospectively analysed 22 cases operated used tonsillectomy. On initial follow-up, 16 patients (76%) were improved. In late follow-up, the success rate was 68%. Alfieri et al, reported that surgical decompression with durotomy, arachnoid opening, tonsillar shrinkage, and recreation of the cisterna magna was a safe and effective procedure. Prognosis was excellent, with

global clinical and radiological improvement in more than 90% and 80% of patients, respectively Stanko et al [77] suggested that tonsillar cauterization might provide an extra benefit in the resolution of the syrinx compared with bone-only decompression alone or in combination with dural opening. Another previous study reported on 22 adult patients, with the conclusion that sub arachnoid manipulation may improve the symptoms in Chiari I malformation [30]. In an older study, seven of eight patients who underwent sub arachnoid manipulation showed very good clinical outcomes [36,37] for some neurosurgeons sub arachnoid manipulation are generally accepted as the effective surgical procedures in the treatment of Chiari I malformation [67,70,72], and their effects have been confirmed by clinical practice.

In our series postoperative, MRI scan reveals clearly regression of the syrinx cavity in 09 case, and Slightly regression of the syrinx cavity in 13 cases, based on the Vaquero index and absence of cerebellar tonsil herniation in all cases. Wetjen [82] and co-authors have estimated the rate of syringomyelia resolution by examining the postoperative images in patients after Chiari I malformation decompression. Based on the largest anteroposterior diameter of the syringomyelia, the authors concluded that the median time to greater than 50% narrowing of the syringomyelia was 3.6 months postoperatively, whereas the mean time was 6.5 months. In a follow-up study by Wu et al. [86], syringomyelia was found to be obviously reduced in all patients examined and completely eliminated in eight patients. In the study of Bao and al [14], the re-examination by MRI in 44 patients showed successful construction of the *cis-terna magna*, with eliminated or obviously reduced syringomyelia in 42 patients. According to de Lotbinière ACJ [58] The tonsillectomy or cerebellar tonsil exeresis proposed by some authors probably adds to the mortality and morbidity rates. It can be an unnecessary and maiming surgical manoeuvre. Alden [4] states that "no neurological deficit has been demonstrated as a result of tonsillar resection; however, the exact function of this structure is largely unknown we agree with Alden effectively, we have practiced it since 1999 and we have not had neurological disorders following their resection including cognitive disorders. taking into consideration that, the role of the cerebellum in learning and cognition

began to be considered. In 1997 and 1998 Schmahmann and Sherman [75] named dysfunction of the cerebellum contribution to cognition and behavior the cerebellar cognitive affective syndrome. The posterior lobe of the cerebellum and the vermis contribute to verbal fluency, short-term memory, abstract reasoning, and spatial cognition, functions that may underlie the frequent complaint of "brain fog" in patients the Chiari I malformation. According to Royo Salvador MB [71] the tonsillectomy for syringomyelia with Chiari I, is not indicated, given that no benefit is obtained and it involves an amputation of a part of the cerebellum that can only contribute to sequelae, situations of permanent instability and vertigo.

In our study of clinical presentation in 32 patients with the Chiari I malformation with syringomyelia, we did not consider the psychological and or congenital state during the preoperative clinical examination.

Finally, and generally, the results of this procedure are favourable and differ little between the series. This was confirmed by the present study that the results were good, the complications limited in number. In 2005 we presented our comparative study of 40 patients between bone decompression with dural plasty (20 patients) and bone decompression with dural plasty followed by intrapial aspiration of cerebellar tonsils (20 patients) we found that the clinico-radiological results of bone decompression with dural plasty followed by intrapial aspiration of cerebellar tonsils are comparable and sometimes better than the bone decompression with dural plasty [18].

We believe that one of the advantages of arachnoid dissection, in the context of Syringomyelia with Chiari I malformation, is that it allows the surgeon to release the adhesions especially at the foramen of Magendie which could contribute to the obstruction of the cerebro spinal fluid flow from the fourth ventricle to the spinal canal. Whereas the subpial resection of the cerebellar tonsils, especially when they are bulky, we recommend it as a means of improving particularly the passage volume of the cerebro spinal fluid flow and increasing the communication between the fourth ventricle and the spinal cord.

Our experience that patients treated by tonsils resection had a good outcome with no increased operative risk and no additional surgery required

surgical technique. I totally agree with Arruda and al [1] in his study Arruda conclude that craniocervical decompression with tonsillectomy and duramater graft proved an effective method for the treatment of Syringomyelia and Chiari malformation.

Limitations

First, the present study was a retrospective analysis of 22 patients and the small number may have resulted in a lower statistical power. Second a prospective multicentre study with a large and equal number of patients in the occipito cervical decompression and occipito cervical decompression with intra pial aspiration of cerebellar tonsils or tonsillectomy groups might provide sufficient data for an adequate comparison of these 2 techniques to better define the indications and benefits.

CONCLUSIONS

For the treatment of symptomatic patients, various approaches may be used: bone decompression with dural graft, or bone decompression with dural graft and intradural dissection of adhesions and reduction by intrapial aspiration of the cerebellar tonsils or resection of tonsils because the key point of surgery in syringomyelia with Chiari I malformation is to allow a cerebro spinal fluid flow at the level of foramen of Magendie and foramen magnum. For our part, we have opted for a certain category of patients for osteo-dural decompression associated with subpial resection of the cerebellar tonsils for several reasons: -no neurological disturbance has been demonstrated to result from the intra pial aspiration resection of ectopic cerebellar tonsils,- the function of which is not yet clearly determined - the attribution of the neurological disorders, noted in the pre-surgical phase, to the malformation of Arnold Chiari, the MRI appearance of cerebellar tonsils of considerable size totally obstructing the foramen Magnum. -the intraoperative finding, through the arachnoid, of the absence of passage of the cerebro spinal fluid due to the bulging of the cerebellar tonsils. according to Beecher. J.S.[17] the indications for subpial resection of the cerebellar tonsils surgery are the presence of one or more of the following criteria:

1. Karnofsky score of 70 or less secondary to Chiari malformation stereotypic constellation of symptoms

2. An expanding syringomyelia on consecutive MRI scans, syringomyelia cavities in excess of 75 % of the transverse cord diameter on the index MRI, or eccentric appearance of the syringomyelia cavity with intraparenchymal blebs
3. Severe, rapidly progressive neurological deficit

However, it should be acknowledged that this is an observational study and ultimately, we can say that the technique can be used in particular cases. It would be interesting to pay more attention to the effectiveness / inefficiency of the indication of intrapial aspiration of the cerebellar tonsils in the syringomyelia surgery with tonsils herniation (Chiari I malformation).

For these reasons, I believe long-term follow-up, with periodic measures, is required to really understand the success of surgery.

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