

Method to perform safety stereotactic procedures in children under 2 years of age

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Abstract

Introduction Stereotactic procedures have been used in neurosurgery for many years. In children especially, care should be considered to avoid complication caused by fixation of the frame in a not fully developed skull bone. We present our method to adapt the frame in children under 2 years of age.

Methods Twelve procedures in patients under 24 months were performed between 2003 and 2015. Micromar frame was used. It was adapted with a small pillow made of gauss attached to the posterior part to hold the head, then four pins were fixed without adjustment. We analyze for each patient age, indication, histopathology, and complications.

Results Eleven patients with a mean age of 13.5 months (range 9 to 22 months) underwent 12 stereotactic procedures. In all cases, biopsy samples were obtained, histopathology was positive in 11/12 cases. No complications occurred.

Conclusion Stereotactic frame procedures need special attention in small children where the skull bones are not fully developed. We present a simple method to perform this surgery in patients under 2 years of age.

Keywords Pediatric stereotactic · Frame fixation · Brain biopsy · Safety · Thin skull bone

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Introduction

Stereotactic surgery has been used for several years in minimal invasive neurosurgery [3, 8]. Complication resulting from the fixation of the frame, such as skull fractures, dislodgement of the pins, penetration of the skull, and epidural hematoma have been described and must be considered specially in pediatric patients where the skull bones are not fully developed [3, 4, 9, 10].

To overcome these problems, we developed a modification of the frame allowing fixation to the skull with minimum pressure of the pins.

Materials and methods

Between 2003 and 2015 from a total of 129 stereotactic procedures, 12 were performed in 11 patients under 2 years of age. In all cases, Micromar frame was used. It was adapted with a small pillow made of gauss and fixed with bandage to the posterior part of the frame between the pins (Fig. 1). If lateral position was needed (we use that position for transcerebellar approaches), another small pillow was attached laterally (Fig. 2). After induction and general endotracheal anesthesia, the head was placed resting on the attachment. Once aligned, four pins were used, two frontal and two posterior. They were adjusted just contacting the bone, without applying any pressure to avoid trespassing the skull and in order to maintain the frame in place; the weight of the head was supported by the attachment and not by the pins. A D-shaped gel pad positioner was used under the neck to help maintain the right angle between the frame, the head, and the table (Fig. 3).

Although the frame is placed supratentorial, we also used this technique for posterior fossa procedures.



Fig. 1 Frame adapted with small pillow in the posterior part

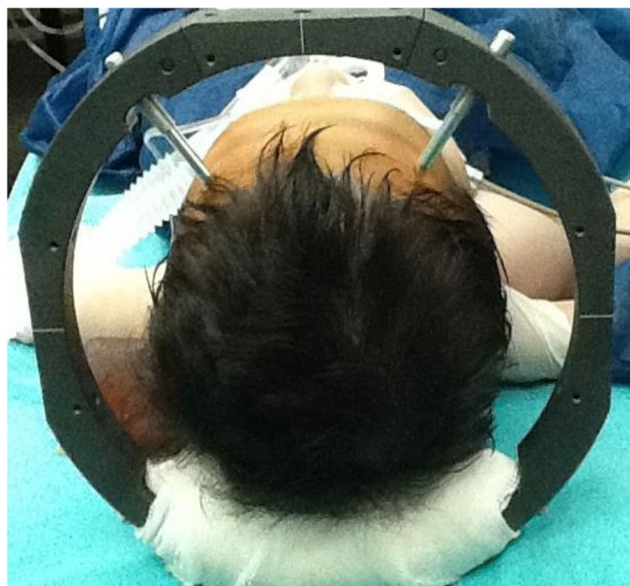


Fig. 3 Frame attached to patient

A CT scan was performed aligning the frame with the gantry without using the adapter for the table. Coordinates were calculated with informatics procedures (MEVIS software).

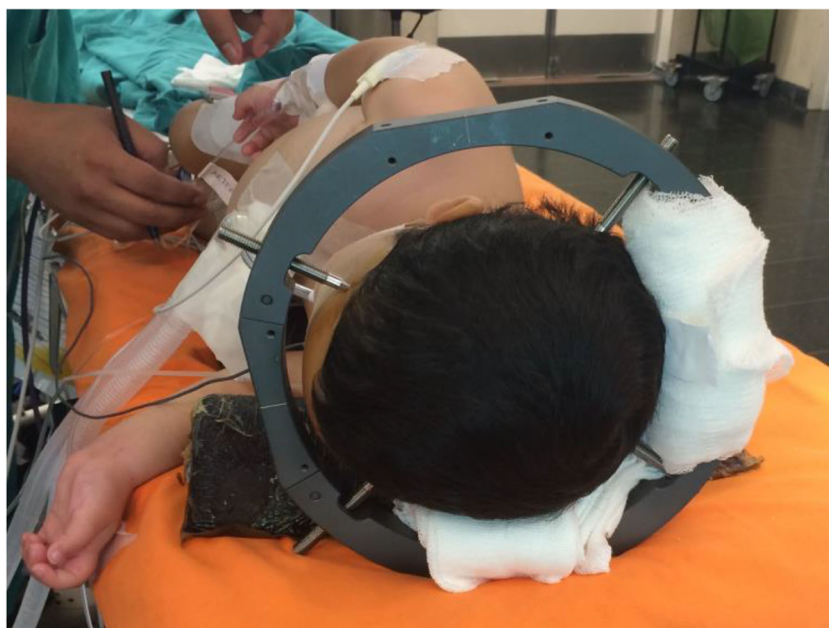
Once in the OR, the patient was positioned on the operating table without the devices adapted to a headset arm.

Then, the stereotactic procedure continued as usual using the arc and a Sedan needle.

The biopsies underwent first squash and then paraffin section diagnosis in all patients.

Cultures were performed in patients with signs of inflammatory diseases or history of infection.

Fig. 2 Patient in lateral position with adapted frame



Results

Eleven patients under 2 years of age underwent stereotactic procedures, 6 males and 5 females with a mean age of 13.5 months (range 9 to 22 months). Four patients presented brain stem tumors, 2 thalamic tumors, 3 supratentorial masses, 1 cerebellar mass, and 1 postinfectious brain stem cyst (Table 1).

Diagnosis could be achieved in 11 procedures. In only one case (cerebellar mass), histopathology was negative.

In the patient with postinfectious brain stem cyst, evacuation was performed.

Table 1 Stereotactic procedures in children under 2 years of age from 2003 to 2015 (Procedures 2 and 3 were performed in the same patients).

Procedure no.	Age (months)	Gender	Indication	Procedure	Histopathology
1	20	F	Brain stem tumor	Biopsy	Anaplastic glioma
2	18	M	Thalamus tumor	Biopsy	Gliosis
3	22	M	Thalamus tumor	Biopsy	Ganglioglioma
4	10	M	Supratentorial masses	Biopsy and culture	Granuloma (culture–)
5	11	F	Brain stem tumor	Biopsy	Glioma
6	22	M	Supratentorial masses	Biopsy and culture	Chronic inflammation (culture–)
7	11	F	Brain stem tumor	Biopsy	Diffuse glioma
8	9	M	Brain stem tumor	Biopsy	Anaplastic ependymoma
9	13	M	Thalamus tumor	Biopsy	Low-grade glioma
10	10	F	Supratentorial tumor	Biopsy	Foreign body granuloma
11	16	F	Cerebellar mass	Biopsy	Negative
12	9	M	Brain stem cyst	Evacuation, culture, and biopsy	Inflammatory (culture–)

No complication related to pin fixation occurred.

Discussion

Frame stereotactic procedures have been used in children frequently for several years; however, the risk of complication due to fixation of the frame sometimes is considered as a contraindication in patients under 2 years of age [10].

The thickness of the cranium varies considerably up to the age of seven and acquires 94% of its final length and 89% of its adult width by the age of 3 to 5 years [4, 7].

Most reports about the risk of head fixation and age, concerned clamp for general neurosurgery or halo for neck injuries are different options to avoid complications [7, 11, 12].

Mark Lee et al. described the use of six pins instead of four with the Sugita system; nevertheless, they do not use fixation in children under 3 years of age [6].

Sgouros et al. used three small disc-shaped pieces of Perspex adapted to the pins of a skull clamp and suction bean bag placed on the operation table to support the weight of the head when using image-guided surgery in children under 2 years [11].

In a survey of 605 neurosurgeons published in 2008 about cranial fixation pins in pediatric neurosurgery by Berry et al., they suggested, in the first place, using as many pins as possible for Sugita cranial fixation head holder and extreme caution pin fixation in addition with non-pin head support for Mayfield device in children under 2 years [2].

Considering skull bone thickness and complication reported by other authors [3, 4, 9, 10], we suggest 24th month as an age limit to adapt the frame in order to avoid pin penetration and skull fractures.

Regarding stereotactic procedures, there are few case reports. In 1987, Uematsu et al. described the use of a custom-

fitted thermoplastic helmet and modified pins for the fixation of a standard Leksell frame in a 7-month-old patient [12].

In 1989, Pattisapu et al. reported the use of the Brown-Roberts-Wells frame without any basic changes in technique for 62 patients from 5th month to 18 years with only one complication not related to pin fixation [9].

In 1996, Kondziolka and Adelson reported a technique used in a 5-month-old infant based on a description of a Mayfield clamp fixation used by Aoki and Sakai [1]. They used a semi-rigid foam to support the body and head of the patient. A rubber top obtained from blood sampling tube is placed into the tip of the pins preventing penetration [5]. However, we prefer to avoid any material between the pins and the skull to prevent damage to the skin caused by continuous pressure during the procedure. We also use only a simple D-shaped gel pad under the neck to keep the right position between the head and the body without the need of a semirigid foam.

More recently, in 2015, Furnaletti et al. published their experience with 99 patients, 11 under 12 months and 33 under 3 years of age with a complication rate of 18 and 6%, respectively. They used a modified Riechert-Mundinger stereotactic frame with a classic technique without any variation according to patient's age [3].

With the technique we propose, no material is interposed between pin and skull. A simple modification based on the support of the head by an adaptation on the rear part of the frame was sufficient to avoid pin-related complications.

Conclusion

Stereotactic frame procedures are useful in patients of all ages and can be performed in small children. Our simple adaptation of the frame may be suggested in patients under 2 years of age

in order to maintain the head fixed, resulting in good accuracy and avoiding complications.

Compliance with ethical standards

Conflict of interest On behalf of all authors, the corresponding author states that there is no conflict of interest.

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