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Original Paper

# Mild trigonocephaly and intracranial pressure: report of 56 patients

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**Abstract**

*Introduction* We report the surgical results in patients with mild trigonocephaly and clinical symptoms. Since high intracranial pressure (ICP) was noted during surgery in our previous patient series, we began to record intraoperative ICP. The importance of treating mild trigonocephaly with clinical symptoms is stressed.

*Patients and methods* Fifty-six children (44 boys, 12 girls) in whom ICP was measured were diagnosed with mild trigonocephaly (nonsyndromic type) with symptoms such as language delay, hyperactivity, autistic tendencies, self-mutilation, motor delay, etc. Their ages ranged from 2 to 8 (mean 5.1) years. ICP was measured after a burr hole was made under endotracheal general

anesthesia and a sensor was inserted in the right frontal lobe epidurally immediately in front of the right coronal suture. The first recordings were made at around 30 mmHg of $PCO_2$ as for neuroanesthesia, and the second were at around 40 mmHg of $PCO_2$ as during natural breathing. We also investigated which factors accounted for the improvement of clinical symptoms.

*Results* The first ICP records at 29.1 mmHg of $PCO_2$ indicated a mean ICP of 13.3 mmHg. The second changed to a mean 38.2 mmHg of $PCO_2$ for an increased mean ICP of 19.8 mmHg. The pulse pressures were a mean 7.1 mmHg in the first recordings and 8.5 mmHg in the second. The mean ICP and pulse pressure were thus high in these children. Clinically, 30 out of 56 patients improved markedly and 22 improved slightly, while 4 did not exhibit any change. Factors contributing to improvement were younger age, relatively higher development quotient, marked digital impressions on skull X-rays, abnormal findings on SPECT, and moderate degree of trigonocephaly.

*Conclusion* Although our patients had mild trigonocephaly, their ICP and pulse pressure were high. Decompressive cranioplasty in cases of mild trigonocephaly is feasible.

**Keywords** Trigonocephaly - Intracranial pressure - Developmental delay - Decompressive cranioplasty

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# Introduction

In 2002, we reported the surgical results in 65 patients with mild trigonocephaly associated with symptoms such as delays in language development, hyperactivity, autistic tendencies, and motor dysfunctions [19]. After that report, numerous trigonocephaly patients were referred to us. We pointed out in the previous paper that patients with mild trigonocephaly had minimum cosmetic problems, although clinical symptoms were present, and that they showed some improvement after decompressive cranioplasty. Generally speaking, the indications for surgery in craniosynostosis patients include cosmetic considerations and prevention of neurological injury [6, 12]. Several authors

have recently reported that patients with minimal cranial deformity presented with clinical symptoms [4, 14, 21, 23]. Many patients in those reports presented with later than usual onset, elevated intracranial pressure (ICP), and single-suture craniosynostosis. Although it has been stressed that the occurrence of raised ICP in single-suture synostosis is low [17, 18, 22, 25], the above reports noted elevated ICP in the mild form and single-suture synostosis. In our experience, we found a high rate of marked digital impressions on skull X-rays in our patients with mild trigonocephaly, and also noted ICP elevation during surgery in our previously reported patients [19]. After our previous report, we began to record ICP epidurally during surgery in consecutive patients. We report here the results and assessment of surgical outcome.

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# Patients and methods

## Patients

From March 2000 to June 2002, 56 children (44 boys and 12 girls) diagnosed with mild trigonocephaly were examined in the Division of Neurosurgery, Okinawa Prefectural Naha Hospital. The age distribution was 2–8 (mean 5.1) years (Fig. 1). ICP was measured in all patients epidurally during surgery. All patients underwent chromosome testing, but no abnormal results were found. All 56 patients were considered to be in the nonsyndromic trigonocephaly category.

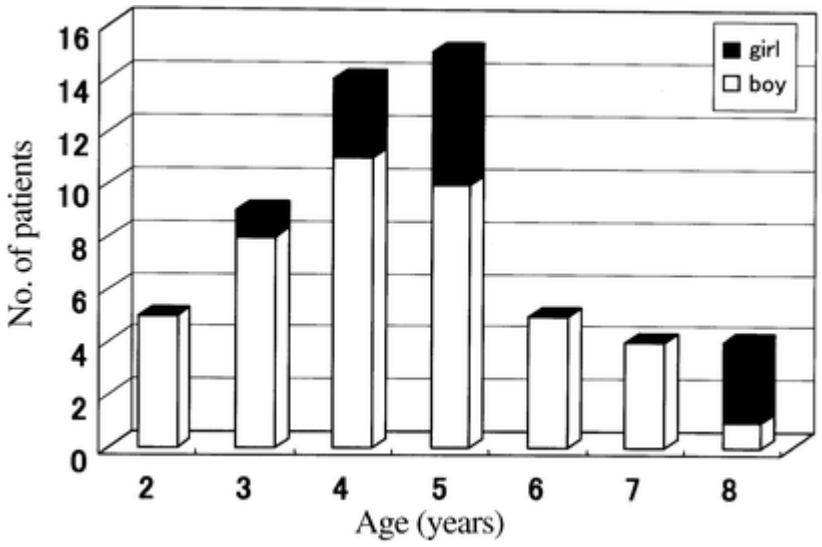


**Fig. 1** Age distribution and sex of patients

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Since July 2000, we have explicitly informed parents that this surgery was for the purpose of improving some of the child's symptoms rather than for cosmetic purposes.

# Preoperative evaluation

## Facial features

The characteristic facial features of mild trigonocephaly were as described in the previous paper:

1. A heel-shaped forehead

2. Depressed temples

3. Mild hypotelorism

4. A palpable forehead ridge [19]

The most important finding is palpation of the metopic ridge. However, patients with milder cases are somewhat difficult to diagnose physically because their shallower metopic ridge and broader forehead appear normal. All patients were diagnosed using three-dimensional computed tomography (3D-CT) to determine the presence of the forehead ridge.

## Symptoms

None of the patients were diagnosed before the age of 1 year. Fourteen out of 56 patients had shown regression in language acquisition and use. All patients except for one were thought to be mentally retarded (a patient with normal intelligence had complained of severe headaches every day). The development quotient (DQ) was measured using the K-form Developmental Test (a commonly used test in Japan) in all surgical patients preoperatively and postoperatively.
The main symptoms included delays in language development, behavioral problems (hyperactivity, inappropriate social interaction, self-mutilation, panic, and irritability), and motor dysfunction. These were described in detail in our previous report.

## Neuroradiologic findings

The findings of the sclerotic change in the metopic suture and hypotelorism on skull X-rays were essentially the same as those described in the previous report [19]. However, in this series of patients, the digital impressions on X-rays were investigated. The lateral view of the patient's skull X-ray is divided into four areas (frontal, parietal, temporal, and occipital). The lateral skull X-rays showed digital impressions in all four areas in 22 patients and in three of the four areas in 20 patients, totaling 75% of all patients (Fig. 2).

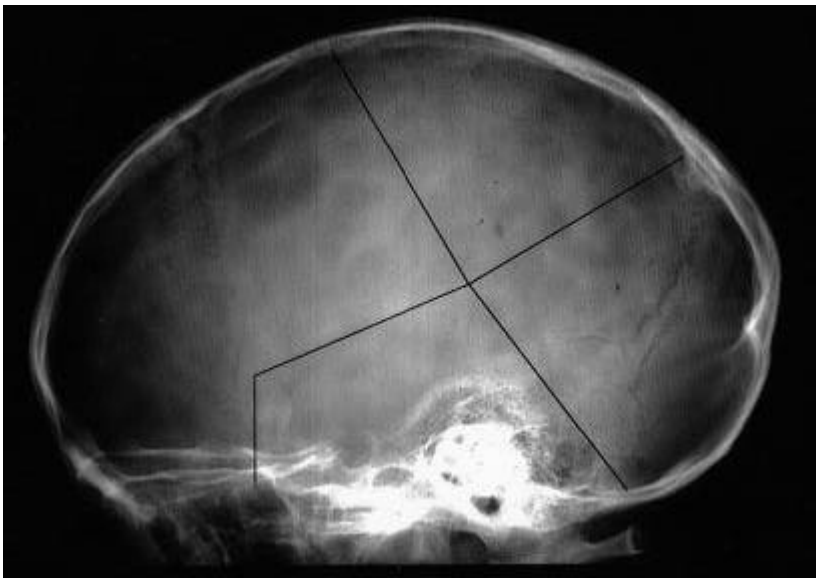

**Fig. 2** Marked digital impressions seen on a skull X-ray. The lateral skull X-ray showed digital impressions in 75% of all patients over three-quarters of the area

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Because it was thought that the occurrence of digital impressions correlated with age, we investigated the incidence of the appearance of digital markings on the lateral skull X-rays in the same age groups. Two neurosurgeons and one pediatrician evaluated 35 skull X-rays of healthy patients with simple head injuries and of 31 randomly selected patients with mild trigonocephaly. They estimated that the incidence of marked digital impressions was 45.7% in the former and 77.4% in the latter. The difference was statistically significant ($p$=0.012, chi-square test).

## Diagnosis and classification of trigonocephaly

The 3D-CT scans with findings of the metopic ridge were used to make the final diagnosis of mild trigonocephaly. The other characteristic findings of small anterior fossae, depressed pterional regions, and hypotelorism were also seen on 3D-CT. Trigonocephaly was classified as severe, moderate, or mild following the system of Oi and Matsumoto [16]. Our cases were classified as mild based on the facial features, and were also classified as moderate (39 cases) and mild (17 cases) in Oi and Matsumoto's system (Fig. 3).

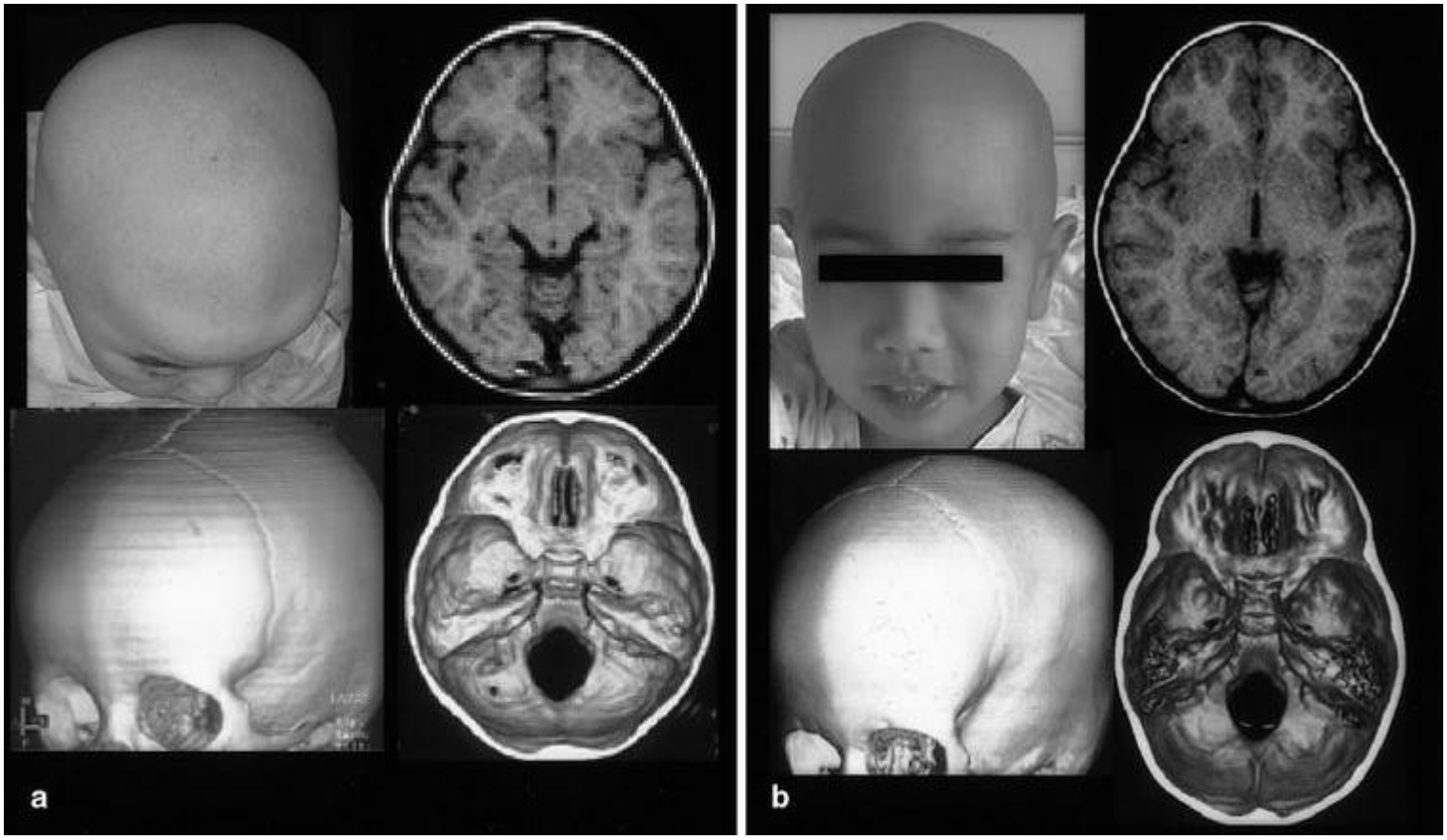


**Fig. 3a, b** Grading system. **a** Patients with mild trigonocephaly had a broad forehead and shallow metopic ridge. However, small anterior fossae and frontal lobes were noted. **b** Patients with moderate trigonocephaly had a narrow forehead and higher metopic ridge. The small anterior fossae and frontal lobes were more apparent

Regular CT and magnetic resonance imaging (MRI) were used to evaluate the parenchyma of the brain. No abnormal findings were found except for small frontal lobes.

Fifty-five patients underwent preoperative single-photon emission computed tomography (SPECT) and 57% were found to have decreased cerebral blood flow (CBF), mainly in the frontal lobes. These must be regarded as qualified results, since there is no established standard for SPECT evaluation of CBF in childhood.

## Measurement of ICP

Intracranial pressure was measured in all 56 children. The patients were placed under endotracheal general sevoflurane anesthesia and the maximal inspiratory pressure was controlled at around 18 mmHg. ICP was measured after a burr hole had been made and a sensor (Camino's monitoring system) was inserted in the frontal lobe epidurally immediately in front of the right coronal suture. The first recordings were made at a $PCO_2$ level of around 30 mmHg as for neuroanesthesia (hypocapnea), and the second at a $PCO_2$ level of around 40 mmHg as in natural breathing (normocapnea). The blood gases were examined at each pressure condition.

## Surgical procedure

The surgical procedure was described in detail in our previous report [19]. It should be stressed that the most important points were sufficient decompression of the sphenoid bone including the sphenoid ridge and the supraorbital bar with the orbital roof removed in one piece. The procedure is referred to as decompressive cranioplasty.

# Results

## Facial features

Although the purpose of surgery was not cosmetic, the entire forehead was broader and the depressed temples flatter postoperatively.

## Symptoms

The rate of improvement of individual symptoms tended to be the same as in the previous study [19], and therefore the details are not described here. Among the 55 patients with global delays in language development, improvement was seen in 38 postoperatively. Those who used fewer words before surgery exhibited less improvement thereafter. Hyperactivity levels decreased in 33 of the 43 patients with hyperactive behavior within a few months of surgery. The reduced hyperactivity allowed some to sit still during school classes. Some of them could stop rushing toward a car, and some could undergo CT scanning without sedation.

Postoperative improvement was also noted in 21 out of 31 patients who exhibited impaired social interactions preoperatively. Some began playing with their siblings and other children within a few months of surgery, which made it easier to make friends. Panic and irritability were noted preoperatively in 19 patients in this series, which improved in 18; in some they disappeared completely and in some were markedly decreased. Preoperatively, the patients continued to cry for a long time when not allowed to do something that they wanted to do. However, the duration of crying became much shorter postoperatively. Head banging occurred in 9 patients before surgery but disappeared completely in all after surgery. Six out of seven patients with motor dysfunction improved after surgery. Most of them had gross motor dysfunction such as walking sideways instead of forward, difficulty in riding a tricycle, and inability to jump. All improved after surgery. One patient who had difficulty in making precise movements with the fingers before surgery showed no improvement after surgery (Table 1).

**Table 1** Improvement in symptoms after surgery (*n*=56)

| Symptom | Present preoperatively (number of patients) | Improved postoperatively (number of patients) | Improvement rate (% of patients) |
|---|---|---|---|
| Language delay | 55 | 38 | 69 |
| Hyperactivity | 43 | 33 | 79 |
| Impaired social interactions | 31 | 21 | 68 |
| Panic and irritability | 19 | 18 | 94 |
| Head banging | 9 | 9 | 100 |
| Motor dysfunction | 7 | 6 | 68 |

Overall, 52 patients (93%) showed some improvement after surgery. In 4 patients, however, no change in symptoms was seen. The improvements were classified as slight, i.e., a change in any symptom, in 22 patients and as marked in 30 patients 6 months postoperatively.

The DQ was measured in 44 patients more than 1 year postoperatively. The DQ was a mean 55.0 points preoperatively and 55.9 points postoperatively. Two patients had a gain of more than 21 points after surgery. Thirty patients maintained the same DQ±10 points postoperatively (Table 2).

**Table 2** Changes in development quotient (DQ) after surgery (*n*=44)

| Preoperative DQ | Change in DQ score postoperatively | | | | |
|---|---|---|---|---|---|
| | –20 to ≤ –11 | –10 to ≤ –1 | 1 to ≤ 10 | 11 to ≤ 20 | ≥ 21 |
| 21–30 | | 1 | | | |
| 31–40 | 1 | 2 | 2 | 1 | |
| 41–50 | 1 | 5 | 3 | | |
| 51–60 | 2 | 6 | 2 | 2 | |

| Preoperative DQ | Change in DQ score postoperatively | | | | |
|---|---|---|---|---|---|
| | –20 to ≤ –11 | –10 to ≤ –1 | 1 to ≤ 10 | 11 to ≤ 20 | ≥ 21 |
| 61–70 | 1 | 3 | 2 | 4 | 1 |
| 71–80 | | 2 | 2 | | 1 |
| 81–90 | | | | | |
| Number of patients | 5 | 19 | 11 | 7 | 2 |

## Neuroradiologic evaluation

Postoperative 3D-CT and MRI examinations showed larger frontal lobes and anterior fossae in all patients compared with the preoperative size. Postoperative SPECT examination was performed 1 year after surgery, but the surgical wound where bone had been removed in the central frontal area had not closed sufficiently to allow a precise evaluation of the results.

## Measurement of ICP

Intracranial pressure and blood gas analysis results during hypocapnea and normocapnea are summarized in Table 3. The mean $PCO_2$ was 29.12 mmHg during hypocapnea and 38.19 mmHg during normocapnea. These values are close to those desired. ICP changes in each patient during hypocapnea and normocapnea are shown in Fig. 4.

**Table 3** Blood gas analysis and intracranial pressure (ICP) levels. The results are the mean of all 56 patients during hypocapnea and normocapnea

| | Hypocapnea | Normocapnea |
|---|---|---|
| $PCO_2$ | 29.12 | 38.19 |
| $PO_2$ | 202.9 | 185.8 |
| pH | 7.455 | 7.364 |
| Systolic ICP | 17.2 | 24.4 |
| Diastolic ICP | 10.3 | 15.9 |

| | Hypocapnea | Normocapnea |
|---|---|---|
| Pulse pressure | 7.1 | 8.5 |
| Mean ICP | 13.3 | 19.8 |

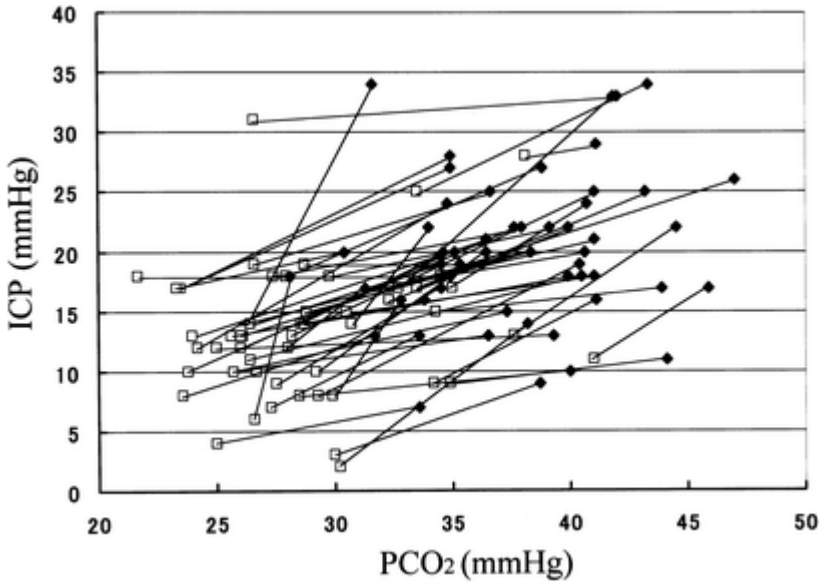


**Fig. 4** Changes in ICP during hypocapnea and normocapnea

During normocapnea, a mean ICP of less than 10 mmHg with pulse pressure of 9.2 mmHg was recorded in 5 patients. Seven patients had a mean ICP of 11–15 mmHg with a pulse pressure of 7 mmHg. Forty-four patients had a mean ICP of 22.1 mmHg and a pulse pressure of 8.7 mmHg (Table 4). The actual ICP recordings in one patient are shown in Fig. 5.

**Table 4** Intracranial pressure and blood gas levels during normocapnea

| | ICP (mmHg) | | |
|---|---|---|---|
| | <10 | 11–16 | ≥16 |
| Number of patients | 5 | 7 | 44 |
| $PCO_2$ | 40.1 | 37.2 | 38.2 |
| $PO_2$ | 155.8 | 167.4 | 180.9 |

| | ICP (mmHg) | | |
|---|---|---|---|
| | <10 | 11–16 | ≥16 |
| pH | 7.330 | 7.373 | 7.366 |
| Systolic ICP | 13.4 | 17.0 | 26.8 |
| Diastolic ICP | 4.2 | 10.0 | 18.2 |
| Pulse pressure | 9.2 | 7.0 | 8.7 |
| Mean ICP | 8.3 | 13.1 | 22.1 |

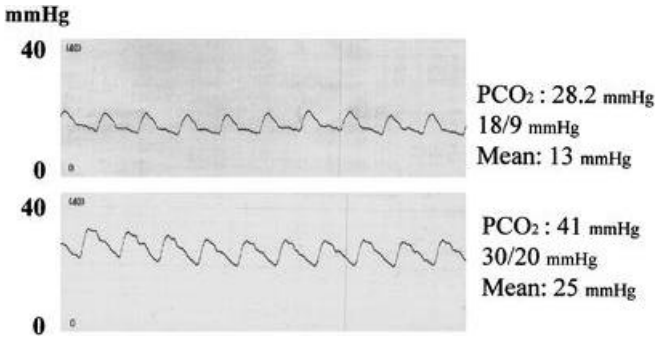


**Fig. 5** Intracranial pressure recordings in a 3-year-old boy presenting with language delay, hyperactivity, and autistic tendencies. ICP was 18/9 mmHg (mean 13 mmHg) with $PCO_2$ of 28.2 mmHg and 30/20 mmHg (mean 25 mmHg) with $PCO_2$ of 41 mmHg

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## Relationship between clinical results and physical examinations

Patients, results of physical examinations, and clinical postoperative results are listed in Table 5. Preoperatively, the unchanged group of patients tended to be older and to have a lower DQ, no significant findings of digital impressions on skull X-rays, no abnormal findings on SPECT, and mild trigonocephaly. In contrast, the improved group of patients tended to be younger and to have a relatively higher DQ, marked digital impressions on skull X-rays, decreased CBF on SPECT, and a moderate degree of trigonocephaly.

**Table 5** Postoperative outcomes and physical examination results. *UC* unchanged, *SI* slightly improved, *I* improved

| Clinical result | Number of patients | Age at surgery (years) | DQ score | | Degree of trigonocephaly | | Digital impressions | | SPECT | | Mean ICP (mmHg) | Mean pulse pressure (mmHg) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Preoperative | Postoperative | Mild | Moderate | ≤ 2/4 | ≥ 3/4 | Normal | Abnormal | | |
| UC | 4 | 6.2 | 37 | 28 | 4 | 0 | 3 | 1 | 3 | 1 | 22 | 9.5 |
| SI | 22 | 5.3 | 46 | 42 | 9 | 13 | 5 | 17 | 10 | 12 | 20.5 | 8.9 |
| I | 30 | 4.7 | 59.7 | 63.9 | 6 | 24 | 5 | 25 | 11 | 19 | 19.1 | 7.9 |

One patient with ICP of less than 10 mmHg was in the unchanged, 3 in the slightly improved, and 1 in the improved group postoperatively. Based on these results, it cannot be concluded that lower ICP is not a definitive factor in better surgical outcome. However, the majority of patients with high ICP also had a high pulse pressure.

# Discussion

Although it had generally been believed that patients with typical trigonocephaly rarely exhibited clinical symptoms [5], recent papers [3, 10, 20] have reported that such patients experienced developmental delays. In our previous paper [19], we proposed that patients with mild trigonocephaly might manifest such clinical symptoms as language delay, hyperactivity, autistic tendencies, and motor dysfunction. All 56 patients reported in the present paper were considered to have mild trigonocephaly as diagnosed based on 3D-CT findings of metopic ridge and small anterior fossae. The standard CT and MRI examinations yielded no evidence of abnormal brain findings. We now believe that even patients with mild trigonocephaly of the nonsyndromic type can manifest certain clinical symptoms. Most of our patients in whom a bony forehead ridge was noted were referred from an institution where they were receiving therapy for developmental delays. They had low DQ scores and were older than 1year of age. Most mild trigonocephaly patients do not exhibit abnormal development in the 1st year of age. As in a number of our patients, it is suggested that numerous patients with mild trigonocephaly may also have mental retardation.

In our previous paper [19], we suggested that the improvement of dinical symptoms was to some degree due to the release of constricted frontal lobes. We noted that the incidence of digital impressions was fairly high in our patients, and during surgery pulsating brain pressure could always be felt. Therefore, we believed that high ICP contributed to worsening the effect of the constricted bilateral frontal lobes in these patients. Marked digital impressions were seen in 75% of the patients in the present study, which is a very high incidence compared with that in normal children. These marked digital impressions suggest high ICP, as reported by Tuite et al. [24], who found higher subdural ICP in patients with digital impressions compared with those with no impressions.

For these reasons, ICP was recorded intraoperatively in all of our patients with mild trigonocephaly. Continuous recording of ICP while awake and asleep is the ideal method. However, almost all of our patients had mental retardation and it would have been technically difficult to conduct continuous ICP recordings. It was also not possible to justify the making of a burr hole and subjecting them to general anesthesia simply to perform a minimally invasive examination.

Therefore, in this study, ICP was recorded epidurally in the right frontal lobe during surgery. Sevoflurane was used for general anesthesia since it is thought to have little effect on ICP [2, 11]. In addition, the maximal inspiratory pressure was kept constant. The ICP values recorded were thus thought to be close to the actual values.

In this study, the first ICP recording was made during hypocapnea (30 mmHg) when the actual mean $PCO_2$ was 29.12 mmHg, and the second during normocapnea (40 mmHg) when the mean $PCO_2$ was 38.19 mmHg. The changes in ICP were greater during normocapnea, which meant that normal reactions related to $PCO_2$ level occurred. The mean pH was lower during the second recording but remained within the normal range. Under these conditions, ICP measured in the epidural space of the right frontal lobe reflected the actual regional pressure. In this study, 44 out of 56 patients had a mean ICP of greater than 16 mmHg during normocapnea and 7 patients had ICP of 10–15 mmHg. Only 5 patients had ICP of less than 10 mmHg. The mean ICP was 19.8 mmHg in all patients during normocapnea.

Normal ICP in children varies with age. In the review by Newton [15], it was reported that in neonates ICP is less than 2 mmHg, at 12 months 5 mmHg, at 7 years 6–13 mmHg, and in older children up to 15 mmHg. In their summary, Eide et al. [7] stated that several authors considered ICP values of 10 mmHg to be the upper limit of normal and 15 mmHg to be abnormal, with ICPs between 10 and 15 mmHg borderline. Foltz et al. [8] measured ICP in normal children and found the mean to be 79 $mmH_2O$ (6.2 mmHg). Our patients' ICP levels were thus high compared with levels in those reports.

Pulse pressure during normocapnea in our patients was a mean 8.5 mmHg. Foltz et al. [8] reported a pressure of 12±8 $mmH_2O$ in normal children. Again, the pulse pressure in our patients was much higher, indicating low intracranial compliance [9, 13]. High pulse pressure was observed even in our 5 patients with normal ICP. This suggests that low intracranial compliance occurs even in mild trigonocephalic patients with normal pressure.

There have been several reports on the relationship between ICP and single-suture craniosynostosis [1, 17, 18, 22, 25]. Renier et al. [18], using epidural monitoring, reported that 62% of patients with craniosynostosis involving one suture had ICP of less than 10 mmHg and only 14% had ICP

greater than 16 mmHg. Thompson et al. [22] estimated that in the single-suture craniosynostosis group as a whole ICP was elevated in 13 (17%), borderline in 28 (38%), and normal in 33 (45%) patients. They also found a tendency toward elevated ICP in patients with midline-suture craniosynostosis (scaphocephaly and trigonocephaly). In general, as Renier [17] reported, ICP in patients with single-suture craniosynostosis is low.

Our findings of elevated ICP in 44 (78.4%), borderline ICP in 7 (12.5%), and normal ICP in 5 (8.9%) out of 56 patients indicate that the incidence of ICP elevation in the single-suture craniosynostosis group is higher than previously reported. Whittle et al. [25] reported that 5 (55%) out of 9 patients with premature fusion of a single suture had markedly increased ICP. Their patients with increased ICP also had marked digital impressions, as did most of our patients.

The present results confirm our intraoperative impressions of elevated ICP in the previous patient cohort. One reason for the elevated pressure may be patient age of more than 1 year, as Renier [18] pointed out that ICP in older children is high up to 6 years of age.

All of our patients had mild trigonocephaly with clinical symptoms and a high incidence of elevated ICP. Recently, there have been several reports on patients with minor and single-suture closures and elevated ICP [4, 14, 21, 23]. Cohen et al. [4] reported that 3 patients with craniosynostosis in whom the underlying suture involvement was not easily identified by physical examination or radiological examination manifested late-onset symptoms and signs of ICP elevation,. At the time of surgery, direct inspection of the skull morphology pointed toward a diagnosis of metopic synostosis in 1 of these patients, whereas in the other 2 a definitive diagnosis could not established. They referred to this type of patient as having “relatively mild craniofacial deformities.” Stavrou et al. [21] reported that 9 children with craniosynostosis (2 with the single-suture type) presented with symptoms of vision failure and increased ICP. These symptoms occurred much later than usual and in some the diagnosis had been missed because the deformity was mild.

Martínez-Lage [14] et al. reported the cases of a 9-year-old girl and a 6-year-old boy who presented with evident signs of elevated ICP together with a negligible skull deformity. They referred to these as minor forms of “occult”

craniosynostosis in an attempt to contribute to the understanding and classification of the diverse types of craniosynostosis. Those reported cases presented with symptoms of increased ICP, mainly papilledema, whereas all of our patients presented with mental retardation and developmental delays.

Thompson et al. [23] reported their interesting results of longitudinal psychological evaluation of children with intellectual impairment, particularly in those with scaphocephaly and trigonocephaly. Those results indicated that behavioral and language problems occur frequently in such patients, although often in subtle form (unpublished data). Scaphocephaly and trigonocephaly presenting later than 1 year of age, particularly in the presence of developmental delay, were regarded by Thompson et al. [23] as indications for ICP monitoring. If ICP were elevated, surgery would be recommended in an attempt to reduce the potential effects of any secondary insult to the brain.

In the present study, our patients, like those described by Thompson et al. [23], had mental retardation, developmental delays, and high intraoperative ICP. Renier [17] and Renier et al. [18] stressed that patients with elevated ICP tend to have low mental function. From this point of view, decompressive cranioplasty is an appropriate treatment for patients with mild trigonocephaly.

The patients with mild forms of craniosynostosis reported previously [4, 14] and our patients were sometimes difficult to diagnose based on physical examination and plain skull X-rays. It should be emphasized that 3D-CT is the most useful tool for the diagnosis of all forms of craniosynostosis.

The treatment method we used is decompressive cranioplasty to relieve high ICP. Since a 93% improvement rate was achieved in this patient series, the method appears appropriate. The preoperative factors influencing postoperative improvement are younger age, higher DQ, marked digital impressions on skull X-rays, abnormal findings on SPECT, and moderate degree of trigonocephaly. However, little improvement can be expected in patients aged 8 years or older.

We received many patient referrals from an institution for the training of patients with developmental delays associated with mental retardation. After we informed the referring pediatricians of the characteristic facial features of mild trigonocephaly, they began to palpate the foreheads of all children with developmental delays. When they believed that the characteristic facial features of trigonocephaly were present, they referred the patients to us. Thus, we feel

that undiagnosed patients with mild trigonocephaly are present among the group with developmental delays and mental retardation. Most such patients develop normally up to more than 1 year of age and have mild craniofacial deformities; thus, physicians do not make the diagnosis of craniosynostosis. It is important that physicians caring for children with developmental delays and mental retardation be informed of the signs and symptoms of trigonocephaly.

Neuroradiologic examinations like CT, MRI, and SPECT confirmed that the frontal lobes are constricted due to deformation of the frontal bones in mild trigonocephaly. This study also confirmed that ICP in most patients with trigonocephaly was high. This may worsen the effects of trigonocephaly on the patients and underlines the need to treat patients with even mild trigonocephaly, since improvement can be expected in most.

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# Conclusion

1. Many children with developmental delays and mental retardation have mild trigonocephaly

2. ICP measured in the frontal lobe is high in most patients with mild trigonocephaly

3. Decompressive cranioplasty may improve the clinical symptoms of children with mild trigonocephaly

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