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Positional plagiocephaly from structure to function: Clinical experience of the service of pediatric osteopathy in Italy

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A B S T R A C T

Objective: Aim of the study is to evaluate disorders related to positional plagiocephaly and introduce a new model of early intervention based on the osteopathic integrated approach.
Methods: We review clinical experience of the "Program for Neurodevelopmental Follow-up and Pediatric Osteopathy", a service dedicated to newborns at risk for developmental disorders.
Results: We present clinical data of 310 newborns followed during first years of life. Data analysis examines perinatal history, general features and disorders that could be related to plagiocephaly.
Conclusions: The experience confirms that plagiocephaly is not only a problem regarding the shape of the head, it involves the functions. In our Service most babies (81%) with positional plagiocephaly showed isolated or associated disorders that had an impact on growth, behavior and development. The early intervention based on the osteopathic integrated approach is addressed not only to the cranial shape but consider the baby as a whole, and the environment where he lives.

1. Introduction

Positional plagiocephaly is a clinical condition that refers to a newborn with a flattening of a portion of the occipital region of the head. The flattening of the parieto-occipital region determine adaptive modifications too that result parallelogram shaped head [1]. A review of recent literature suggested positional plagiocephaly is an increasing problem. Prevalence appears to be age-dependent with a peak in the first months of life (up to 30%) and a tendency to in the first years [2,3].

Plagiocephaly is caused by the application of external forces on the malleable bones of the baby's skull that interferes with its intrinsically normal, symmetric and harmonious development [4].

Positional plagiocephaly could have different pathogenesis:

Prenatal origin

Fetal plasticity and fetal mobility make the fetus sensitive to the intrauterine molding

Some conditions could exacerbate intrauterine constraint, such as macrosomia, multiple gestation, oligohydramnios, and maternal conditions such as increased abdominal muscular tone, and anomalies of the uterus or of the birth canal [5].

Perinatal origin

The skull of the newborn is designed to provide maximum flexibility during the birth. At birth skull bones are not completely ossified, and for this reason the applied forces can cause deformation [6].

The bones of the cranium accommodate the size and shape of maternal pelvis by sliding and overlapping each other at the level of the sutures. This process is referred to as molding. It results in different head shapes postpartum, depending on the presentation of the fetal head and characteristics of maternal pelvis [7]. Some conditions increase the risk of plagiocephaly: assisted vaginal delivery (with use of forceps or vacuum), prolonged labor, long period of contractions, unusual birth position [4].

Postnatal origin

The position of the infant head during the first months of life could interfere with normal development of cranial bones. A prolonged position of the head may have adverse effects due to environmental factors such as position of the crib in the room or one sided breastfeeding. The rapid increase of the problem has been linked to the Back to Sleep Recommendation campaign, to avoid the risk of sudden infant death

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syndrome, by the American Academy of Pediatrics in 1992. In this regard it is important to note that this policy resulted in a 40% reduction of the sudden infant death syndrome rate [8].

Identified risk factors for positional plagiocephaly are: male sex (2:1), premature birth, first born child, multiparity, presence of cephalohematoma at birth, congenital muscular torticollis [2,4,9], advanced maternal age, ethnicity (Caucasian more than African) [3]. While macrosomia is considered a risk factor for intrauterine molding, surprisingly the infant's length, birth weight and head circumference did not correlate with presence of a flat area or other unusual head shape [10].

Cranial flattening is most frequently observed on the right side, because the right side of the occiput is more often exposed to stresses and strains during delivery [3,11].

Positional plagiocephaly is considered a benign condition but could lead to important consequences

Many studies suggest that positional plagiocephaly can be associated with several short and long term disorders.

1.1. Postural and musculoskeletal disorders

Musculoskeletal disorders include a limited range of cervical and head motion, torticollis and global postural asymmetry. Limited neck motion may increase the possibility of persistent skull deformation [12,13]. Other associated anomalies are: hip dysplasia, clubfeet, mandibular asymmetry or hypoplasia [5]. Long term consequences include temporomandibular articulation disorders, occlusal problems and asymmetries of the spine, including scoliosis [13,14].

1.2. Sensory disorders

Moderate to severe plagiocephaly could lead to facial asymmetry (anterior shift of the ipsilateral forehead, ear and cheek) with asymmetric opening of the palpebral fissures and misalignment of the eyes and/or ears. These asymmetries could interfere with auditory processing and visual development [15].

1.3. Impact on neurological development

An increasing number of studies show that positional plagiocephaly is a risk factor for developmental delay in some motor, sensorial and cognitive areas of development [16–23].

Dr. V. Frymann in 1976 demonstrate that various cranial strain pattern were observed in children with learning difficulties and in children with visual problems [24].

Recent study on school age patients highlighted a relationship between positional plagiocephaly and the need for interventions during primary school years and special education services including speech therapy, occupational therapy, and physical therapy. Moreover, an association between plagiocephaly and lower cognitive and academic outcome is demonstrated [25,26].

This implies that children with this condition require early evaluation and early intervention and should be monitored during their growth [27,28].

The therapeutic approach is multidisciplinary and requires different treatments such as behavioral interventions, physical therapy, manual therapy, and helmet [1]. Osteopathy is considered a safe and effective approach and contributes to modify the cranial shape [13,14,29].

2. Methods

This descriptive study is a review of clinical data about newborns followed at the Service “Neurodevelopment Follow-up and Pediatric Osteopathy” at Desenzano del Garda Hospital (Italy). The objectives are:

- to introduce the program of osteopathic integrated approach proposed on the Service
- to identify babies with positional plagiocephaly that has been followed, review clinical data about perinatal history and identify plagiocephaly related disorders.
- to consider the value of the program for children with positional plagiocephaly.

The Program is a public health service dedicated to newborns at risk for developmental disorders and offers a new model of early intervention based on an osteopathic integrated approach.

The professionals who operate at the program are two medical doctors (MF, SB) with experience in neurodevelopment problems and pediatric rehabilitation. In addition to that they are also osteopaths (DO) trained in traditional pediatric osteopathy who followed specific professional trainings at the Osteopathic Center for Children (San Diego, California) with Viola M. Frymann, DO, FAAO, an internationally recognized authority for pediatric osteopathy.

Clinical data related to medical history and pediatric and neurological evaluation are reported in the medical records of each child.

Patients are referred to the Service as outpatients. Usually the first appointment is about 2 weeks after the discharge from the neonatology department (for preterm babies or babies with congenital problems) or when the pediatrician found a disorder during the regular follow up of babies.

Main reasons for referral to the program are: prematurity, dystocic delivery, positional plagiocephaly, postural and orthopedic disorders (torticollis, foot deformities), gastrointestinal functional disorders (gastroesophageal reflux, constipation), neurological disorders (hyperexcitability, hypotonia, hypertonia, tremors), congenital syndromes and neurological diseases (Down Syndrome, epilepsy), others (sleep disorders, visual problems).

2.1. Medical history

During the first appointment we record the age of the baby and we collected information about ethnic origin, pregnancy, labor, perinatal period, and health conditions. Moreover during the first meeting we present to the parents the program of follow up and we introduce the osteopathic approach.

2.2. Clinical evaluation

2.2.1. Cranial evaluation

The evaluation of the head includes the observation of the head shape from anterior (frontal), posterior and superior view to determine the side (right, left, bilateral) and severity of plagiocephaly. Facial evaluation focused on eyes position, ear alignment, mandibular symmetry. The exam included palpation of the fontanellae and cranial sutures.

2.2.2. Postural assessment

The assessment of the posture consists in taking time to observe the global natural position of the body, with attention to the head, trunk and upper and lower limbs alignemnt.

2.2.3. Motor behavior

Motor assessment requires the observation of spontaneus motor activity, to determine the fluency and elegance of global movements and freedom of head and neck movements. Assessment is performed in supine position and involves staring and visual tracking with age appropriate targets (black and white objects at a distance of 20 cm in newborns).

2.2.4. Neurological assessment

It consists of an accurate evaluation of muscle tone, reflexes,

neurovegetative signs (hyper excitability, tremors, postural instability) and developmental assessment. Neurological evolutionary profile emerge from he repeated evaluation performed at each meeting.

2.3. Intervention

The program of early intervention includes osteopathy and a specific home program to support child development according to the principles of neurodevelopmental care.

2.3.1. Osteopathic evaluation and treatment

The osteopathic approach begins with an evaluation based on standardized assessment of the whole musculoskeletal system and craniosacral system and includes examination of posture and motor patterns. A gentle perceptive palpation, appropriate to the delicate tissues of a newborn, can detect somatic dysfunction. Somatic dysfunction, listed in the International Classification of Diseases (ICD-10 Segmental and Somatic Dysfunction), is a restriction of movement in a part of the musculoskeletal system [30]. Childbirth frequently results in somatic dysfunctions in cranial, cervical, lumbar, and sacral regions, that can predispose the infant to musculoskeletal problems, such as plagiocephaly [11,31].

Osteopathic manipulative treatment consists in very delicate manipulations and soft mobilization of the musculoskeletal structures. The treatment is personalized, based on the somatic dysfunctions found in each baby. The objective is the restoration of unrestricted, symmetric, physiologic mobility of all body parts in order to improve postural setting and movement [14,30,32]. Osteopathic approach follows the principles of traditional osteopathy, according to the teachings of Dr. Frymann. Any possible adverse events were reported in the medical record of each baby.

2.3.2. Home program to promote development

During each session a program which involved parents to create a good environment was proposed to improve their relationship and support motor and sensory development during home activities. This is a program carried out at home by the family day by day. The program has been developed according to recent discoveries about the importance of the experiences during the first months of life, when the nervous system is very plastic. Evidence suggests that early intervention programs positively influence cognitive and social development in children at risk for developmental impairment [33–35].

The program consists in taking care of posture and of the baby and stimulates motor skills. Some examples of intervention are: to alternate the position of the child while is awake (left and right side, supine and prone position, under the parent supervision); to use adequate toys that motivate the child to rotate the head in both directions; to limit the amount of time the infant spends in the car seat; to vary head position during feeding, especially in case of bottle feeding.

2.3.3. Follow-up

The Program offers services covering the first years of life, the standard program included appointments at ages of 2–3–6–12–18 months. The approach is customized, if necessary further treatment sessions are planned. Discharge is expected when the improvement of the head shape is satisfactory and the baby shows normal development. In case of developmental delay, babies are sent to more local services for specific rehabilitative programs.

We considered newborns followed between 2011 and 2018. Exclusions criteria are: diagnosis of craniosynosostis, congenital syndromes (e.g. Down Syndrome), severe prematurity (gestational age less than 32 w), congenital malformations, serious neurological disorders (e.g. epilepsy, cerebral palsy).

Table 1
Characteristics of newborns with positional plagiocephaly (N. 310).

General features						
Gender	Male	198	64%			
	Female	112	36%			
Ethnic origin	Italian	236	76%			
	Others	74	24%			
				Est Europe	28	38%
				Marocco and Northern Africa	20	27%
				Asia	19	26%
				Central and South Africa	5	6%
				South America	2	3%
Reason for consultation	Plagiocephaly	170	55%			
	Others	140	45%			
				Prematurity	78	56%
				Minor neurological disorders	24	17%
				Gastrointestinal disorders	14	10%
				Torticollis	11	8%
				Dystocia	10	7%
				Sleep disturbances	3	2%
Side of plagiocephaly	Right	201	65%			
	Left	88	28%			
	Bilateral	21	7%			

3. Results

During 8 years of experience, the program has taken care of 530 newborns.

We identified 310 infants with positional plagiocephaly. Summary statistics will be provided for the data.

3.1. General features

Characteristics of newborns are described in Table 1.

3.1.1. Gender

We observed a higher prevalence of male than female children with plagiocephaly. 198 (64%) were males while 112 (36%) female, with a relation M:F of 1.7:1.

3.1.2. Ethnic origin

236 (76%) of the families were Italian, while 74 (24%) were of different origins, according to Italian social landscape.

The average age at the time of the first evaluation was 2 months (with an interval between 10 days and 6 months of age). This is important to ensure an early intervention.

3.1.3. Reason for consultation

We examined the reasons why pediatricians and neurologists sent patients to the Program. 170 babies (55%) were recommended consultation because of a diagnosis of positional plagiocephaly. The remaining 140 babies (45%) was sent to the Program due to other reasons (follow-up of preterm babies or dystocic delivery, minor neurological disorders, gastrointestinal disorders). In this group the first evaluation identified the presence of plagiocephaly. Probably the plagiocephaly in these babies would have been identified if the problem had become more evident, and they probably would not have received adequate treatment in time achieve optimal results.

Table 2
Information about perinatal history.

Perinatal history						
Delivery	Vaginal	220	71%			
				Normal	167	76%
				Dystocic	53	24%
	Cesarean session	90	29%			
				Urgent	61	67%
				Programmed	30	33%
Gestational age	Term	208	66%			
	Preterm	102	33%			
				Mild (34–37 w)	49	48%
				Moderate (32–34 w)	53	52%

3.1.4. Side of plagiocephaly

Most of the children had an occipito-parietal plagiocephaly on the right side (201 babies, 65%); for 87 infants (28%) was on the left side and in 22 (7%) it was bilateral.

3.2. Perinatal history

Information about perinatal history is described in Table 2.

3.2.1. Delivery

220 babies (71%) were born with spontaneous vaginal delivery; 53 of these (24%) had a dystocic delivery due to the following conditions: use of vacuum assisted delivery, failure of labor to progress spontaneously, fracture of clavicle, fetal acidosis. The remaining 90 (29%) babies were delivered by cesarean section. 9 cases featured a twin pregnancy.

3.2.2. Gestational age

The number of preterm babies, born earlier than 38 weeks, was 102 (33%). We considered mild and moderate prematurity (32–38 weeks), while newborns with severe prematurity (gestational age less than 32 w) were excluded from this study.

3.3. Clinical disorders

Clinical disorders are defined according to the interviews with parents regarding the well-being, behavior and feeding of the child, and according to the clinical and neurological evaluations of the babies. We could determine that from 310 babies with positional plagiocephaly, 58 babies (19%) did not have any other disorders except plagiocephaly. The remaining 252 babies (81%) showed isolated or associated disorders that had an impact on growth, behavior and development and could affect the well-being of the child and family. Table 3 shows clinical disorders showed in 252 babies (81%).

Table 3
Clinical disorders in newborns with positional plagiocephaly.

Types of disorders					
Limitation on head rotation	192	62%			
Neurological minor disorders	56	18%			
			Tonus anomalies	29	9%
			Motor anomalies	15	5%
			Signs of developmental delay	12	4%
Gastrointestinal disorders	98	31%			
			Gastroesophageal reflux	62	20%
			Constipation	36	11%
Sleep disturbances	18	6%			
Torticollis	17	5%			
Ocular disorders	15	5%			
Feet anomalies	8	3%			
Recurrent otitis	3	1%			

3.3.1. Limited head rotation

Newborns with positional plagiocephaly showed a preferred rotation of the head toward the same side as the flattening. During the evaluation of neck mobility we found that the rotation of the head was limited toward the side opposite the flatten occiput in 192 babies (62%).

3.3.2. Minor neurological signs

In 56 babies (18%) minor neurological symptoms such as alterations of muscular tone (hypo or hypertonia), delay in some areas of neurodevelopment were evident.

3.3.3. Gastrointestinal disorders

Mothers of 98 babies (31%) reported the presence of gastrointestinal functional disorders, especially gastroesophageal reflux (62 babies) and constipation (36 babies). In some cases both disorders were detected. Among the 62 babies with gastroesophageal reflux, 17 babies (27%) were prescribed pharmacological therapy.

3.3.4. Other disorders

Muscular torticollis was present in 5% of babies. Other disorders were: sleep disturbances (6%), ocular disorders (strabismus, alterations in staring and pursuit eye movements 5%), feet anomalies (3%), recurrent otitis (1%).

3.4. Observed outcome

All families accepted the suggested follow-up program and osteopathic treatment.

No child has had any adverse effect. Each child received an average of 6 evaluations and treatment sessions (for a total of more than 1800 osteopathic treatments). The average age at discharge from the treatment program was 20 months of age. Most of the babies showed a visible improvement in general head shape, symmetry of occipital parietal region and facial symmetry.

As far as the freedom of head movements is concerned, in most cases, we observed a resolution of that problem after the first treatment. Among 192 babies with a limitation in head rotation, 163 babies (85%) showed a complete rotation freedom of the head on both sides, without limitations, during the second evaluation, after the first treatment. In the remaining 29 babies (15%) this result was obtained after the second treatment.

The evaluation of postural and motor assessment showed changes on postural alignment and stability and a progress in motor behavior, in terms of harmony, fluidity and symmetry. This type of evaluation was difficult to quantify.

Gastrointestinal functions improved in all children. No child has had any impact on weight growth and babies that received pharmacological treatment for gastroesophageal reflux stopped the therapy in 95% of cases, after 2–3 sessions.

Significant results concerned neurological development. The evolutionary neurodevelopment profile has been described for each baby, based on the clinical neurological evaluation. 270 babies (87%) showed a normal developmental profile at age of 12 months, the remaining 40 babies (13%) reached that result at the age of 18 months. We report that all babies reached a normal development profile and no child showed delay or impairment. Further evaluations have been programmed to create developmental profiles as our population of children progress through life.

4. Discussion

The model of early intervention offered in our Program considers the baby as a whole. The Program offers a traditional osteopathic

approach performed by professionals skilled in pediatric osteopathy, following the model of Dr. Viola Frymann. No child enrolled in the study had adverse effects. According to previous studies, the osteopathic treatment can be considered safe for children, and appropriate in a model of integrated medicine, especially for newborn with positional plagiocephaly, that is one of the most common reasons for consultation [36–39].

Small clinical observational pilot studies do suggest that there may be benefit of osteopathic treatment when applied to children diagnosed with positional plagiocephaly [13,40].

Our study focused on the unitary vision of the child and showed the presence of high rates of clinical disorders (about 80%) related to positional plagiocephaly. Most of those disorders improved or resolved with the offered intervention.

In most children (62%) the problem of the head shape was associated with a limitation of head rotation. Head shape impacts on head and neck movements. Freedom of head movements is important to develop visual and sensorial abilities, interact with the environment and with the parents [41–43]. Moreover it is a main prerequisite for a harmonic and symmetric neurological development and for feeding. After the first or second treatment all babies showed a normalization of the head movement, with freedom of rotation in both directions. This result can be considered a good support for child development.

Some babies showed disorders in muscular tone and delay in normal stages of development. Alterations in muscular tone have an impact on motor behavior and can limit sensorial opportunities; that could interfere with normal development [44,45].

Incidence of gastrointestinal disorders is also significant. Osteopathic treatment is appropriate to promote good posture, support motor and self-regulation, improves and stabilizes autonomic functions. Moreover, increased postural stability and midline orientation support feeding, digestive and gastrointestinal function, which likely explains the improvement of gastrointestinal function [29].

All babies reached normal neurological development, this allowed the discharge from the Program at maximum age of 18 months.

However the study has methodological limitations. We do not have a control group. Ethical consideration suggests that all infants with plagiocephaly should receive adequate treatment as soon as possible. Neurological assessment was performed using accurate clinical evaluation without neurological scale. We are working to reassess the 310 babies after leaving the Service for developmental assessment. A further limitation is that 140 (45%) of babies were referred to the program because of problems other than plagiocephaly. Therefore, our patient group may have a higher rate of disorders besides plagiocephaly than that which may be seen in a non-specialty clinic setting.

5. Conclusions

Pagiocephaly is not only a problem of shape, but also a problem of function. We have to be aware of the short and long term consequences of plagiocephaly and work in the field of prevention, to enable every child to achieve his/her developmental potential. When we find an asymmetrical head shape in a newborn, we must remember that this can have an impact on all aspects of his/her life: global posture and motor development, sensorial development, neurovegetative state and finally this can influence the baby growth and development.

"*The human body does not function in separate units, but as a harmonious whole*" [46].

"The baby grows as a unit: the physical, mental and emotional states and degrees of growth cannot be considered separately, they are very interdependent" [9].

During this 8 year experience in Desenzano del Garda Hospital, 310 babies with positional plagiocephaly were followed for over 1 year and a half. Our experience confirmed the presence of clinical disorders related to plagiocephaly. We realized that an appropriate early intervention can improve head shape and support child development. While further studies are needed to quantify results, the experience we report supports the value of the proposed intervention, based on the osteopathic integrated approach.

Table of contents summary

Clinical experience encourage to consider the potential of osteopathic integrated approach for babies with positional plagiocephaly.

What's known on this subject

Babies with positional plagiocephaly can show short-and-long term disorders, and are at risk for delayed or impaired development.

What this study adds

The study confirms the presence of disorders related with positional plagiocephaly. Osteopathic integrated approach, based on traditional osteopathy following teaching of Dr. Frymann, could be considered a safe and appropriate intervention.

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Declaration of competing interest

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