Membranous articular strain, also known as cranial strain pattern, occurs when an articular or soft tissue restriction permits motion of the occiput and sphenoid in one direction but limits it in the opposite direction at the sphenobasilar synchondrosis. Particular strains can be either physiologic in origin, such as those caused by daily strains on the human body, or traumatic, such as those that are a result of surgery, dental work, uncompensated external force, or birth trauma. In fact, it has been suggested that all individuals will present with one or multiple cranial strain pattern as a result of birth mechanics and may present with other subsequent traumatic forces encountered throughout life.

Membranous articular strains cause restriction of the normal membranous articular functioning, which alters cerebrospinal fluid motion, the physiology of arterial and venous blood flow, and lymphatic flow in the cranium. Research studies have suggested correlations among cranial strain patterns and some neurologic disorders. Frymann indicated that craniosacral dysfunctions are associated with nervous symptoms in infants, while Rivera-Martinez and colleagues explored an increase in the frequency of specific patterns among patients with Parkinson disease.

Some cranial strain patterns, particularly torsion and sidebending rotation, are considered common and physiologic if their presence does not interfere with extension and flexion motion of the cranial mechanism. These patterns will usually resolve if the somatic dysfunctions surrounding them are brought into alignment. Patients with these cranial strain dysfunctions may have common conditions that are usually not incapacitating, such as neuromusculoskeletal system pain syndromes, headache, endocrine disorders, altered visual perception, or motor disturbances.

Lateral and vertical strain patterns are usually not physiologic and are frequently a result of physical trauma. Such patterns are unlikely to resolve on their own—even if surrounding stresses are diminished. In addition, their symptoms are often more severe and incapacitating than those of sidebending rotation and torsion patterns.

Although some researchers have addressed the association of different strain patterns with neurologic disorders, there remains a dearth of knowledge on the prevalence of these strain patterns among a healthy population. Understanding the prevalence of common cranial strain patterns...
may aid physicians in correlating unusual strain patterns to neurologic disorders and may also provide scientific support to the existing anecdotal evidence.

In the present study, we describe the prevalence of common cranial strain patterns and their combinations through a retrospective review of data of healthy subjects who participated in one of two studies that examined osteopathy in the cranial field.

We expected to observe torsion and sidebending rotation patterns more frequently than lateral and vertical strain patterns because the former patterns are considered common and physiologic. Also, because humans often experience multiple physiologic stresses throughout life and some patterns may superimpose on each other, combinations were expected to be more common than any one individual cranial strain pattern in healthy adults.

Methods
The present study was conducted as a retrospective review of records from two previous studies on osteopathy in the cranial field that were conducted at Nova Southeastern University (NSU) from September 2001 to January 2002 and August 2003 to January 2006. The purpose of both studies—a pilot study and a main study—was to examine the effect of osteopathic cranial treatment on visual function. Both studies are being prepared for manuscript submission.

The NSU Institutional Review Board approved all procedures used in both studies. All study subjects consented in writing before study participation.

Subjects
Healthy adult subjects were recruited for the two studies through posted flyers on the campus of the NSU Health Professions Division. All participants in both studies were required to meet the following inclusion criteria:

- no active ocular or systemic disease
- no history of previous closed head trauma or brain injury
- no history of treatment with cranial osteopathic manipulation
- a refractive error between six diopters of myopia and five diopters of hyperopia with regular astigmatism of any amount
- normal best corrected visual acuity to 20/40 or better
- aged between 18 and 35 years
- not pregnant at the time of the study

These criteria allowed for data collection from a typical healthy population with some participants having very good visual function and others with reduced visual function. Students from the NSU College of Osteopathic Medicine and College of Optometry were excluded from the studies to prevent study bias based on prior knowledge of the diagnostic or therapeutic procedures.

Data Collection
All data in both studies were collected by an osteopathic physician (M.S.) who was certified by the American Osteopathic Board of Family Physicians and by the American Osteopathic Board of Neuromusculoskeletal Medicine as a specialist in osteopathic manipulative medicine. In addition, this investigator (M.S.) had basic cranial course training and more than 18 years of experience in medical practice.

After providing each subject with an explanation of the study and procedures, the osteopathic physician (M.S.) asked the participant to lie down in a supine position and to relax. The subject was told that some gentle pressure would be applied to the head intermittently for approximately 5 to 10 minutes. The cranial examiner (M.S.) was then seated at the head of the table with his fingers contacting the sphenoid and the occiput on both sides of the subject’s head. Tendency of the cranial bones to move into certain cranial strain positions was assessed by applying a few ounces of pressure.

No masking protocol was used in the present study for the examiner (M.S.). The patient’s age and sex was recorded, as was the presence of one or more of the following cranial strain patterns, as described by Rivera-Martinez and Lay:

- **Lateral (left or right)**—This type of dysfunction is present when the sphenoid and occiput rotate in the same direction about their respective vertical axes, producing a shearing type of motion at the sphenobasilar synchondrosis. This strain pattern is described for the direction of the shift of the sphenoid in relation to the occiput.

- **Sidebending rotation (left or right)**—Sidebending occurs when the sphenoid and occiput rotate in opposite directions around two parallel vertical axes—one through the body of the sphenoid and the other through the foramen magnum. Rotation occurs around an anterior-posterior axis in which the sphenoid and occiput rotate in the same direction. Both bones rotate inferiorly on the convex side. The dysfunction is named for the side of the convexity formed at sphenobasilar synchondrosis.

- **Torsion (left or right)**—This type of strain occurs around an anterior-posterior axis of the skull when the sphenoid and occiput rotate in opposite directions, creating a twist at the sphenobasilar synchondrosis. Torsion is named by the side in which the greater wing of the sphenoid has a tendency to move higher.

- **Vertical (superior or inferior)**—A vertical strain occurs when rotation of the sphenoid and occiput occur in the same direction about their respective transverse axes. The transverse axis for the sphenoid is through the zygomatic process of the temporal bone and body of the sphenoid. For the occiput, the axis is midway between the mastoid process and asterion, above the foramen magnum. This strain is described for the direction of the superior or inferior shift of the sphenoid in relation to the occiput.
Subjects in both studies were evaluated for the presence of cranial strain patterns at an initial visit and after osteopathic cranial treatment. However, in the present study, only the cranial strain data from the initial visits were used.

Data for the present study were compiled using SPSS 15.0 for Windows (SPSS Inc, Chicago, Ill). Cranial strain pattern prevalence for each specific strain was measured by percent occurrence out of all strains that were recorded. The prevalence of cranial strain pattern combinations was also assessed by percent occurrence among study participants.

Results
Data were collected from the initial visits of all 142 subjects who participated in the previous studies. All subjects—119 women and 23 men—were between the ages of 18 and 35 (mean [SD], 24.47 [4.04]) and were from the NSU community.

In the current study, torsion (39%) and sidebending rotation (33%) were the most prevalent cranial strain patterns observed (Table). When stratified by the strain pattern’s side of dysfunction in the order of most frequent occurrence, right torsion (31%), left sidebending rotation (23%), and left lateral (19%) were the most common. Right sidebending rotation (10%), left torsion (8%), and right lateral strain (7%) together comprised 25% of cranial strains. Inferior and superior vertical patterns were the least common strains noted.

All subjects had at least one cranial strain pattern. Combinations of cranial strain patterns were found in 131 subjects (92%). The most common combinations were left sidebending rotation and right torsion (17%); left lateral strain, left sidebending rotation, and right torsion (14%); and right sidebending rotation with right torsion (11%) (Figure).

Comment
The present retrospective review was conducted to determine the prevalence of common cranial strain patterns and their combinations in healthy patients. The data demonstrate that torsion and sidebending rotation were the most common cranial strain patterns in the study population, altogether comprising 72% of the patterns diagnosed in this study. These results support previous evidence.1,6,7

When evaluated in order of highest frequency by pattern and side, right torsion, left sidebending rotation, and left lateral strains were the most common patterns observed in healthy subjects based on individual cranial strain prevalence. In addition, more than 90% of participants were found to have a combination of cranial strain patterns present. Thus, the prevalence of cranial strain pattern combinations in the healthy population may be of greater significance than individual cranial strains.

When evaluating the applicability of these results, it is important to consider certain study limitations. The demographics of the study group is one such limitation. Because the study population consisted primarily of women in the NSU community, the outcomes may not be applied easily to the general US population.

The lack of multiple observers may present another limitation. The present study used one osteopathic physician (M.S.). In this single-rater design, the observer may have been biased to specific cranial strain patterns, and there was an absence of control. However, single-rater design also has certain advantages—such as a lack of interobserver variation. A recent study7 described substantial intrarater reliability in diagnosing cranial strain patterns, while interobserver reliability in cranial osteopathy remains to be proven.8

The cranial strain pattern findings observed in the present study may be a result of birth mechanics or a common compensatory pattern. Based on the teachings of William G. Sutherland, DO, DSc,1 Wales suggested that each subject will present with at least one cranial strain pattern as an outcome of birth mechanics and other subsequent traumatic forces encountered throughout life. For example, right torsion may occur initially during the birth process, but an additional strain pattern, such as left sidebending rotation, may occur as a result of additional life stress and thus may overlay the findings of right torsion.

In her cranial study of 1250 newborns, Frymann1 demonstrated that prevalence of sphenobasilar strain patterns in the craniosacral system can be as high as 77%. Frymann1 explored the physiologic reasons for the abnormalities in the size and shape of the fetal head secondary to molding by a maternal contracted pelvis. These abnormalities may occur as a result of an atypical fetal position and birth presentation or when forces of labor are disproportionately strong and lead to incomplete re-expansion of the fetal cranial bones after birth. Thus, it is

![Table: Prevalence of Cranial Strain Patterns in Healthy Subjects Calculated by Total Occurrences Recorded (N=142)*](https://jaoa.org.NSU)
In further discussion of the common compensatory pattern, Zink and Lawson described three patterns for various regions of the body: “ideal” physiologic, common compensatory, and disparate compensatory. In describing body movement, he stated that the physiologic “image” represents the ideal state for the human body and is “best suited for locomotion.” However, compensatory patterns, which allow the body to accommodate dysfunction, are common. Alternatively, if the patient presents with a disparate, uncompensated pattern, he or she could either be acutely ill or fail to respond to the ordinary treatment approach. Patients with disparate, uncompensated patterns may have a history of trauma, chronic illness, or surgical intervention.

According to Zink and Lawson, the key principle for treating these patients is to recognize the uncompensated findings and treat them so that they are brought into conformity with the common compensatory pattern, after which one should use appropriate clinical judgment to bring the patient to the physiologic—or ideal—pattern. Zink and Lawson did not establish a physiologic, common compensatory, or uncompensated pattern for the cranium. Instead, they suggested that the compensatory patterns of the cranium should be addressed by those who have been trained in cranial osteopathy. It may be possible that left sidebending rotation and right torsion combination is a common compensatory pattern. If this pattern is supported by further research, it may be used clinically as a transition step from other disparate, uncompensated patterns of the cranium.

### Conclusion

The present study identifies common cranial strain patterns and their combinations in healthy subjects. As a result of the limitations of the present study, such as the lack of population diversity and interobserver data collection, future studies are needed to characterize and support the cranial strain findings likely that persistent cranial strain patterns are found following traumatic delivery.

Furthermore, Frymann stated that among infants with cranial strain patterns, torsion and sidebending rotation were two of the three most common sphenobasilar strain patterns found in newborns (compression strain was second). In fact, torsion was present in 28% of cases; sidebending rotation, 12%; and vertical/lateral strain, 5%. The prevalence rates of these strain patterns are in agreement with the findings in the current study. Thus, cranial strain patterns observed in adulthood may be related to the process of birth.

Like Frymann, Pope noted a similarity in fascial bias of the fetus and the common compensatory pattern in the adult, wherein both patterns result in the atlantooccipital fascia rotating to the left, indicating that patterns present after childbirth may persist into adulthood.

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* Percentages do not total 100 because of rounding.
of this study. A fully defined rate of prevalence of the common cranial strain pattern combinations may be helpful to physicians in determining whether cranial findings are physiologic, common compensatory, or uncompensated patterns, thus potentially improving the treatment process and, perhaps, correlating unusual patterns with neurologic and other disorders.

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References


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