# Dentofacial and Occlusal Asymmetries

Edited by **Birte Melsen** | **Athanasios E. Athanasiou**

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# 1

# Introduction

*Birte Melsen and Athanasios E. Athanasiou*

**CHAPTER MENU**



Although each person shares with the rest of the population many characteristics, there are enough differences to make each human being a unique individual. Such limitless variation in the size, shape, and relationship of the dental, skeletal, and soft tissue facial structures are important in providing each individual with their identity (Bishara et al. 2001).

Dorland's Medical Dictionary defines symmetry as "the similar arrangement in form and relationships of parts around a common axis or on each side of a plane of the body" (*Dorland's Illustrated Medical Dictionary* 2000).

The absence of symmetry is asymmetry and is frequently experienced by man in their facial features, both structurally and functionally.

The term symmetry is generally used in two different contexts:

The first meaning is a precise and well-defined concept of balance or "patterned self-similarity" that can be demonstrated or proved according to the rules of a formal system, namely geometry, physics, or otherwise.

The second meaning is an imprecise sense of harmonious or esthetically pleasing proportionality and balance reflecting beauty or perfection. As such, symmetry was demonstrated within art by Leonardo Da Vinci in his Vitruvian Man in 1492 (Figure 1.1) (Baudouin and Tiberghien 2004).

Asymmetry has, on the other hand, been part of the features characterizing the unpleasant and the unharmonious (Edler 2001; Rhodes et al. 2001).

Whereas symmetry in art is used to express harmony, beauty, and peace, asymmetrical layouts are generally more dynamic, and by intentionally ignoring balance, the designer can generate tension, express movement, or convey a mood such as anger, excitement, joy, or casual amusement (Komoro et al. 2009).

Facial asymmetry, being a common phenomenon, was probably first observed by the artists of early Greek statuary who recorded what they had found in nature – normal facial asymmetry (Lundstrom 1961).

A perfect facial symmetry is extremely rare and practically all normal faces exhibit a degree of asymmetry (Figure 1.2). As in art, where the side has an importance in the interpretation of a movement displayed on a painting, the two sides of the face may express feelings (Schirillo 2000).

The left side of the face is considered more emotionally expressive and more often connotes more negative emotions than the right side. Also interestingly, artists tend to expose more of their models left cheek than their right. This is significant, in that artists also portray more females than males with their left cheek exposed. These psychological findings lead to explanations for the esthetic leftward bias in portraiture (Schirillo 2000; Powell and Schirillo 2009).

The studies of asymmetry of the craniofacial region can be divided into two categories. One is focusing on facial asymmetry in various populations and its impact on perception of the individual's attractiveness and health. The second category is dealing with the influence of asymmetry

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on treatment of patients receiving orthodontic treatment or craniofacial surgery.

Studies of various populations belong to the first category, and facial symmetry has been associated with health, physical attractiveness, and beauty of a person. It is also hypothesized as a factor in interpersonal attraction, and relevant research indicates that bilateral symmetry is an important indicator of freedom from disease and worthiness for mating (Edler 2001).

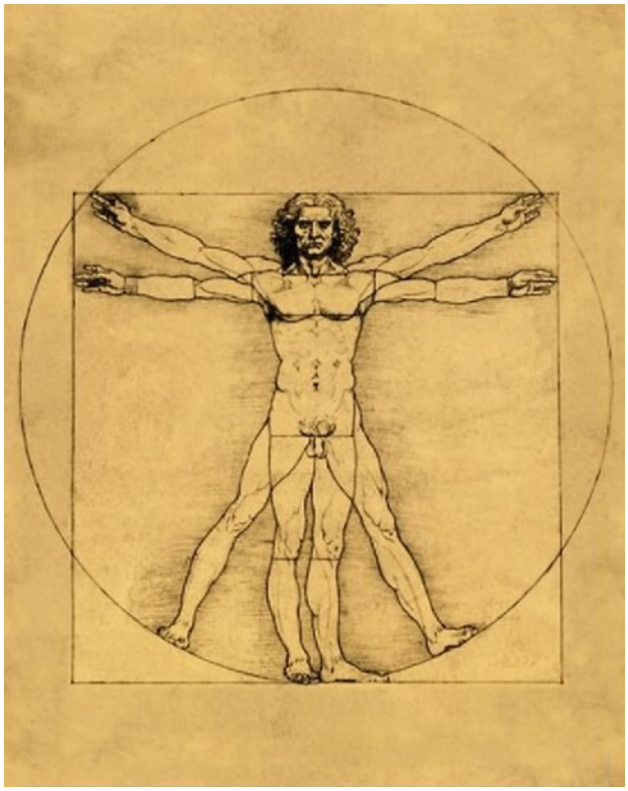

**Figure 1.1** Vitruvian Man drawn by Leonardo Da Vinci in 1492 demonstrating the symmetry of the ideal body.

Most facial asymmetries among nonpatients are, however, fluctuating meaning that they have no significant influence on the attractiveness of the face. The perception of a face as attractive is more influenced by averageness meaning: what do the persons I like in "my tribe" look like. The beauty ideal is clearly changing with time and between various populations (Rhodes et al. 2001). The impact of averageness was studied by Komoro et al. (2009) who let laypeople evaluate the effect of symmetry and averageness on photographs and found that symmetry had a limited if any influence on attractiveness, thus confirming earlier findings by Baudouin and Tiberghien (2004). In a more recent study, it was found that symmetry on one hand reduced attractiveness by decreasing perceived normality, but on the other hand could also increase attractiveness by promoting the perceived symmetry (Zheng et al. 2021). Furthermore, it has been suggested that completely symmetrical faces might appear unemotional and thus less attractive (Swaddle and Cuthill 1995).

The second category of studies deal with asymmetry in relation to treatment. In reference to the need for treatment, it should be noted that the point at which normal asymmetry becomes abnormal cannot be easily defined and is often determined by the clinician's sense of balance and the patient's perception of the imbalance (Bishara et al. 2001). Minor asymmetry of the craniofacial skeleton and in the dentoalveolar region is often not easily detected. This can be the reason for which the optimal result of an orthodontic treatment cannot be reached since the asymmetry will often interfere with a satisfactory finishing.

The true prevalence of asymmetries in a population has never been described. Methodological limitations related to etiological factors, timing of appearance, degree of severity, progressing characteristics, and individuals' age, have enabled relevant studies only in subgroups of patients with facial asymmetry (i.e. hemofacial

**Figure 1.2** Three images where the right face is composed of two right sides, the middle one is the real face, and the left one is composed of two left sides.

microsomia) or dentofacial deformities in university orthodontic clinics.

When studying dentofacial deformity patients at the University of North Carolina, it was found that 34% demonstrated an apparent facial asymmetries. When present, asymmetry affected the upper face in only 5%, the midface (primarily the nose) in 36%, and the chin in 74% (Severt and Proffit 1997).

Recently, Evangelista et al. (2022) performed a review of the prevalence of mandibular asymmetry in different skeletal sagittal patterns and found that there was a significant difference between findings reported from different studies varying from 17.43 to 72.95%, and indicated that the more severe malocclusions exhibited more severe chin deviations than the nonorthodontic population.

Whereas most of the relevant studies have been focusing on facial asymmetry, Sheats et al. (1998) looked into the occlusal status of patients being treated in a graduate clinic and found that in 62% of the patients, the mandibular midline deviated from the facial midline.

An important part of this book will focus on the treatment of patients with various types of facial and dentoalveolar asymmetry focusing on interception, correction, or camouflage. The interception can only be performed for asymmetries related to functional deviations or/and eruption of teeth. Corrections and camouflage in some patients with skeletal asymmetries start at an early age and often continue for the remaining growth period. In adult patients, treatment comprises displacement of teeth and dentoalveolar modeling with goal-oriented biomechanics and orthognathic surgery when needed. For asymmetries with different localization, their etiology and the possible treatment modalities from a biological, biomechanical, and surgical viewpoints will be discussed. In relation to management, generating symmetry is among the goals of most treatment plans. However, when the outcome of orthodontics is assessed, even minor asymmetries are frequently impossible to generate a result that is compatible with ideal morphology and function.

The challenges in dealing with problems related to facial asymmetry are numerous and, to the knowledge of the editors, many of them have not been dealt with systematically. The purpose of this book is to satisfy the need for a comprehensive text on etiology, localization, and treatment of asymmetries within the craniofacial region. It is our hope that this books will cover all aspects of asymmetry starting with localization followed by etiology, congenital, or acquired through disease or trauma. In addition, it is crucial to verify if what is detected is reflecting a static or a developing deviation. Not only the localization and the morphological characteristics are important when categorizing the different types of asymmetries, but also the etiology should be established before a treatment plan can be worked out.

All contributing authors of this publication are prominent colleagues recognized as experts each within their specialization and the assigned subject within face asymmetries. It is our hope that this book will serve as inspiration for the colleague to approach a goal-oriented therapy based on all-inclusive diagnoses, localization of the asymmetry, and the definition of a comprehensive treatment goal.

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# Part I

# Etiology

# 2

# The Etiology of Dentofacial and Occlusal Asymmetries – An Overview

*Birte Melsen*

**CHAPTER MENU**



## Introduction

Before generating a treatment plan, the etiology of the asymmetry should be determined.

Asymmetries can be congenital or acquired. The congenital asymmetries will be either deformation or malformation occurring prenatally, some of which may be part of various syndromes. Some of the etiologies related to congenital asymmetries have been reviewed in the past (Bishara et al. 1994; Cohen 1995a, 1995b, 1995c), but almost 30 years later a lot of their aspects remain unclear (Medina-Rivera 2016).

## Congenital

The deformation generated prenatally will be dependent on the space available and, therefore, more frequent in the case of twins or triplets or after a hard delivery. Mild plagiocephaly is routinely diagnosed at birth as it may be the result of a restrictive environment (Flannery et al. 2012; Looman and Flannery 2012).

The congenital deformation will have strong tendency to self-correct postnatal and this is underlined when advising the importance of the sleeping posture. Among the congenital deformations that led to an asymmetry of the craniofacial skeleton, in the side of the skull, the sleeping posture is considered important. A mild and widespread form is characterized by a flat spot on the back or on one side of the head caused by remaining in a supine position for prolonged periods (Laughlin et al. 2011). Plagiocephaly is a diagonal asymmetry across the head shape. Often it is a flattening of one side at the back of the head that will lead to some facial asymmetry. Depending on whether a synostosis is involved, plagiocephaly can be divided into two groups: If there is premature union of skull bones, this is more properly called craniosynostosis (malformation) or nonsynostotic (deformational) (Kadom and Sze 2010). Surgical treatment of these groups includes the deference method; however, the treatment of deformational plagiocephaly is controversial.

The incidence of deformational plagiocephaly has increased dramatically since the advent of recommendations for parents to keep their babies sleeping on their

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backs. Data also suggest that the rates of plagiocephaly are higher for twins and multiple births, premature babies, babies who were positioned in the breech position or back-to-back, as well as for babies born after a prolonged labor (Ditthakasem and Kolar 2017).

The most frequently seen asymmetry visible at birth is cleft palate followed by some kind of plagiocephaly or hemifacial microsomia. Hemifacial microsomia is the asymmetry the cause of which is mostly unknown. Chen et al. (2018) suggested different etiologies for a disruption which occur during the first weeks of gestation. One would be external factors as various types of medication, or maternal intrinsic factors as maternal diabetes or genetic factors. In addition, three other causes have been proposed for hemifacial microsomia including a physical damage to the Meckel's cartilage, an abnormal development of the cranial neural crest cells, and a vascular abnormality and hemorrhage model. However, none of these proposed etiological factors can account for the asymmetry and the related deformation. The impact of the vascularization is, however, stressed also when analyzing the effect of maternal factors either genetic or related to disease as diabetes or medication. Contributing to some of the congenital asymmetries may be expression of genetically determined malformations that attack only tissues on one side. This abnormality may be of all tissues, cleft palate and hemifacial microsomia being the most prevalent. The abnormal growth may be of all parts of the craniofacial skeleton. It may be the size of all the tissues or only the skin. However, according to Tingaud-Sequeira et al. (2022) none of these etiologies account for the abnormal development of the first and second branchial arches described by Kjær (2017).

## Postnatally

### Thumb Sucking

The etiology of asymmetry developed postnatally will, if not related to a congenital disease, be the result of lifestyle or trauma to hard or soft tissues. The most frequent lifestyle cause of asymmetries is the nonnutritional sucking either by pacifier or thumb sucking. During the nonnutritional sucking, the mandible is kept back and the baby does not have to move the mandible forward, a movement as is normally done when sucking and swallowing take place simultaneously. The nonnutritional sucking has been found to be related to open bite and lateral crossbite. The latter may lead to asymmetry and crowding (Dimberg et al. 2010). Apart from the narrow upper arch, an asymmetrical arch form can also be the result of a prolonged thumb sucking (Figure 2.1).

**Figure 2.1** Asymmetric anterior open bite generated by prolonged thumb sucking.

### Mandibular Fractures

A frequent etiology postnatally can be that trauma both in relation to birth or during early childhood will influence the growth. The most prevalent fractures resulting in asymmetry are the unilateral condylar fractures (Figure 2.2). According to the literature between 25% and 40% of all mandibular fractures are condylar fractures (Enghoff and Siemssen 1956; Müller 1963; Rowe and Milley 1968; Zachariades et al. 2006). In addition, epidemiological studies indicate that the majority of the fractures occur in growing individuals (Lautenbach 1967). The literature comprised description of patients with unilateral fractures where the fractures led to reduced growth on the fracture side whereas others demonstrated the opposite effect, an overgrowth of the fracture side. On this background, Lund (1974) decided to perform a cephalometric radiographic registration on both sagittal and frontal images taken with small intervals in order to be able to describe the changes occurring shortly after the trauma. The age of the 38 patients ranged from 4 to 17 years. He performed an examination of individuals who had been seen in the emergency hospital clinic following severe accidents. He realized that in a major part of the patients, the fractured condyle demonstrated not only healing, but also regeneration toward a normal morphology. He developed a classification of the condylar fractures based on their localization. They were categorized as high when they involved the condylar head or the condylar neck or as low if located in the condylar process. He also classified the fractures according to the position of the head in type 1 where the condylar head was situated in contact with the articular fossa and type 2 where the condylar head was displaced outside the articular fossa. It was demonstrated that type 2 was dominant in relation to high fractures whereas type 1 was seen more frequently in relation to low fractures. Type 2 fracture was also the only one seen in the

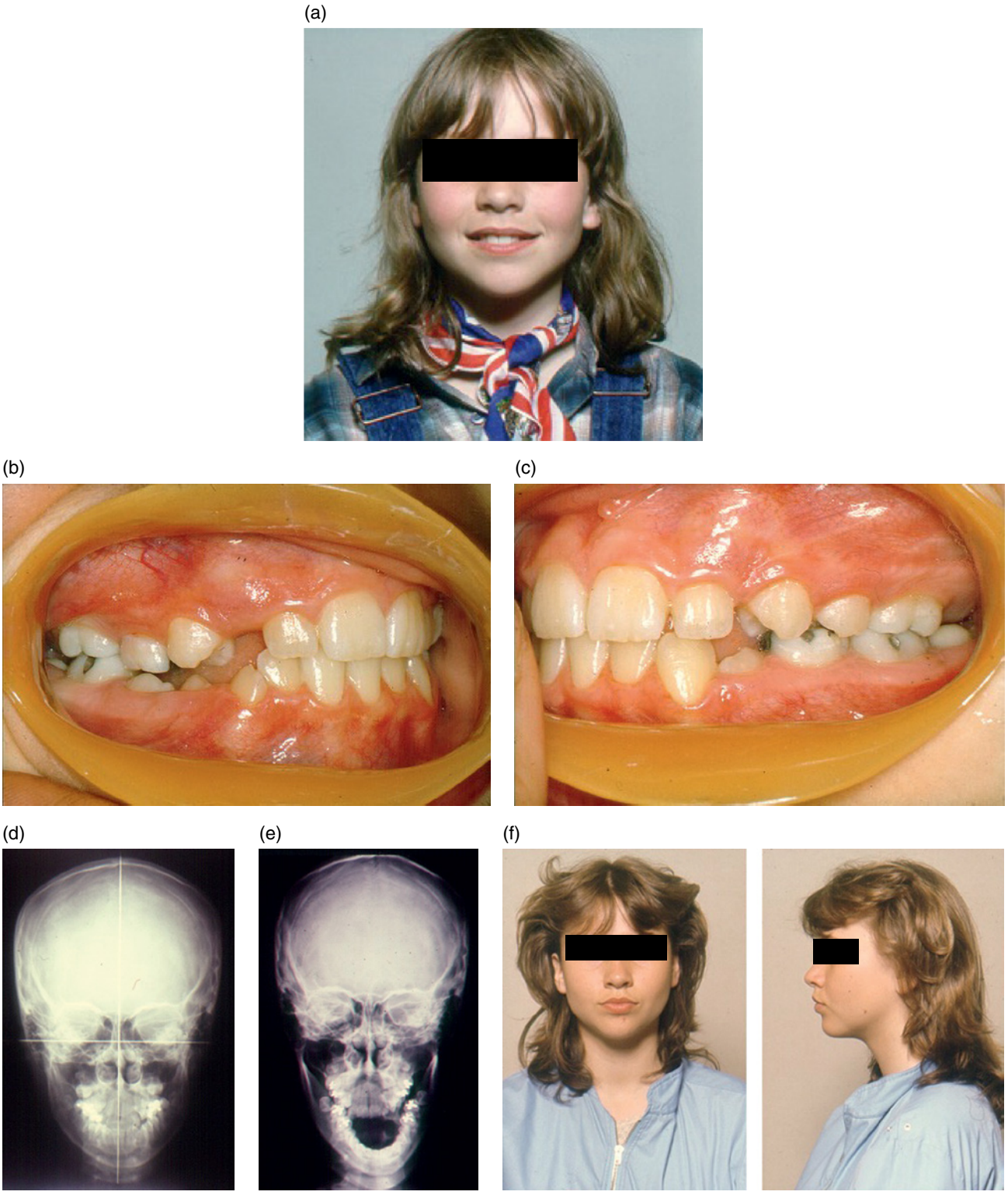


**Figure 2.2** Twelve-year-old girl referred for treatment of maxillary space deficiency. (a) Extraoral images reveal a slight face asymmetry; (b and c) intraoral images exhibiting neutral molar occlusion bilaterally, normal overjet, and overbite. There was a midline discrepancy of the lower midline almost one tooth width to the left and space deficiency especially in relation to the upper left canine. The lower arch was characterized by moderate crowding; (d) frontal cephalometric radiograph disclosing an asymmetry, the lower midline displaced to the left; (e) frontal radiograph of the patient with an open mouth. There is an obvious deviation of the mandible to the left; (f) extraoral images of the patient after two years of treatment. The asymmetry is less visible.

older age group. The conclusion drawn from this thorough report was that the changes, namely compensation, occurring following the fracture led to growth that in many cases was larger than that of the healthy side so that an asymmetry characterized by midline displacement to the healthy side was observed. Unfortunately, the classification of the fractures and the systematic way of analyzing the changes occurring after the fracture were not followed up in the multitude of reports on condylar fractures published later. When Strobl et al. (1999) followed 55 patients aged between 2.6 and 9.9 years with the same combination of cephalogram and orthopantomogram as Lund (1974) they found that within the first year there was a very varying reaction to a treatment with a myofunctional appliance, but generally the younger patients (4–7 years old) had no or only minor condylar deformity at the end of the observation period whereas the 7–10 years old children exhibited everything from moderate deformity with reduced height to increase growth and hypertrophy. Unfortunately, this publication did not focus on the influence on the facial asymmetry and midline discrepancy.

Later epidemiological studies collecting data from patients with condylar fractures only assembled information obtained at one point of time. Based on a review of 466 cases seen in an emergency hospital clinic Zachariades et al. (2006) concluded that most fractures occurred between 21 and 30 years of age and, thus did not interfere with growth. Most fractures were exhibiting a displacement of the condylar head but had still contact between the mandible and the fractured condyle. In these cases, it seemed as if the best treatment was done with a functional treatment or intermaxillary fixation. The authors formulated a conclusion regarding type of fracture and need for surgical treatment, but none of their observations or their references who also described fractures in children focused on the midlines or the asymmetries nor at the fracture moment or at the end of growth.

When adult individuals present at a hospital after an accident which may involve several organs the focus is rarely at the occlusion, but later the patient may complain over changes in the way he/she bites, e.g. a gradual opening of the bite and an asymmetry. The panoramic radiograph does not render very much information while cone-beam computed tomography (CBCT) images providing sagittal and frontal images make it obvious that a condylar fracture has taken place (Figure 2.3). An interference with normal development that may lead to asymmetry can be a fracture that actually does not get detected until the consequences,

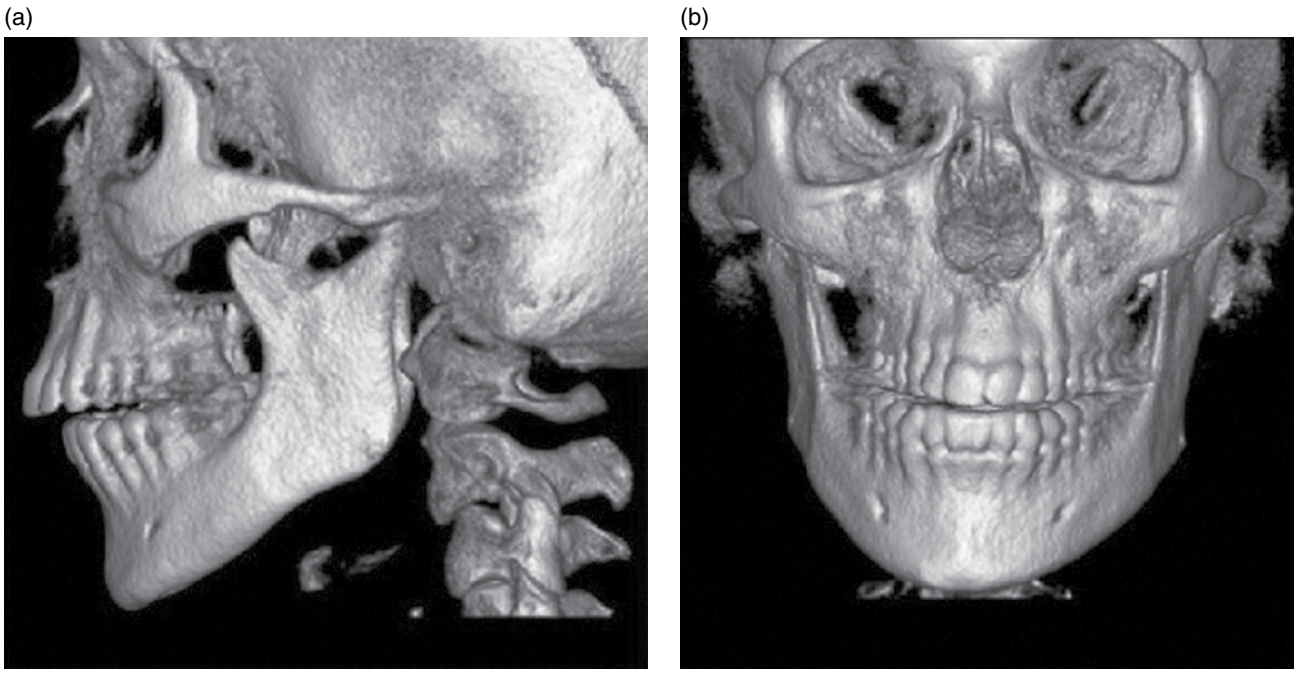


**Figure 2.3** (a–c) Radiographs of a patient who days after a trauma detected an opening of the bite and an asymmetry, the reason being a condyle fracture on the right side. (a and b) CBCT images of the patient. A midline discrepancy toward the right side can be observed; (c) the panoramic radiograph does not clearly illustrate what happened to the condyle, but sift of the mandibular midline toward the trauma side can be observed; (d and e) lateral image observed from the traumatized side. It can be observed that the posterior border of the traumatized condyle is pulled back; (f and g) focus on the traumatize condyle on the CBCT image does however illustrate an abnormal morphology; (h) the result of the tomogram clearly illustrate the displacements of the fractured condyle. These images explain why the fracture cannot always be verified on the panoramic radiograph.