

# Posterior Direct Restorations





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# POSTERIOR DIRECT RESTORATIONS

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# DEDICATION



To Mom and Dad, for the love and values they have passed on to me,  
to my brothers,  
to my wonderful, beloved Maria, for always being by my side,  
to my children Francesco, Giuseppe, and Mariapaola, that they may live life in search of knowledge and be free to follow their dreams.  
-Salvatore

To my parents,  
to my sister,  
to Isabella, my marvelous traveling companion,  
to my children Chiara and Edoardo, that they may always be free and curious.  
-Gaetano

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# FOREWORDS



Over the last 30 years, bonding agents and restoration materials have steadily improved. Bonding has radically changed anterior and posterior dental reconstructions, and current treatments are increasingly conservative and esthetic.

The authors of this admirable book have achieved the ambitious aim of providing dentists with state-of-the-art procedures for direct restoration of posterior teeth using composite resin. The book is masterfully illustrated and guides the reader through the various clinical stages from diagnosis to polishing and finishing of restorations. Numerous clinical tips are also described, based on their experience as methodical yet creative practitioners. The chapter on dental anatomy is particularly interesting. Such information is essential to ensure appropriate yet durable function.

Though entertaining to read, the various chapters are never trivial and always supported by scientific evidence. Different materials are widely discussed, and step-by-step clinical procedures are given to provide students and dentists with the information they need to achieve top-quality direct restorations.

Writing this foreword is a privilege and honor because I am sure this worthy text will be widely read.

## **Roberto C. Spreafico, DM, DMD**

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This long-awaited book is a guide for anyone who wishes to devote time to genuine conservative dentistry. Ideal anatomical reconstruction is possible through simple and effective techniques. The dominant themes of this book are diagnosis, anatomy, perception of shape, preparation, and anatomical reconstruction.

It is a great pleasure to write this foreword and advise everyone to read this work. The authors are dear friends whom I have known long enough to be able to appreciate their professional commitment and capacities. This book truly reflects the passion they pour into their daily work and their desire to improve the profession.

## **Vincenzo Musella, DMD, MDT**

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# PREFACE

This book is the outcome of ideas, dreams, discussions, and debates started and continued in phone calls, messages, Skype sessions, and many companionable train journeys from Rome to Naples and back again, with the stunning Italian landscape as a backdrop.

This book also includes the essence of all the places it was written—rarely at a desk, often on a train or airplane heading to another faraway place to attend lectures and courses, next to a power outlet in an airport, in yet another hotel eating a quick meal, at a café table in a train station, or in the car waiting for our children to come out of school.

It reminds us of all the hours we spent writing, thinking, drawing, and advising one another after putting the children to bed or early in the morning in order not to steal valuable time from our families. As you read this book, we hope you will appreciate the endless hours we lavished on documentation. The work is part of ourselves.

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Maria M., Maria C., Felicia, Patrizia, and Stefania—our irreplaceable assistants—because nothing would have been possible without them.

The Italian Academy of Conservative and Restorative Dentistry (AIC) for its passion, integrity, and professional diligence. The AIC remains a benchmark for those who are passionate about restorative dentistry.

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The authors would like to thank the following individuals for their valuable contributions to this book, which are indicated in the text.

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**1**  
Shape and  
Visual  
Perception







To construct occlusal morphology, it is necessary to know exactly how to observe the form to be replicated and to have a good knowledge of dental anatomy. The human brain may be considered a nearly perfect machine, but it will try to make its work simpler by expending as little energy as possible for maximum results. These mental shortcuts lead to limitations in a person's ability to accurately observe shape. This chapter explains how to overcome these limitations through visual decomposition.

The concept of shape, concerning an object's outward appearance, is inseparably linked with the concept of function: Objects are shaped in accordance with the function for which they were designed. For example, the hand, a tactile sensory extension of the brain, can perform prehensile functions because its thumb opposes the other fingers: Many of the fine, precise movements that can be performed with the hand, particularly the fingers, would no longer be feasible if the thumb were aligned with the forefingers. A study of shape begins with a perceptual analysis of how things are done. Visual perception is the outcome of integrating and processing an image through a series of mental processes that are influenced by the observer's cognitive resources (cognitive processing stage). Cognitive experience is influenced by previous experiences as the brain establishes similarities between things that are currently being observed and things that are already known. Full perception of an object (shape) and the ensuing emotional experience can only come about when the various information has been assimilated.

Perception of objects is made possible by two types of stimuli: distal and proximal.<sup>1</sup> A *distal stimulus* allows us to perceive an object's physical presence. A *proximal stimulus* leads the observer to the information needed to arrive at the distal stimulus. In other words, we recognize an apple (distal stimulus) because it is roundish and red in color and has two depressions (proximal stimulus). Based on the proximal stimulus (characteristics of the observed object), we can

perceive an object's presence (distal stimulus) through a process that allows us to create a perceptive representation of the object by reproducing the information embedded in the proximal stimulus.

The Gestalt philosophical movement, established in Germany by Max Wertheimer (1921), Wolfgang Kohler, and Kurt Koffka (1935), adopts an interesting approach to shape. According to this philosophy, "The whole is greater than the sum of its parts."<sup>2</sup> The overall shape is conditioned by the perceptive capacities, which include perception of:

- Outlines
- Space and ratios
- Light and shadow

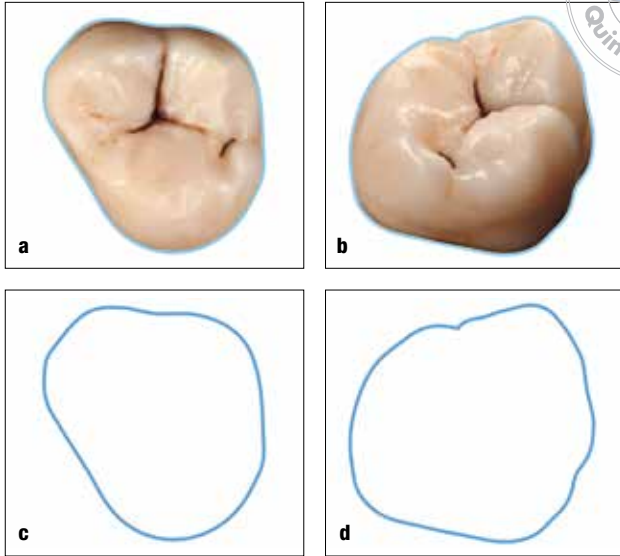
## Perception of Outlines

The perception of outlines defines an object's visual perimeter, which essentially depends on the observation perspective: Different perspectives of observation will correspond to different visual perimeters.

Figure 1-1 shows the same tooth observed from two different perspectives. Marking the outlines of both teeth (in blue) establishes the differences between the visual perimeters. This demonstrates that when observing a tooth, we must observe it from all possible perspectives in order to appreciate its true morphologic variations. Each observation perspective will supply the brain with information that, when assimilated by the memory, can be processed to assemble a perceived overall form.

For example, when performing a Class 2 restoration, the first step is to convert cavities to Class 1 in order to redefine the outline and make it easier to reconstruct the occlusal surface. The optical perception of a restored outline defines the peripheral limits and provides the morphologic information necessary to simplify the occlusal restoration procedure.

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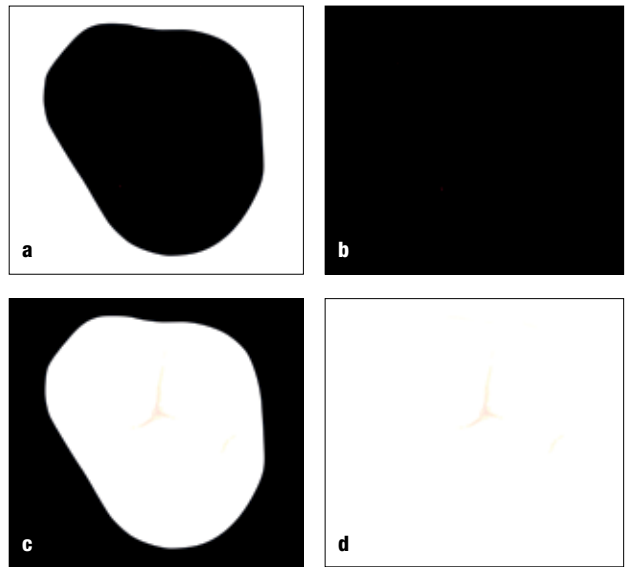
**FIG 1-1** (a and b) Maxillary second molar from two perspectives, outlined in blue. (c and d) Viewing the outlines alone demonstrates how the visual perimeters change based on perspective.



**FIG 1-2** Note the anatomical relationships between the constituent anatomical parts of each molar, between the two molars, and in the space surrounding and between the molars.



**FIG 1-3** Relationship of light and shadow in an occlusal view of a maxillary molar.



**FIG 1-4** (a) Molar from Fig 1-1a with all light removed. (b) Without a contrasting background, the shape is imperceptible. (c) Molar without shading. The shape can be perceived against the contrasting background. (d) Without contrast, the image is imperceptible.



**FIG 1-5** Even though what is shown is a series of dashed lines that do not form complete shapes, the brain draws on its cognitive experience to simplify the information as a circle and a rectangle.

## Perception of Space and Ratios

The perception of space and ratios defines the relationship that the object establishes with the surrounding space and other elements present in the field of observation as well as relationships established between the object's constituent parts: everything must be in relative proportion (Fig 1-2).

## Perception of Light and Shadow

Perception of light and shadow plays a crucial role in perceiving an object's 3D shape and surface details (Fig 1-3). If light is completely removed from the image of the molar shown in Fig 1-1a, only the outline of the figure can be perceived (Fig 1-4a), which is only possible due to the distinct contrast between the image and the white background. If the white background of the same image is replaced by a black background (Fig 1-4b), the shape is not perceptible. Similarly, if all the shading is removed from the molar in Fig 1-1a, only the outline can be perceived, and this is only due to the distinct contrast between the image and the black background (Fig 1-4c). If the black background of the same image is replaced by a white background, the shape is not perceptible (Fig 1-4d).

## Perception of the Whole

All these perceptions (proximal stimuli) integrate with one another to define our perception of the whole, ie, the overall shape (distal stimulus). Visual recognition of a figure or object can be described as assimilation and alignment of a retinal image with a representation stored in our memories. Previous experiences influence visual perception so much that the shapes in Fig 1-5 look like a circle and a rectangle even if they are drawn as dashed lines.

This happens because the data collected are organized in the simplest and most coherent way possible (law of closure). The brain is consistently wired to process observed images in accordance with a simplified process that Gestalt theory describes as the "law of past experience": the brain associates the image of every observed object with a known shape to simplify the perceptive mechanism.<sup>3</sup> The simpler and more regular shapes are, the less likely they are to evade perception (this is called the *law of prägnanz*, ie, that something should be concise and meaningful).<sup>3</sup>

In her book *Drawing on the Right Side of the Brain*, Betty Edwards sets out the fascinating results of her studies regarding the influence of previous experiences on perception.<sup>4</sup> The fact that one half of the brain is dominant over the

other greatly affects the perceptual capacities, especially considering that the right hemisphere expresses one's artistic and creative side, while the left hemisphere expresses one's analytical, rational, and logical side. According to Roger Sperry (1913–1994), if the left hemisphere dominates over the right, an individual finds it difficult to perceive, analyze, and process shape. If the opposite is true, the individual has a strong artistic bent.<sup>5</sup> The neurosurgeon Richard Bergland made this clear when he wrote in 1985, "You have two brains: a left and a right. Modern brain scientists now know that your left brain is your verbal and rational brain; it thinks serially and reduces its thoughts to numbers, letters and words... Your right brain is your nonverbal and intuitive brain; it thinks in patterns, or pictures, composed of 'whole things,' and does not comprehend reductions, either numbers, letters, or words."<sup>6</sup> When a subject's creative side is subdued by the left side, conditions must be created to wake up the right side.

In one of her experiments, Edwards invited her study participants to copy a known design, eg, the Mona Lisa, upside down. This experience disorients the participants, depriving them of any remembered reference that can be traced back to the image, thus simulating their visual perception. It would be interesting if individuals could begin to observe things with a different perceptual approach, freeing themselves from previous patterns and cultural experiences that undermine perceptive capacities and creativity.

The figure/background principle, or the relationship between the figure and the background it dominates, is known as the *principle of contrast* and lies at the root of visual perception; according to the Danish psychologist Edgar Rubin (1886–1951), the presence of a body is perceived only by contrasting the observed body with its background.<sup>7</sup> When clues are few or ambiguous, our minds find it difficult

**“Where there is bright light or no light at all, shape does not exist. The balance between light and shade allows shape to be perceived in its finest details.”**



**FIG 1-6** The image illustrates the concept of figure/background. Looking at the figure, one can perceive the face of a woman and/or see a man playing a saxophone. The information between the figure and the background is not well defined, which causes the mind to be conflicted and unable to distinguish the figure from the background.



which shape should be the figure and which should be the background (Fig 1-6).

Visual decomposition, ie, dismantling each individual element making up the object from all the others, seems to make the shape clear and simple to perceive. If one observes each individual element, analyzes it in detail, and then reassembles the parts, everything acquires a new perception. In geometric terms, a figure is essentially made up of:

- *Edges*: Segments joining the vertices of a solid
- *Vertices*: The points where the edges meet
- *Surfaces*: Figures made up of vertices and edges of a solid lying on the same plane<sup>8</sup>

This holds true for teeth, which can be equated to geometric figures made up of edges, vertices, and surfaces (Fig 1-7).

Transition areas can be equated to rounded edges linking two or more opposing surfaces<sup>9</sup> (Figs 1-8 and 1-9). Bearing in mind the enormous intra- and interindividual anatomical variability occurring in nature, careful observation of the occlusal surface of a posterior tooth reveals that all occlusal anatomy stems from the occlusal perimeter, ie, the set of anatomical summits representing the angle of transition from the buccal, mesial, distal, and palatal/lingual surfaces toward the occlusal surface.

To see how the occlusal surface of a molar is constructed, its structural components must be broken down. For example, if a mesiobuccal cusp of a maxillary molar is broken down, we can see that it is made up of:

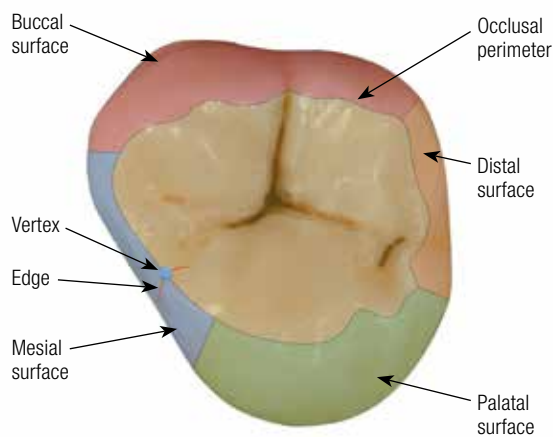
- Occlusal perimeter
- Cusp slope
- Cusp crest
- Triangular ridge

Close examination of the triangular ridge (Fig 1-10) reveals that it is defined by:

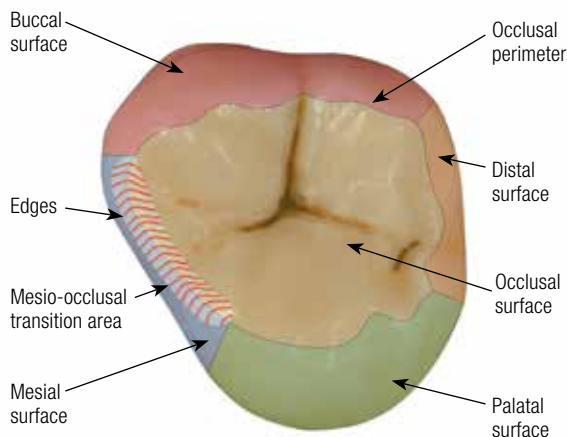
- Occlusal perimeter
- Cusp crest
- Mesial and distal ridge slopes ending in two supplemental grooves

It therefore follows that:

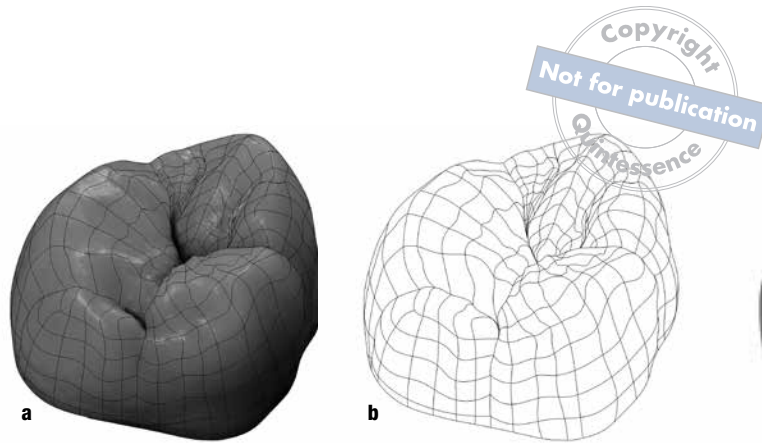
- Each triangular ridge is delimited by the cusp crest, by the ridge slopes (mesial and distal) that define its lateral limit, and by the grooves in which the ridge slopes terminate.



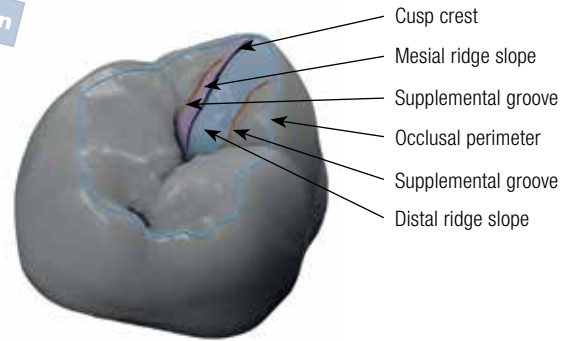
**FIG 1-7** Tooth surfaces, vertices, and edges.



**FIG 1-8** Tooth surfaces and representation of transition areas.



**FIG 1-9** (a and b) Graphic representations of a tooth showing that it is made up of a set of edges and transition areas, where the number of variables is infinite, and every small detail is important.



**FIG 1-10** Triangular ridge broken down into the cusp crest, mesial and distal slopes, and grooves.

- Each ridge slope is contained between a cusp crest and a groove, and each groove is contained between two ridge slopes and can communicate with other grooves.<sup>10</sup>

The interrelationship defined between the parts of the observed object is reflected in the expressive force of the perceived image: the triangular ridge is perceived because slopes and grooves are present; one slope of the triangular ridge is perceived because this is delimited by a cusp crest and a groove; and a groove is perceived because this is contained between two slopes. Everything depends on what is being examined and the perspective of observation.

Rudolf Arnheim states that, “Perceptual shape is the outcome of an interplay between the physical object, the medium of light acting as the transmitter of information, and the conditions prevailing in the nervous system of the viewer. The shape of an object we see does not, however, depend solely on its retinal projection at a given moment. Strictly speaking, the image is determined by the totality of the visual experiences we have had with that object, or with that kind of object, during our lifetime.”<sup>11</sup> With reference to the observation of things in general, Arnheim stresses that “detail is everything” and overall shape is nothing more than a set of details that define it: without detail there is no shape.

The take-home message is that a tooth is anatomically made up of a set of details that interact with one another to define the perceived overall shape.

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