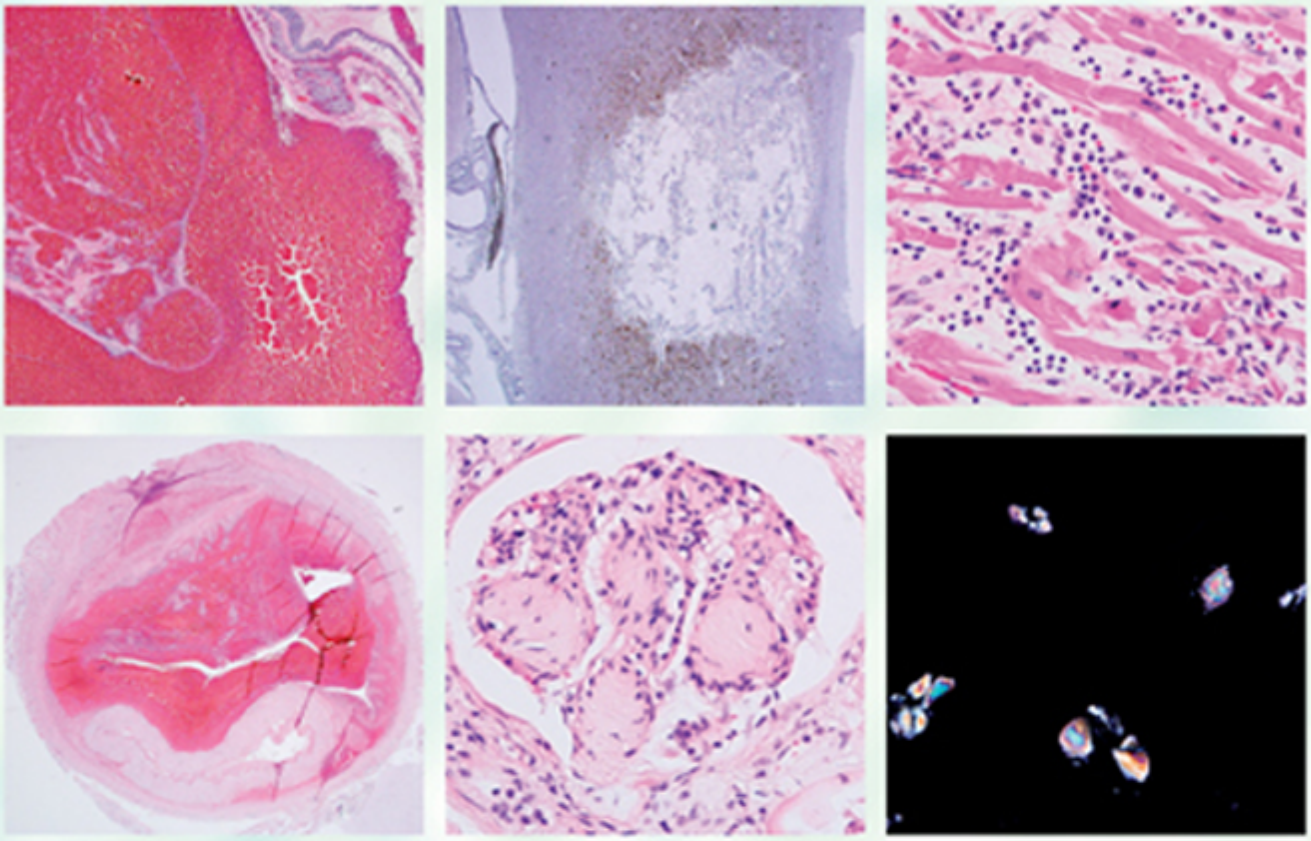
Atlas of FORENSIC HISTOPATHOLOGY

Peter M. Cummings, Darin P. Trelka and Kimberley M. Springer



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To mom and dad, I miss you both.

To Sarah and Fionn, thank you for all the love and support (and for the occasional brief moments of quiet while I tried to finish this thing).

To my big sis Shawna, for all the years of believing I could, even when I had doubts.

To Dr. John Butt, Former Chief Medical Examiner of Nova Scotia. Without you, none of this would have happened. Thank you for introducing me to the amazing world of forensic pathology!

Peter Cummings

To my parents for providing me everything and asking nothing in return.

To my wife and daughter for loving and supporting me through the journey and for always reminding me what is important.

To Ted, Melissa, Chris, Christian, Ian, Joe, Mark, Kevin and Grant, who have influenced my career more than you know.

To Paul and Pete for introducing me to the wonder of forensics.

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To all the trainees in forensic pathology, who must remember the oft quoted adage, "The eye can't see what the mind doesn't know."

Finally, to Dr. Marcella Fierro for instilling in me the need to "take *the word* out."

Darin Trelka

To Michele, thanks for being my favorite lady.

To Lisa, thanks for letting me work on this, even when it annoyed you.

To all past, present, and future Forensic Pathology Fellows – enjoy!

Kimberley Springer

CONTENTS

FOREWORD

Histopathology examination is the daily bread and butter of the general or special-expertise pathologist. However, for many years histopathology had been under-evaluated in many Medical Examiners' and Coroners' Offices here in the USA, and had not been treated much better in the remainder of the world. Nevertheless, in recent decades there has been an increased awareness of the central importance of forensic microscopy in many forensic cases, and the number of histopathology books has increased significantly. However, there are still very few atlases of forensic pathology and by publishing their *Atlas of Forensic Histopathology*, Drs. Cummings, Trelka and Springer have made a highly valuable contribution to forensic medicine. All three authors are experienced and highly regarded Medical Examiners, with an aggregate experience of decades in forensic histopathology. While textbooks of forensic histopathology are valuable, the number of illustrative photos included is always much less than that presented in a microscopy atlas. In the forensic pathology world, as much as in the world at large, a picture is better evidence than a thousand words. Besides presenting a wealth of forensic microscopic illustrations, the authors of this atlas have eminently succeeded in selecting a wide spectrum of color illustrations from both common and difficult type of cases, including the challenging issues of aging of natural, chemical, and traumatic injuries. The legends to the illustrations are very clear and are accompanied by guiding tables of differential diagnoses and time-related pathogenetic changes. The atlas is valuable both to the novice forensic pathologist and to the experienced one, facing a difficult case or in need of supportive or documentary evidence.

The Atlas of Forensic Histopathology by Cummings, Trelka and Springer is an effective and easy-to-use professional tool which should be available in every forensic library.

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PREFACE

This atlas was a labor of love as much as it was a labor of practicality. Forensic pathology is one of those disciplines which, although recognized for over fifty years, has little in the way of literature, in contrast to many of its bigger brethren in anatomic pathology. As such, we found that it is often difficult to find well-presented, clear, and visually compelling forensic micrographs for correlation with what we were finding through our microscopes during slide review. In addition, as one practices this craft, one often finds oneself faced with questions asked by law enforcement officers and agents of the legal system for which anatomic pathology residency programs have not prepared us: "How old is this bruise?", or "…so was the fetus dead before the assault?" It is often enough that the answers to these questions can be found in articles spread out across the literature of the last 10 or 20 years, but the question which remains is whether trainees are aware of this literature and how can it be made more accessible?

In order to address these issues, we all began to build a literature library which we use in our daily practice. This atlas is a product of that library as a reflection of the needs we felt during forensic fellowship training and the first few years of our practice. We think it to be a concise collection of micrographs and descriptive tables of forensic interest, which we have incorporated into our respective practices. It is our hope that this will be a "scope side" referent for trainees in forensic medicine and as a review for forensic pathologists already in practice.

ACKNOWLEDGEMENTS

We would like to thank Karen Neves, the best medical librarian in the world, for all her time and assistance with this project.

POST-INJURY INTERVALS 1

INTRODUCTION

Accurate dating of injuries has been an area of considerable research and debate. The body's response to trauma is diverse and is affected by innumerable variables. A review of the literature will reveal a considerable variation in the time periods associated with injury development and appearance and that there is variation in rates of wound healing in different sites of the same individual. How much force caused the contusion? How deep is it? What is the underlying tissue – is it bone (like the skull or ribs), or is it elastic (such as the abdomen)? What was the nutritional status of the victim and would this be likely to affect their rate of healing? Would the decedent's natural disease state(s) affect the way they heal such that it may be faster or, more likely, slower than in the general population? These are all issues that need to be considered to interpret the age of traumatic lesions, and still we are often left with a more realistic binary decision between "acute" and "remote." It is imperative that you not permit yourself to get "painted in" to an age for a contusion or abrasion. These are best handled in windows of time, posited with the caveat that the vagaries of biology preclude a more precise time factor. Similar issues are encountered with dating subdural hematomas or cerebral contusions. In this chapter there are numerous photographic examples of injuries at many different time points. We have also included a number of tables, reviewed and collected from the existing literature for quick reference.

CONTUSION DATING

Skin

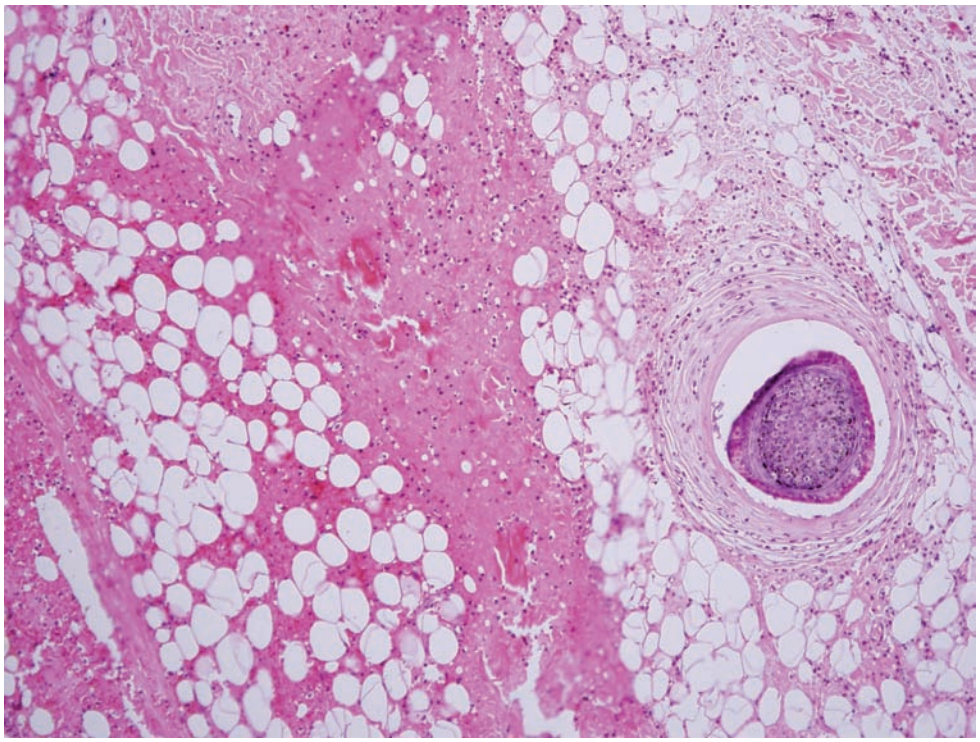

Figure 1.1. Acute contusion (4–12 hours). Acute hemorrhage with marked neutrophilic infiltration.

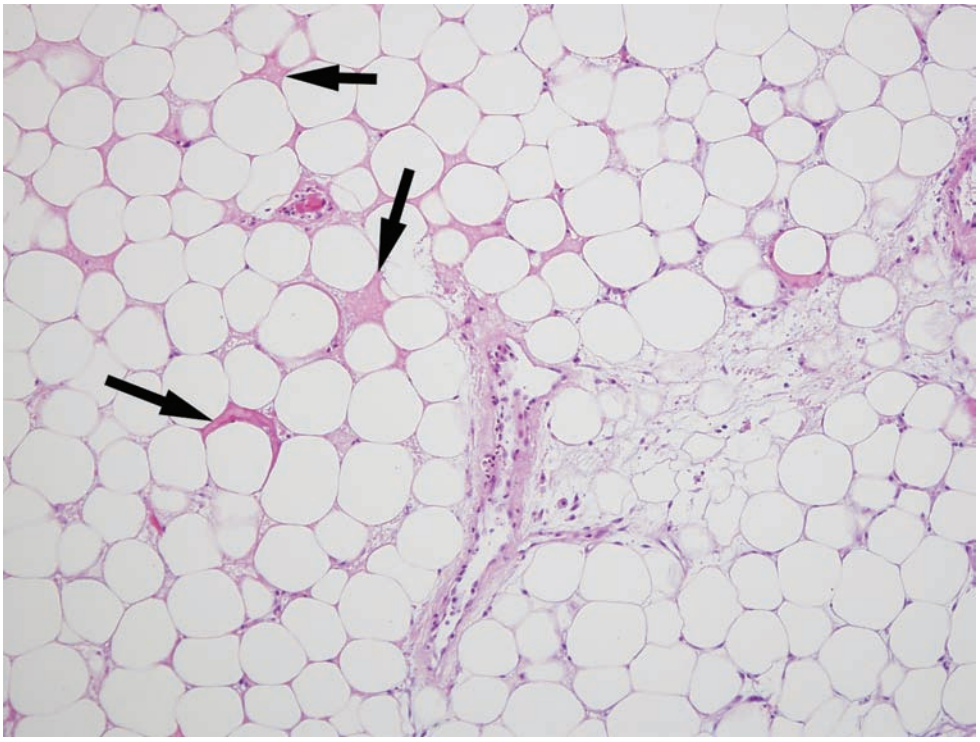

Figure 1.2A. Remote contusion (> 24 hours). Section of subdermal adipose tissue with erythrocyte "laking" (arrows), or loss of erythrocyte borders during close association.

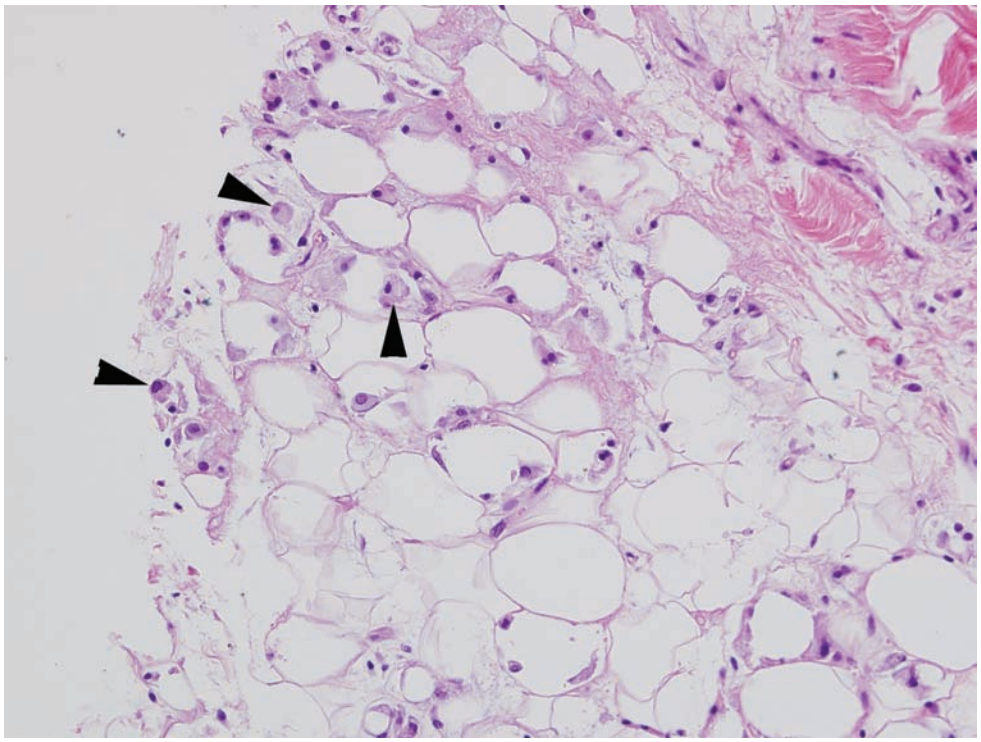

Figure 1.2B. Section of subdermal adipose tissue with numerous foamy macrophages (arrow heads), many of which are visible with stainable iron.

Table 1.1 Contusion ageing.

Time interval	*Histologic appearance*
< 4 hours	- No distinct signs of inflammation - Histological distinction between antemortem and postmortem skin wounds not possible. (Caveat: neutrophilic infiltrates have been reported to appear within 20–30 minutes [1])
4–12 hours	**4 hours**: Some perivascular neutrophils **8–12 hours**: Neutrophils, macrophages, and fibroblasts form a distinct peripheral wound zone. (neutrophils >> macrophages)
12–48 hours	**16–24 hours**: Macrophage infiltrate increases. (macrophages >> neutrophils) **24 hours**: Neutrophils and fibrin deposition at maximum and remain for 2–3 days Cut edge of epidermis shows cytoplasmic processes **24–48 hours**: Epidermis migrates from the edge toward the center of the wound **32 hours**: Necrosis is apparent in central wound zone **48 hours**: Macrophages reach maximum in peripheral wound zone
2–4 days	**2–4 days**: Fibroblasts migrate into wound periphery. Stainable hemosiderin apparent [1][3] **3 days**: Epithelialization of small wounds becomes complete and its stratification is thicker than surrounding epithelium **3–4 days**: Angiogenesis occurs

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Table 1.1 *continued*

Time interval	*Histologic appearance*
4–8 days	**4 days**: New collagen laid down **4–5 days**: Ingrowth of new capillaries, which continues until day 8 **6 days**: Lymphocytes at maximum in peripheral zone **4–8 days**: Copious stainable hemosiderin
8–12 days	- Decrease in number of inflammatory cells, fibroblasts, and capillaries - Increase in the number and size of collagen fibers - Hematoidin becomes apparent
>12 days	- Definite regression of cellular activity in both epidermis and dermis. Vascularity of dermis decreases. Collagen fibers restored and begin to mature and shrink. Epithelium shows definite basement membrane

Table adapted from [2]. Speed of changes are different in different tissues, even in contralateral sites of the same person [3]. Gross and histologic "contusions," or pseudo-contusions, *can* appear after death [1], especially when there is increasing pressure in local vasculature with subsequent rupture and passive extravasation into the surrounding tissues. In these post-mortem pseudo-contusions, there is no inflammatory "vital reaction" seen histologically; however, "the lack of a vital reaction does not imply that the injury occurred postmortem" [1]. Like all things in forensics, these injuries must be correlated with investigatory and gross anatomic findings.

Source:

[1] Langlois, N.E.I., The science behind the quest to determine the age of bruises – a review of the English language literature. *Forensic Sci Med Pathol*, **3** (2007), 241–251.

[2] Raekallio, J., Histologic estimation of the age of injuries. In Perper, J.A., and Wecht, C.H., eds., *Microscopic Diagnosis in Forensic Pathology*. Springfield, IL: Charles C. Thomas, (1980), pp. 3–16.

[3] Vanezis, P.,Interpreting bruises at necropsy. *J Clin Pathol*, **54** (2001), 348–355.

Brain

Subarachnoid hemorrhage dating

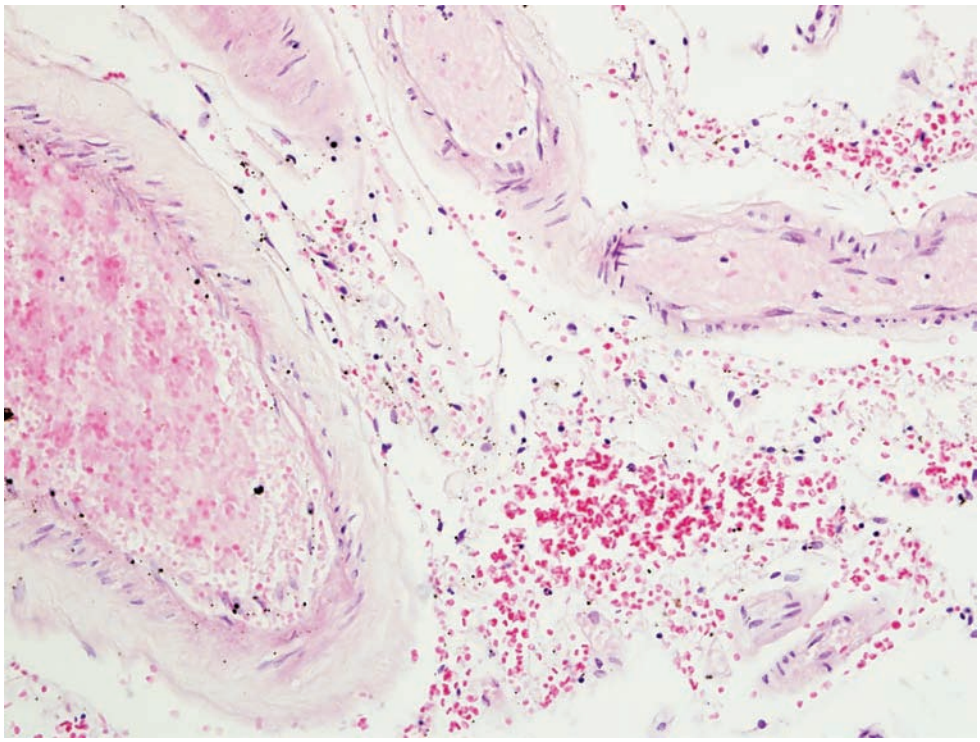

Figure 1.3. Subarachnoid hemorrhage. There is acute hemorrhage in the subarachnoid space. Notice there is no acute inflammatory response and the red blood cell cytoplasmic borders are intact. The age of this lesion is best estimated as less than one hour. After one to four hours neutrophils appear. After four hours the red blood cells begin to lyse.

Table 1.2 Microscopic dating of subarachnoid hemorrhages.

<1 hour	-	Fresh blood in subarachnoid space
1 to 4 hours	-	Occasional neutrophils seen
	-	Some red blood cells begin to break down
	-	Red blood cells begin to creep down the Virchow–Robin spaces
4 to 12 hours	-	Increased neutrophils
	-	Perivascular lymphocytes
	-	Rare macrophages
12 to 24 hours	-	Hemosiderin and fibrin
	-	Increased numbers of lymphocytes and macrophages
24 to 48 hours	-	Increased neutrophils and macrophages
	-	Definite hemosiderin deposition
Up to 3 days	-	Peak neutrophilic infiltrate
Up to 5 days	-	Laking of red blood cells
	-	Increased lymphocytes
	-	Intense fibrin deposition separating islands of red blood cells
	-	Early collagen formation

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