



# Sonic surgery

Application of sonic instruments in oral, periodontal & implant surgery.

*Dr. Alessandro Geminiani*

# Outline

- Understand the mechanism of action of sonic instruments
- Present the surgical applications of sonic instruments
- Evaluate science supporting the use sonic instruments

# Introduction

- First application of ultrasound to human tissue in 1950 (Pohlman)  
Kennedy et al. 2003
- Same year, Maintz used ultrasound for bone healing  
Maintz 1950
- In 1952, ultrasonic unit used for preparation of cavities

# Introduction

Used routinely in periodontics for scaling and root planing.

Indicated in hard-to-reach and difficult area (furcations).





# Introduction



**Sonic**



**Magnetostrictive**



**Ultrasonic Instruments**

<b>Frequency</b>	2'000 - 6'000 Hz	18'000 -45'000 Hz	20'000 - 50'000 Hz
<b>Stroke Pattern</b>	Elliptical	Elliptical	Linear
<b>Power Supply</b>	Dental Unit	Separate Unit	Separate Unit
<b>Irrigation</b>	Dental Unit	Separate Irrigation System	Separate Irrigation System
<b>Pacemakers</b>	No Interference	Interference	Interference

# Introduction

- Hand, Sonic and Ultrasonic resulted in similar healing responses

Badersten et al. 1981, 1984  
Lindhe & Nyman 1985

- Less time spent for debridement

Wennstrom et al. 2005

- Less root surface loss compared to hand instruments

Ritz et al. 1991  
Schmidlin et al. 2001

- Better acces to furcation area and deep pockets

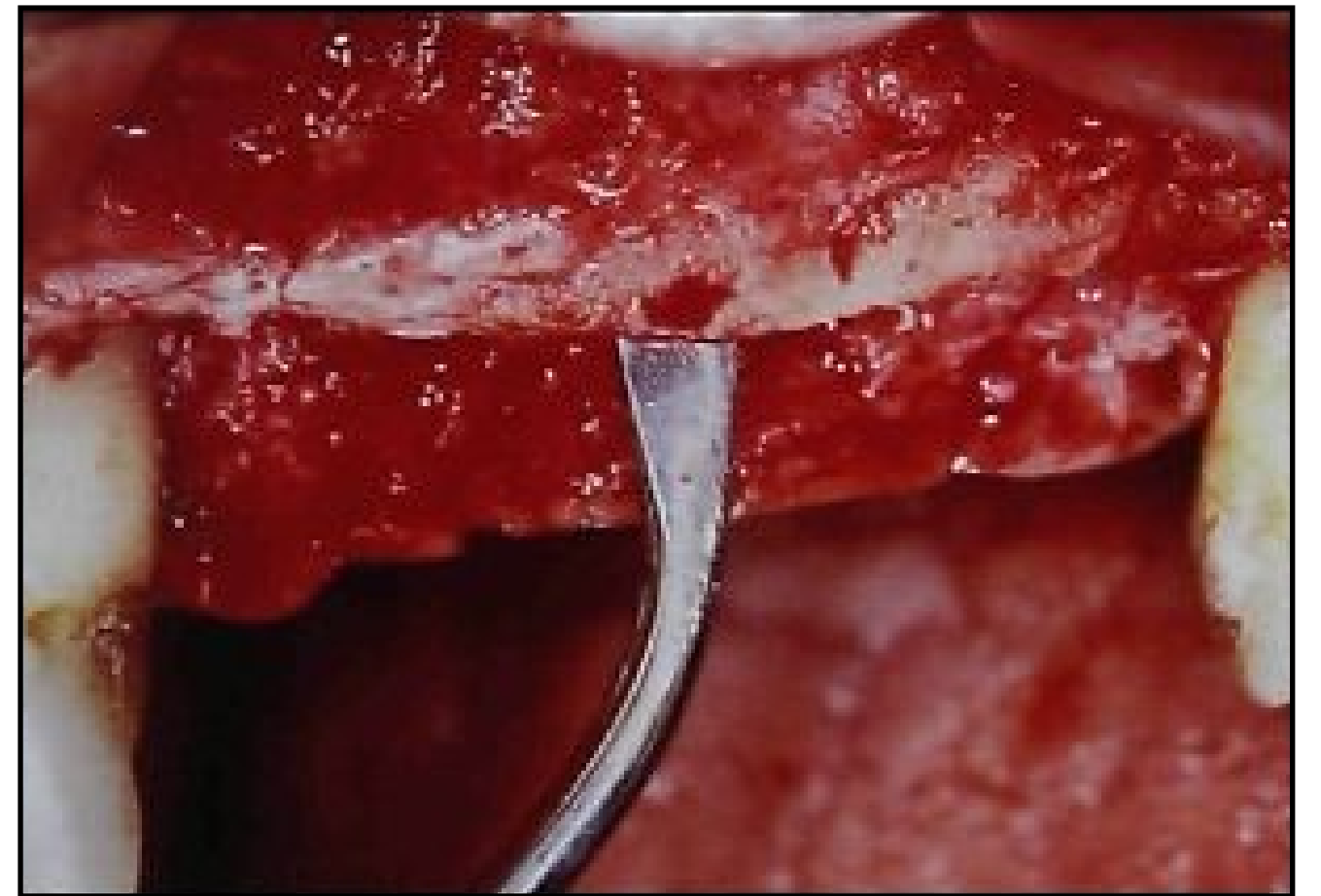
Kocher et al. 1998  
Beuchat et al. 2001

# Introduction

In 1988 first reported application of oscillating instruments  
for bone surgery

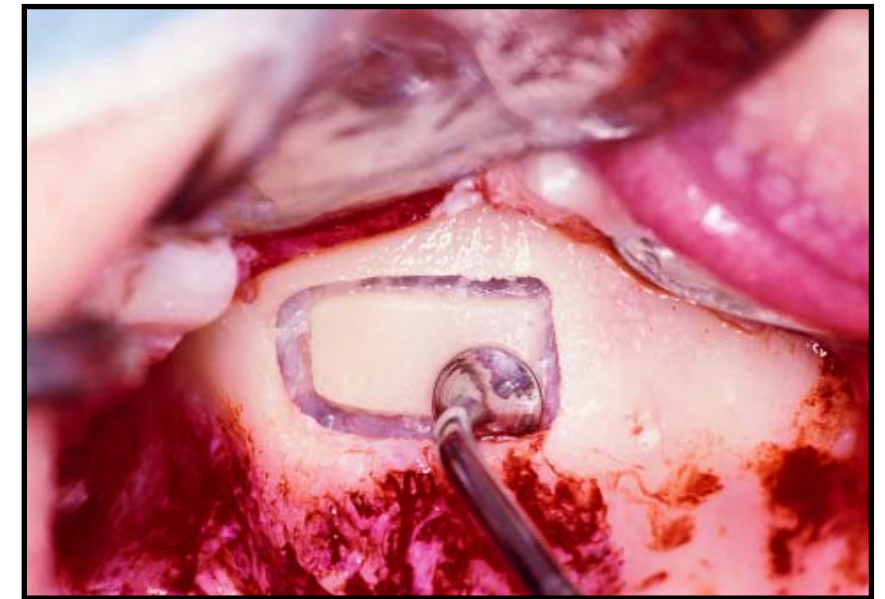
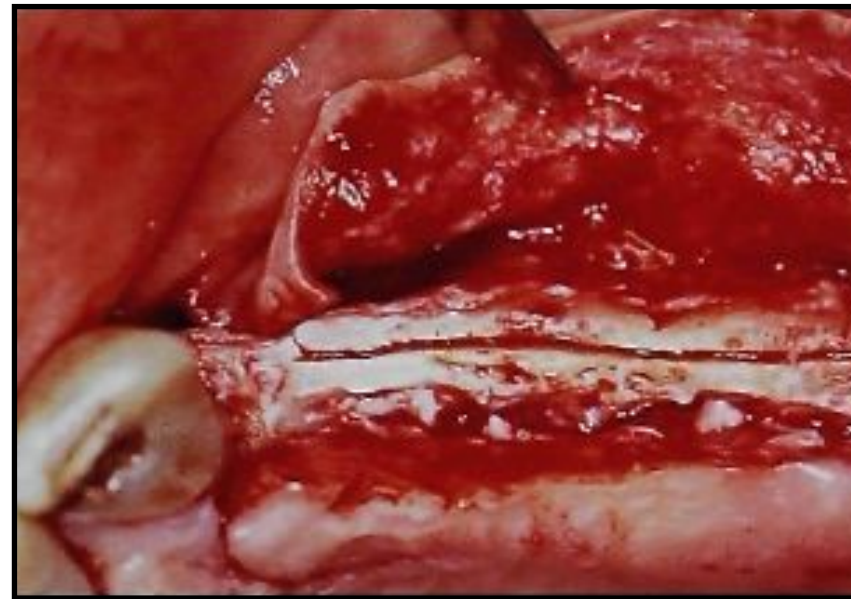
Vercellotti et al. 2000

# Introduction





# Introduction

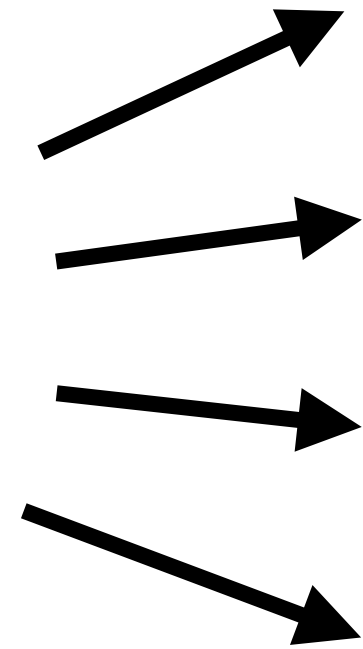


Precise Osteotomy

Selective Cutting Action

Cavitation Effect

# Advantages of Sonic Surgery



Precise Osteotomy

Selective Cutting Action

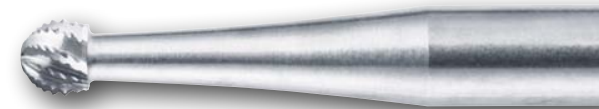
Improved Bone Healing

Cavitation Effect

Manual instruments



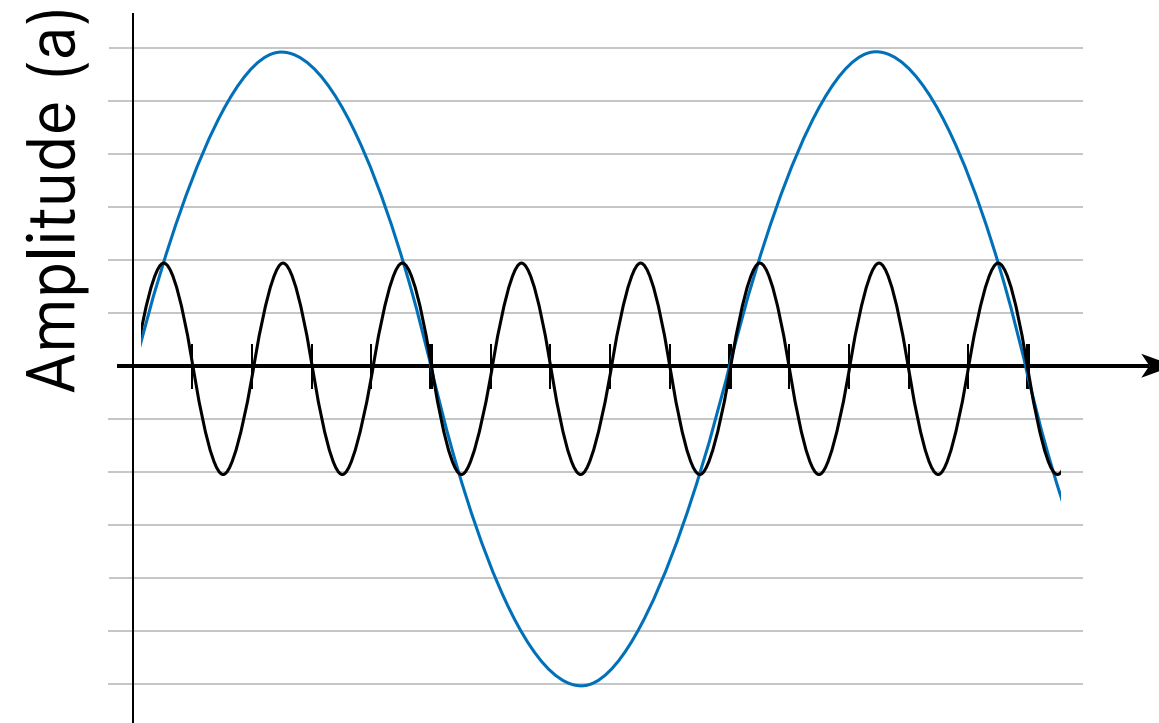
Rotary instruments



Conventional bone saw



# How does it work?



# Sonic vs Ultrasonic



## **Sonic Instruments**

2'000 - 6'000 Hz

Elliptical Stroke Pattern

Connected to Dental Unit

Dental Unit Irrigation System

No Effect on Pacemakers



## **Ultrasonic Instruments**

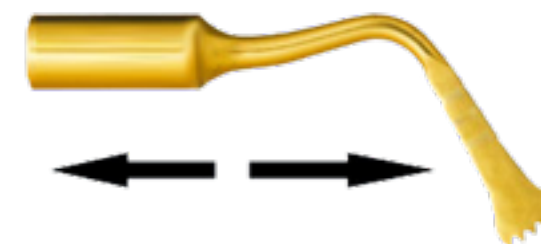
20'000 - 50'000 Hz

Linear (Piezo) Stroke Pattern

Separate Unit

Separate Irrigation System

Electromagnetic Interference Pacemakers

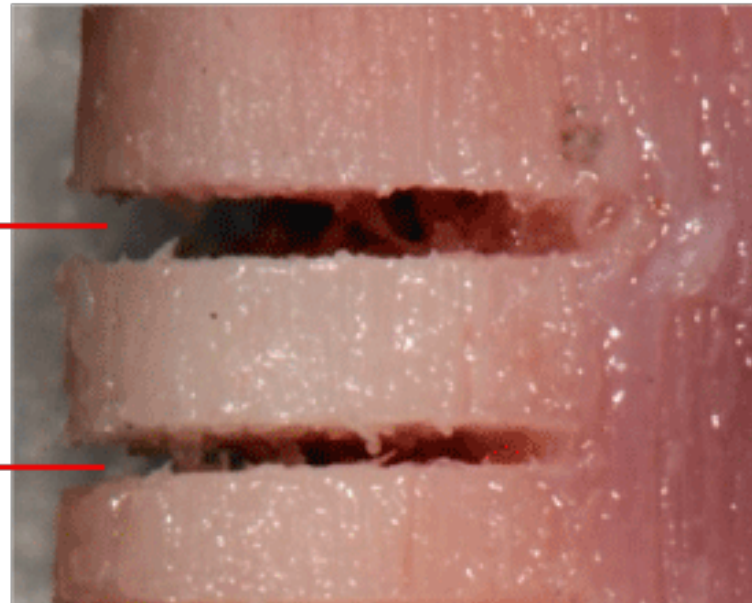
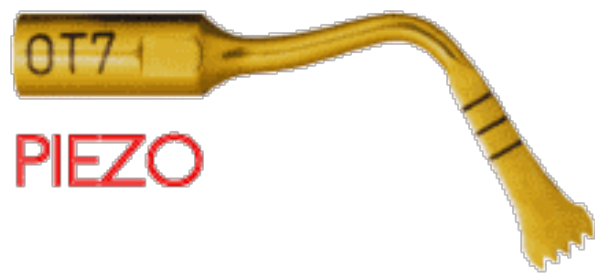
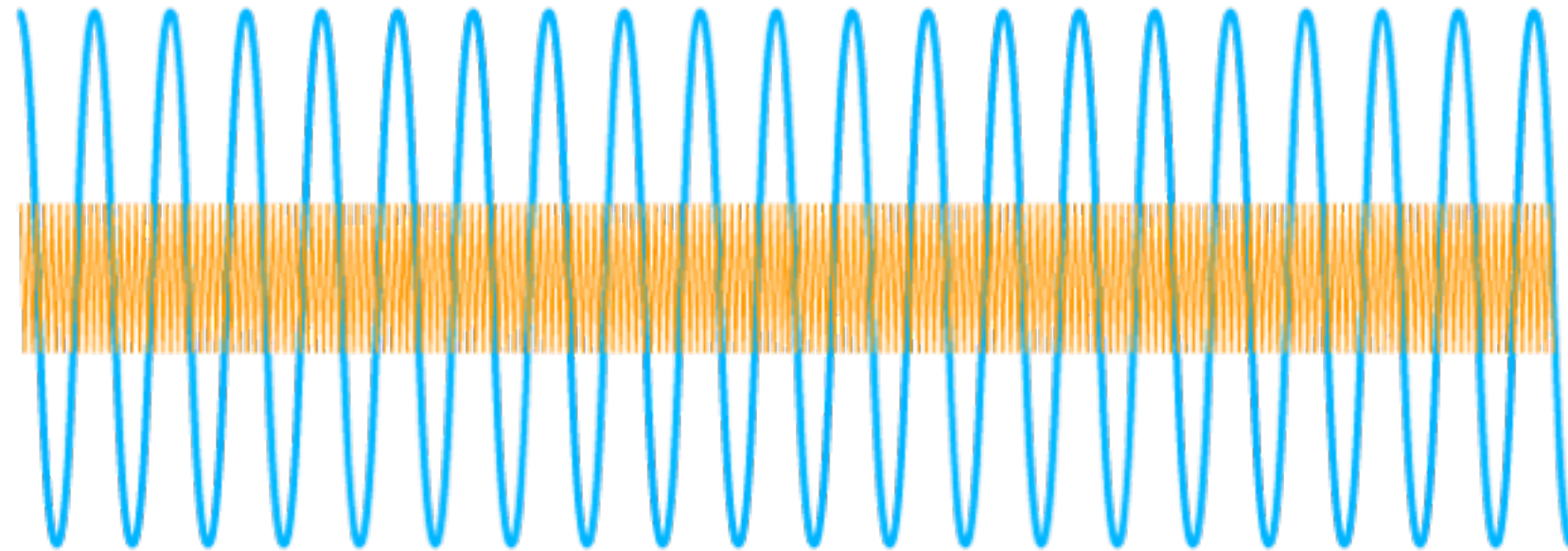




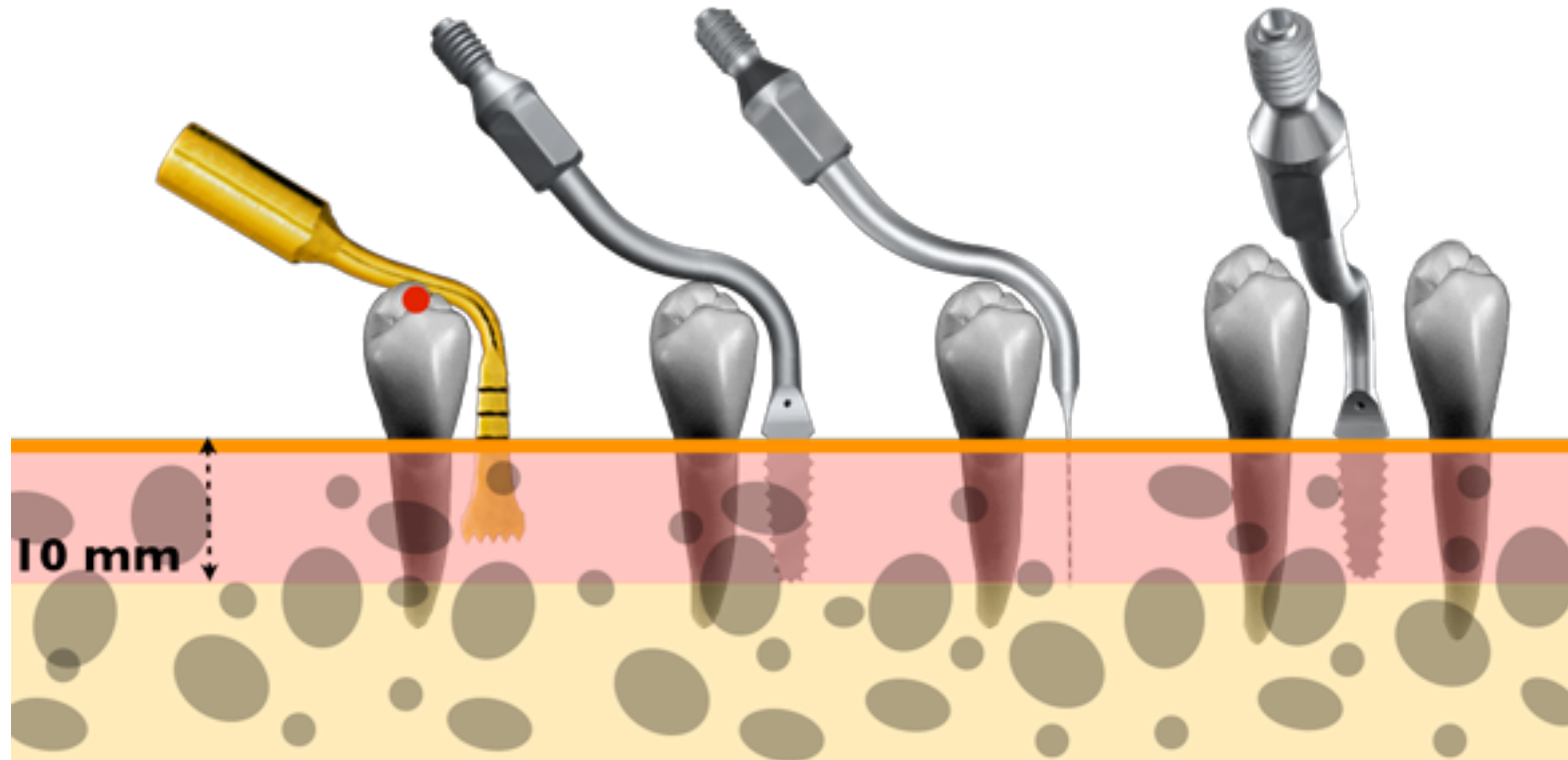
# Sonic vs Ultrasonic

 Sonic

 Ultrasonic



# Sonic vs Ultrasonic

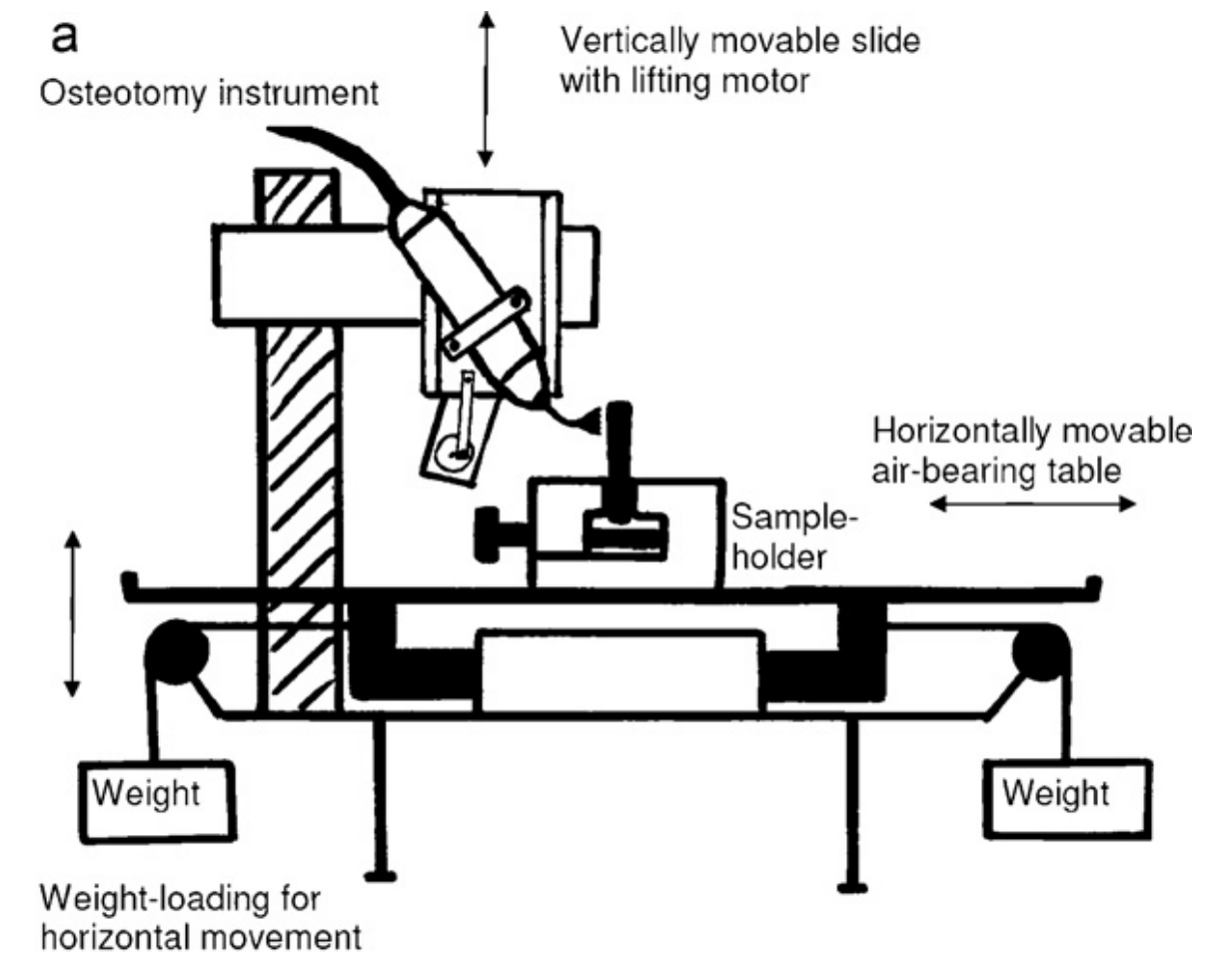


# Sonic vs Ultrasonic

- Heat Generation and Transmission due to:

- High frequency
- Reduce amplitude
- Lack of irrigation

Osteotomy	Temperature difference (°C)		
	Round bur	Piezosurgery®	SONICflex®
1	1.99	5.34	1.59
2	2.98	34.32	4.09
3	0.61	11.95	1.67
4	1.31	14.05	2.73
5	0.82	25.18	1.39
Mean	1.54	18.17	2.29
Std.	0.96	11.51	1.13



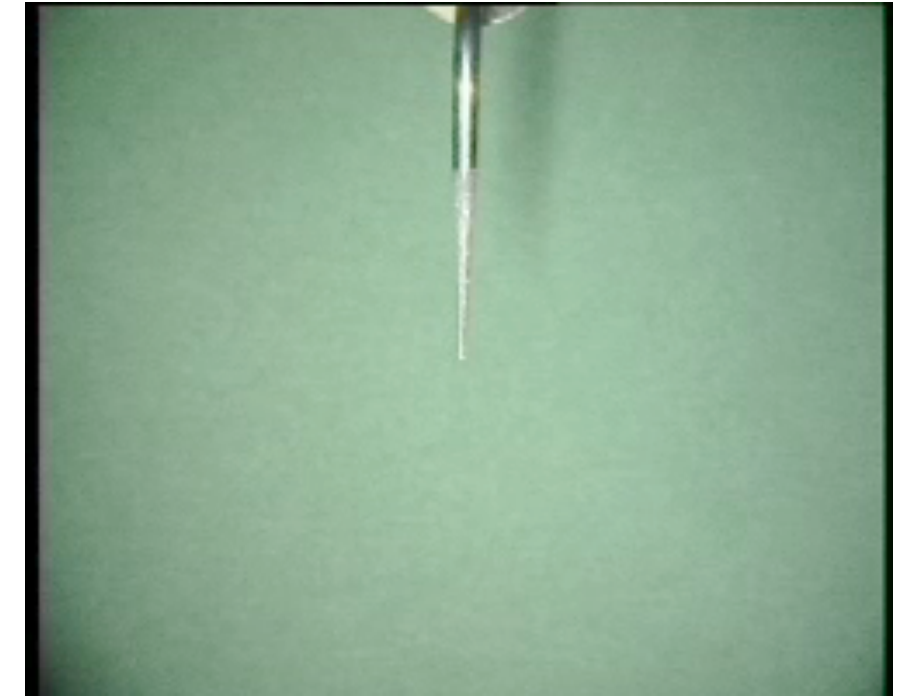
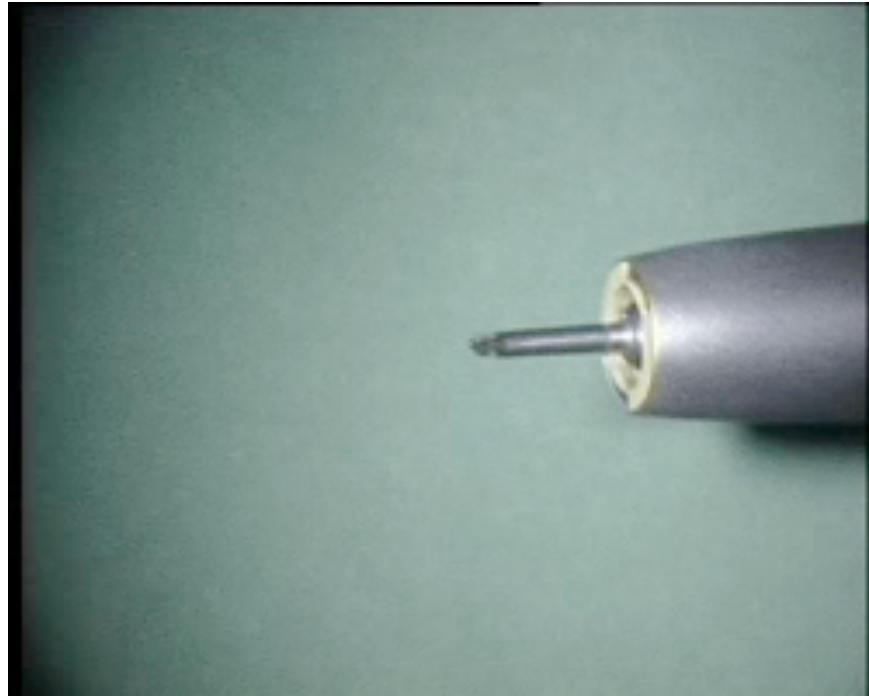


# Sonic vs Ultrasonic





# How does it work?



# Advantages of Sonic Surgery



**Selective Cutting Action**

# Advantages of Sonic Surgery

## Selective Cutting Action

Rat (25) sciatic nerve exposed  
Contact with surgical instrument

**Group 1:** insert (no vibration) contact with nerve (3N) for 5s

**Group 2:** insert (vibration) contact with nerve (3N) for 5s

**Group 3:** surgical insert in contact with nerve (5N) for 1s

# Advantages of Sonic Surgery

**Selective Cutting Action**

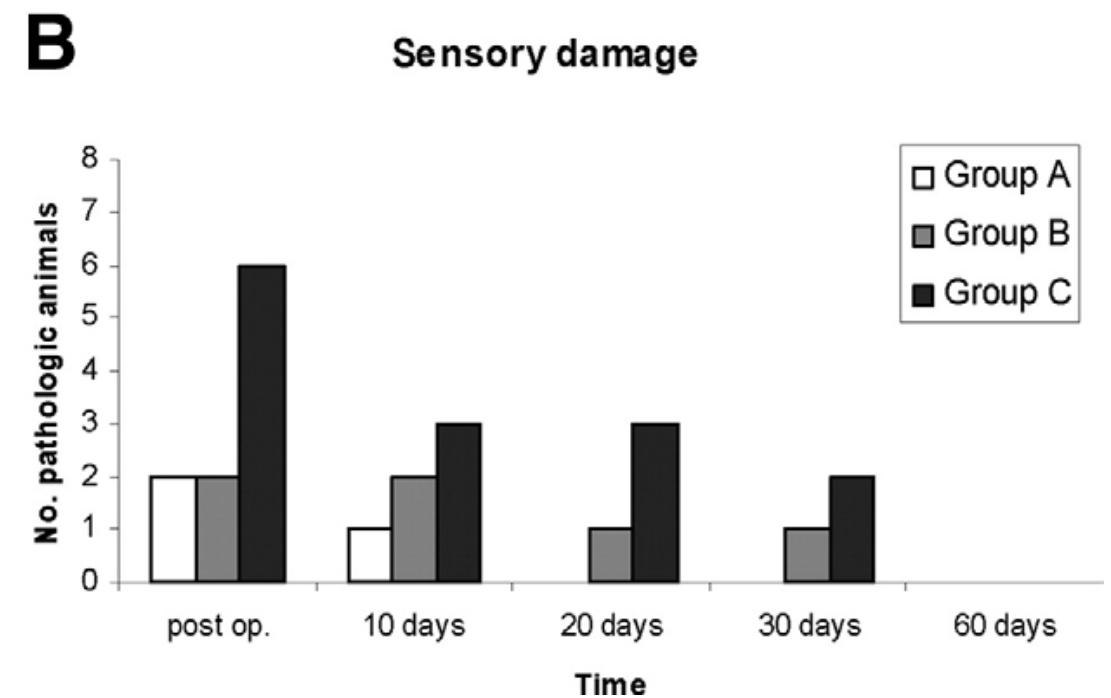
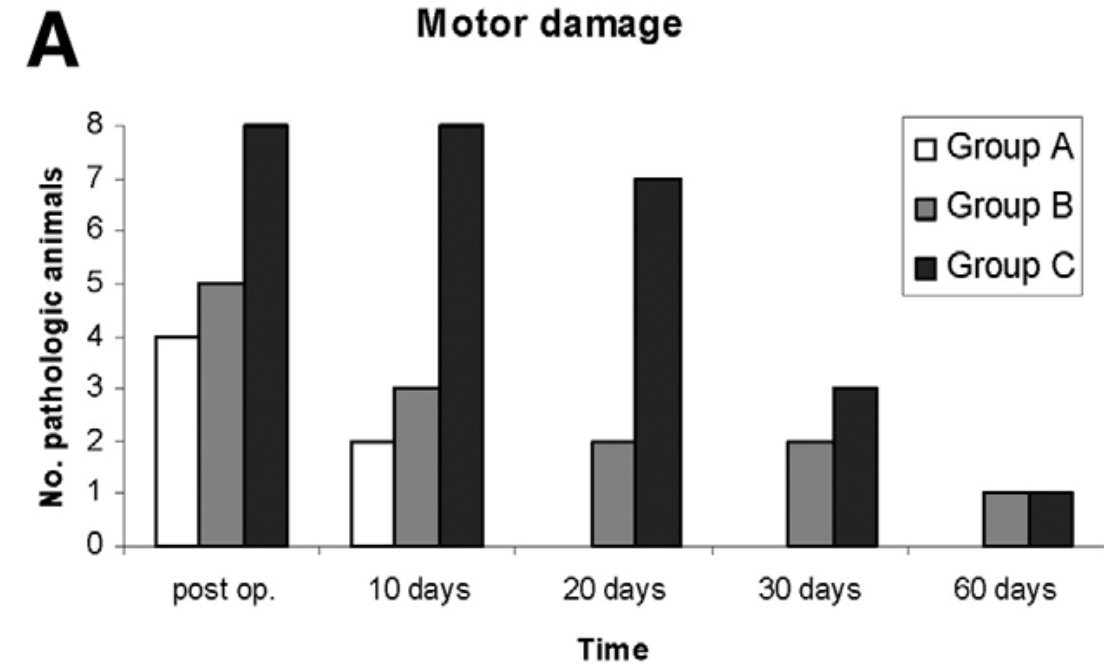
- Motor and sensory nerve function monitored for 150 days
- Histological analysis to assess integrity of the perineurium and axonal damage



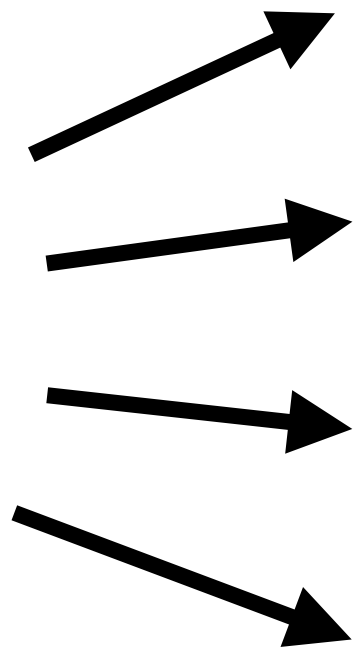
# Advantages of Sonic Surgery

## Selective Cutting Action

- Histologically, no dissection or damage of the perineurium was visible in any of the nerves of groups A, B, or C animals.
- Direct contact of the insert with the nerve did not dissect the nerve although induced some damage.



# Advantages of Sonic Surgery



Precise Osteotomy

Selective Cutting Action

Schaeren et al. 2005

Improved Bone Healing

Cavitation Effect

# Advantages of Sonic Surgery

## Improved Bone Healing

- Animal Model: Female Hound (4), periodontal defect created (mandibular P1 to P4 and M1), removing 4mm of crestal bone.
- Teeth randomly assigned to one of three groups: piezosurgery (PS), carbide bur (CB), diamond bur (DB).
- Notch placed on the root surface at the post-surgical crest level.

# Advantages of Sonic Surgery

## Improved Bone Healing

- Histometrical analysis evaluating bone gain/loss from notch to crest

# Advantages of Sonic Surgery

## Improved Bone Healing

- PS provided more favorable osseous repair and remodeling than CB or DB
- Limitations of the study

Healing time (d)	Instrument		
	CB	DB	PS
0	0.00	0.00	0.00
14	-0.21	-0.03	0.03
28	0.24	0.09	0.21
56	-0.37	-0.83*	0.45*

# Advantages of Sonic Surgery



Precise Osteotomy

Selective Cutting Action

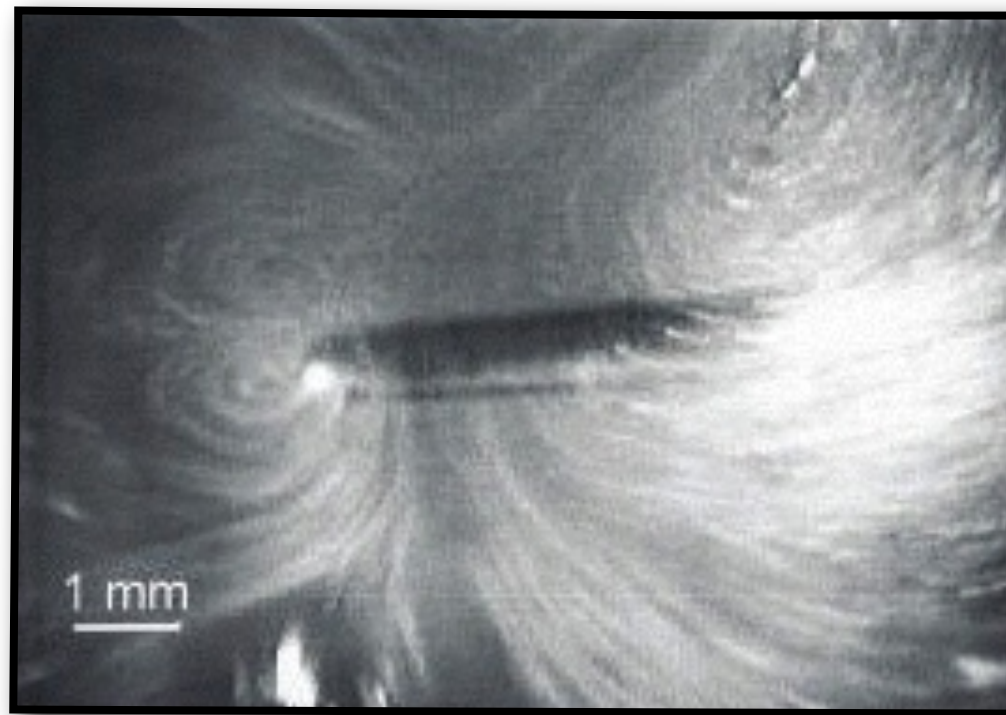
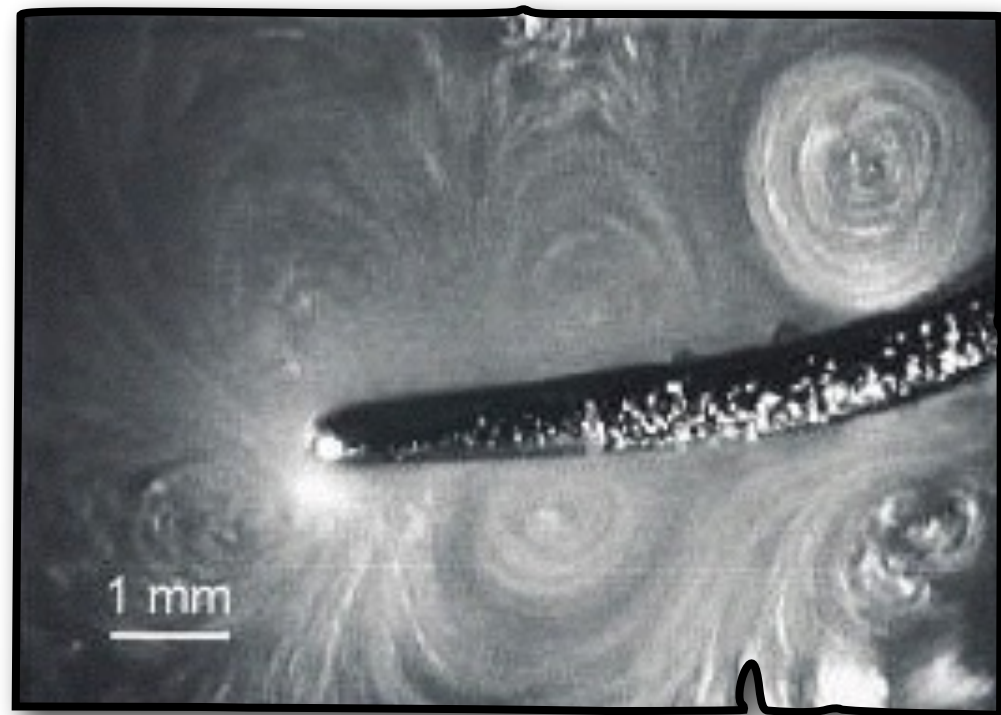
Schaeren et al. 2005

Improved Bone Healing

Vercellotti et al. 2005

Cavitation Effect

# Advantages of Sonic Surgery



**Cavitation Effect**



# Clinical Applications

- ☑ Atraumatic extraction
- ☑ Sinus lift
- ☑ Edentulous Ridge Expansion (ERE)
- ☑ Wisdom tooth extraction
- ☑ Block or Chip bone graft harvesting
- ☑ Corticotomy (Wilcodontics)
- ☑ Tori Removal

# Clinical Applications

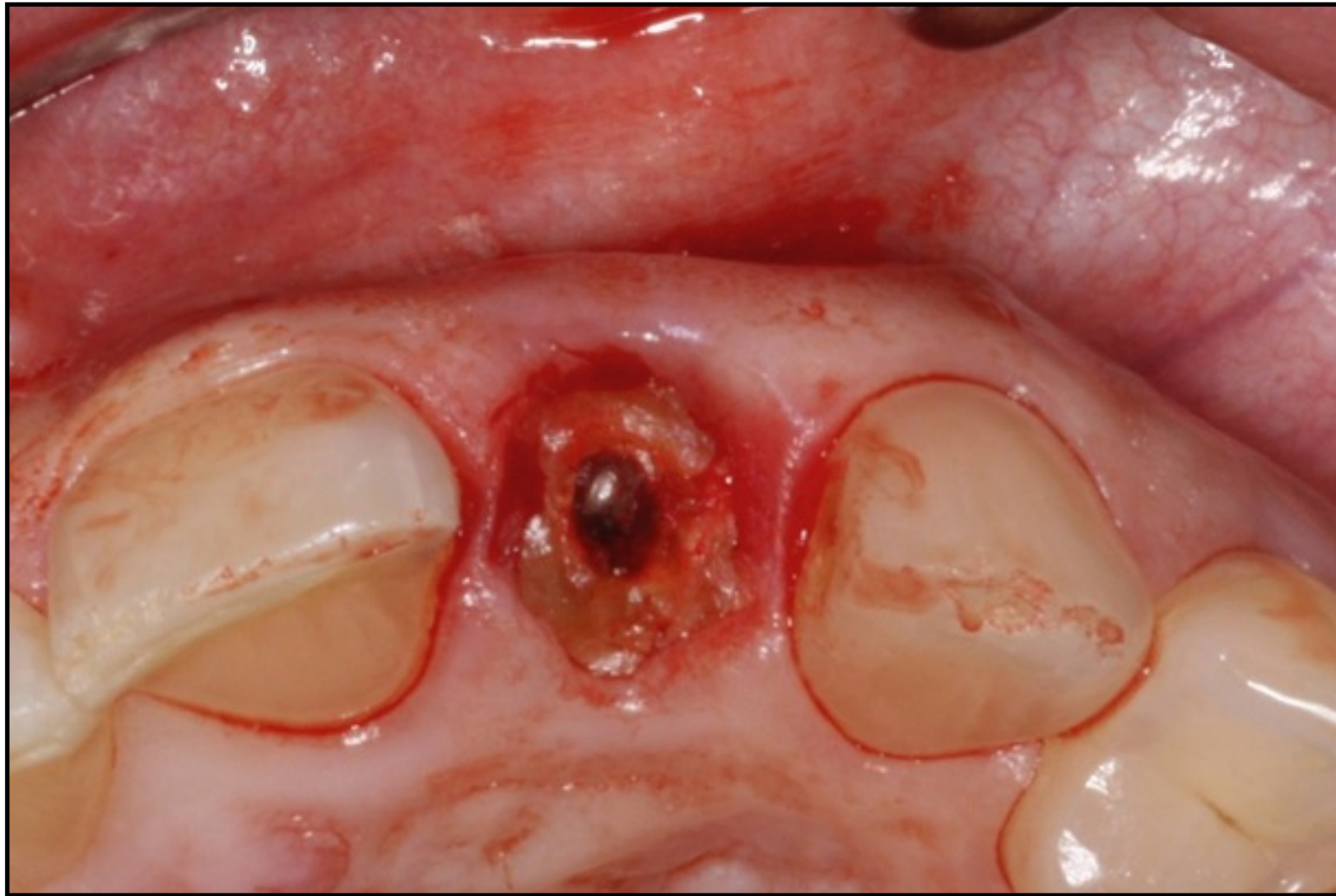
Atraumatic Extraction





# Clinical Applications

Atraumatic Extraction



# Clinical Applications

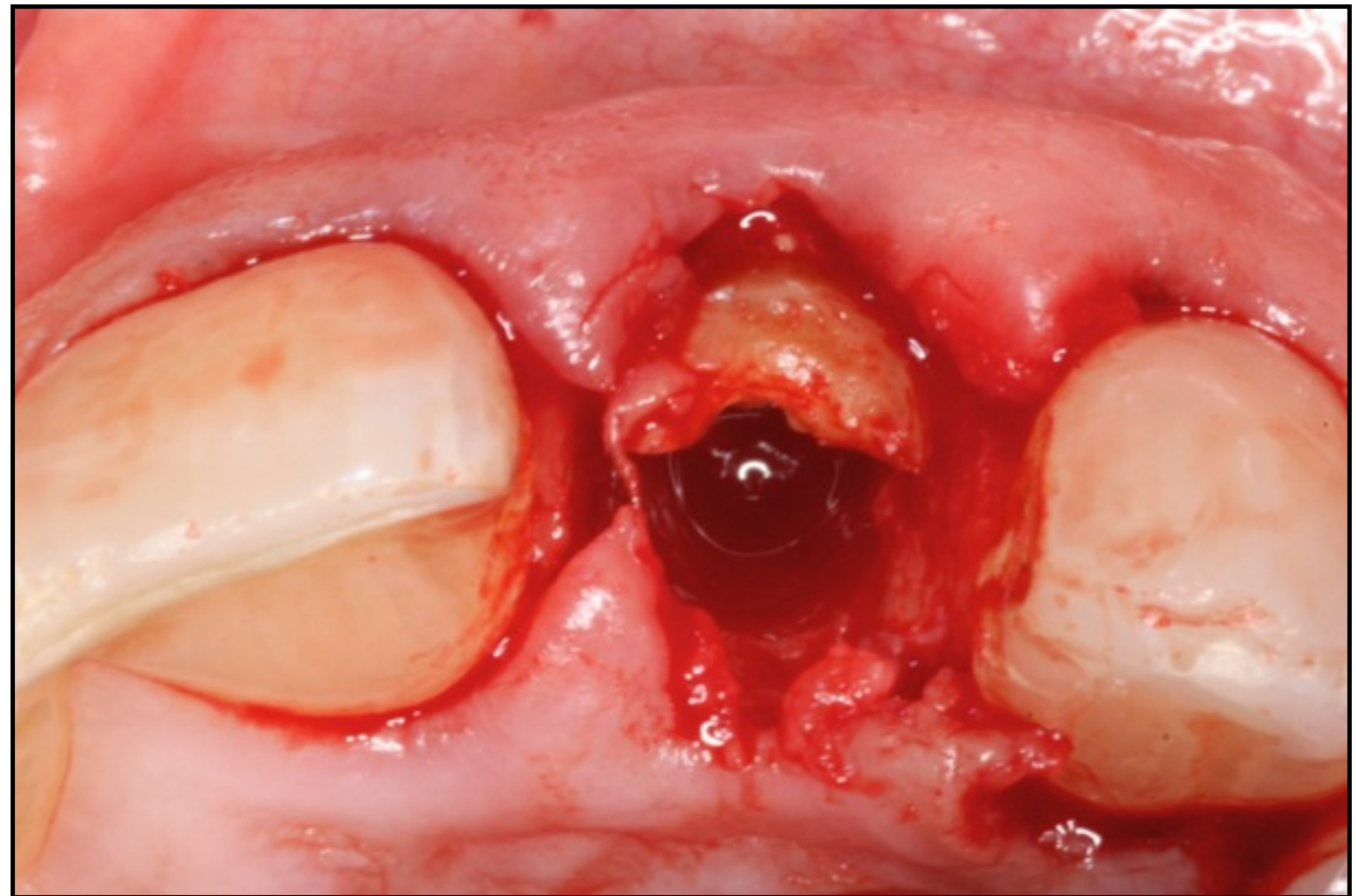
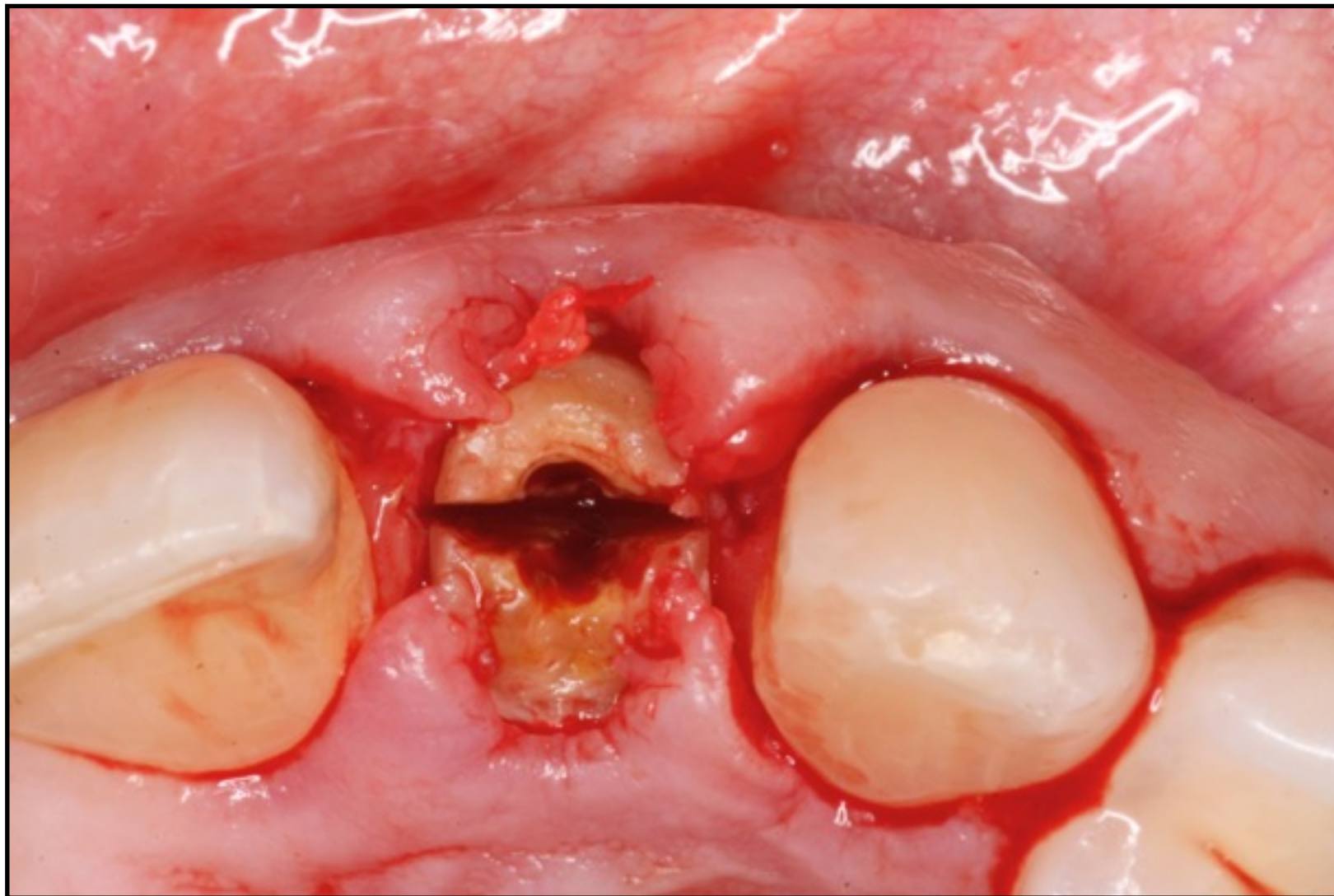
Atraumatic Extraction





# Clinical Applications

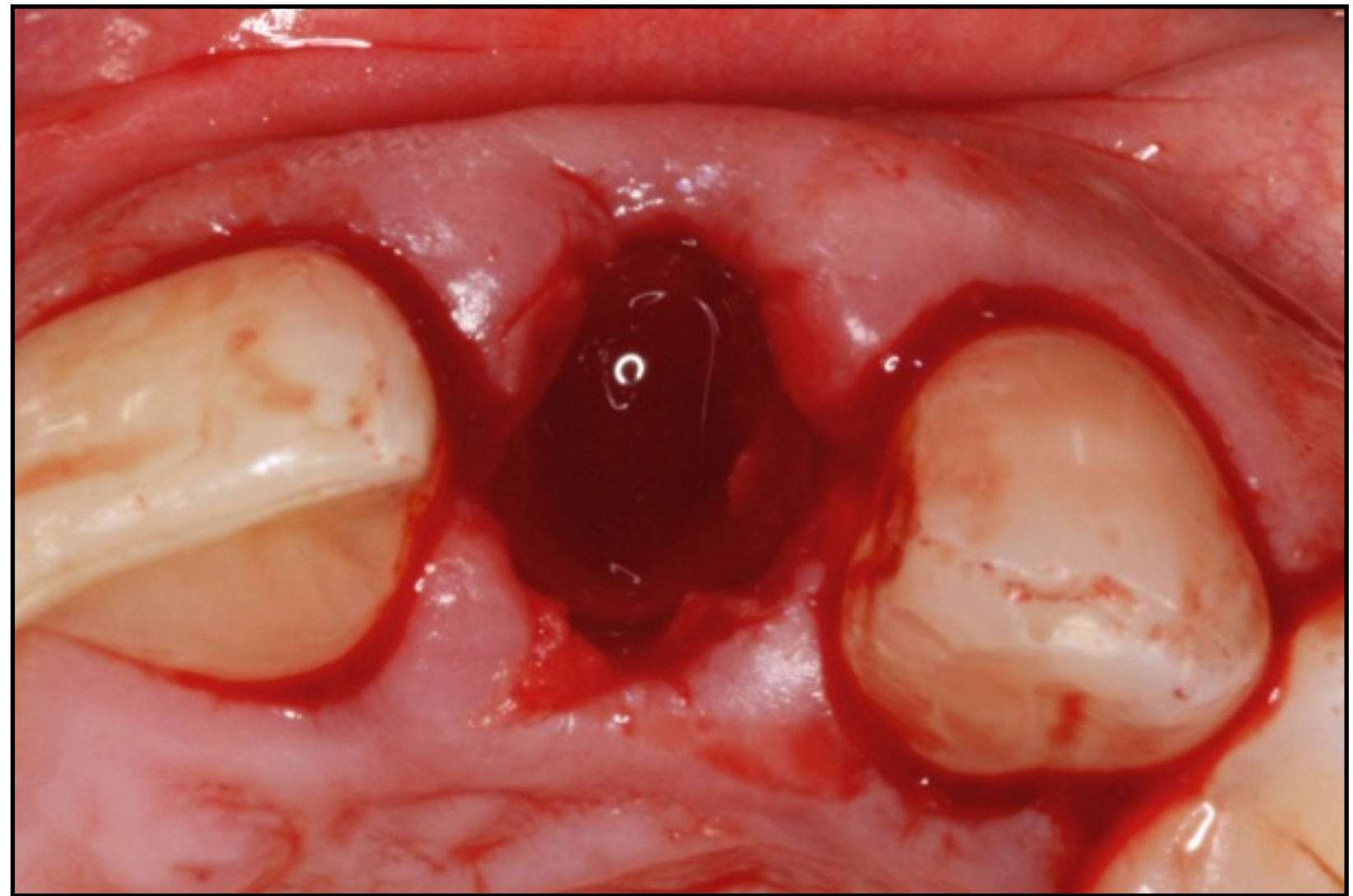
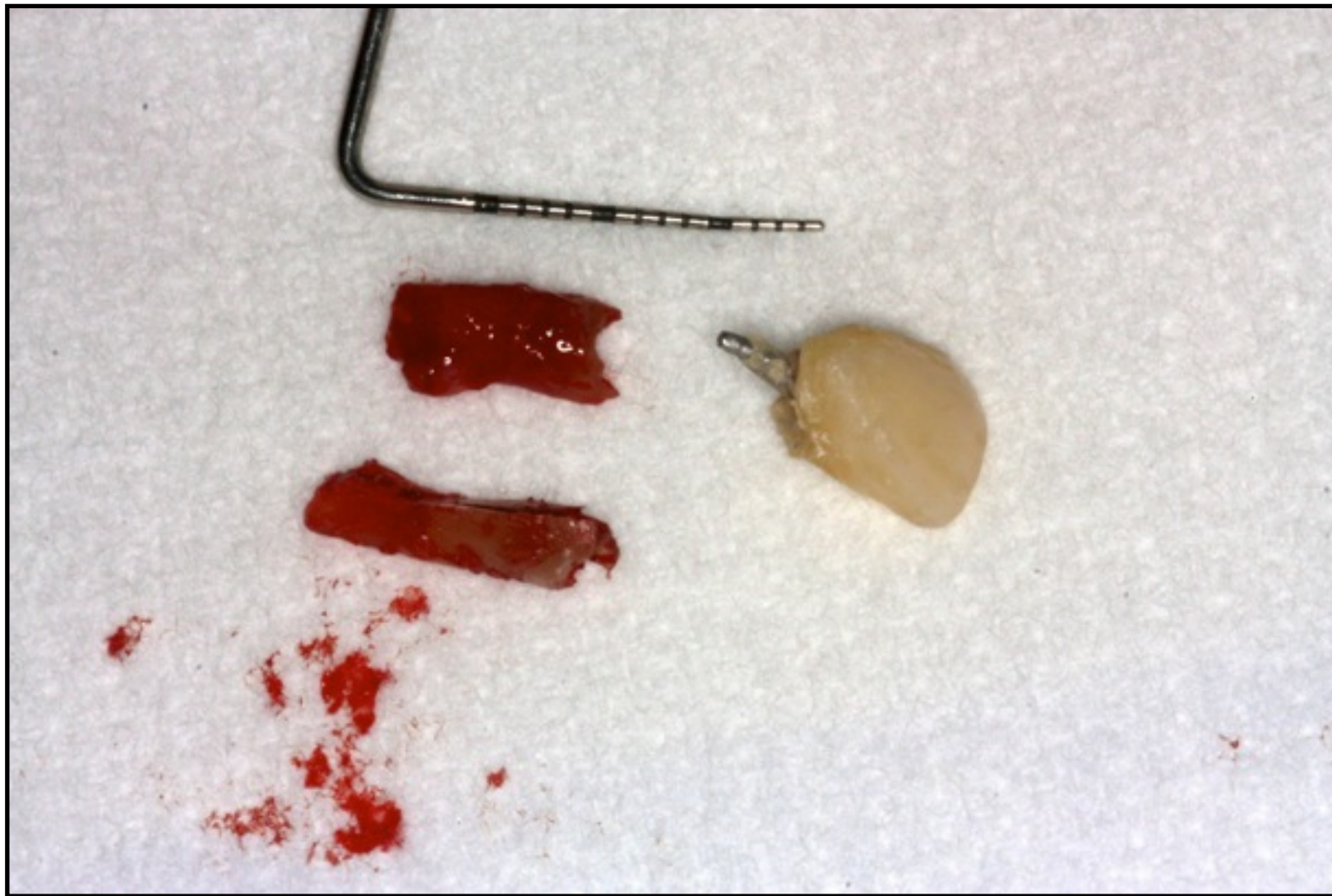
Atraumatic Extraction





# Clinical Applications

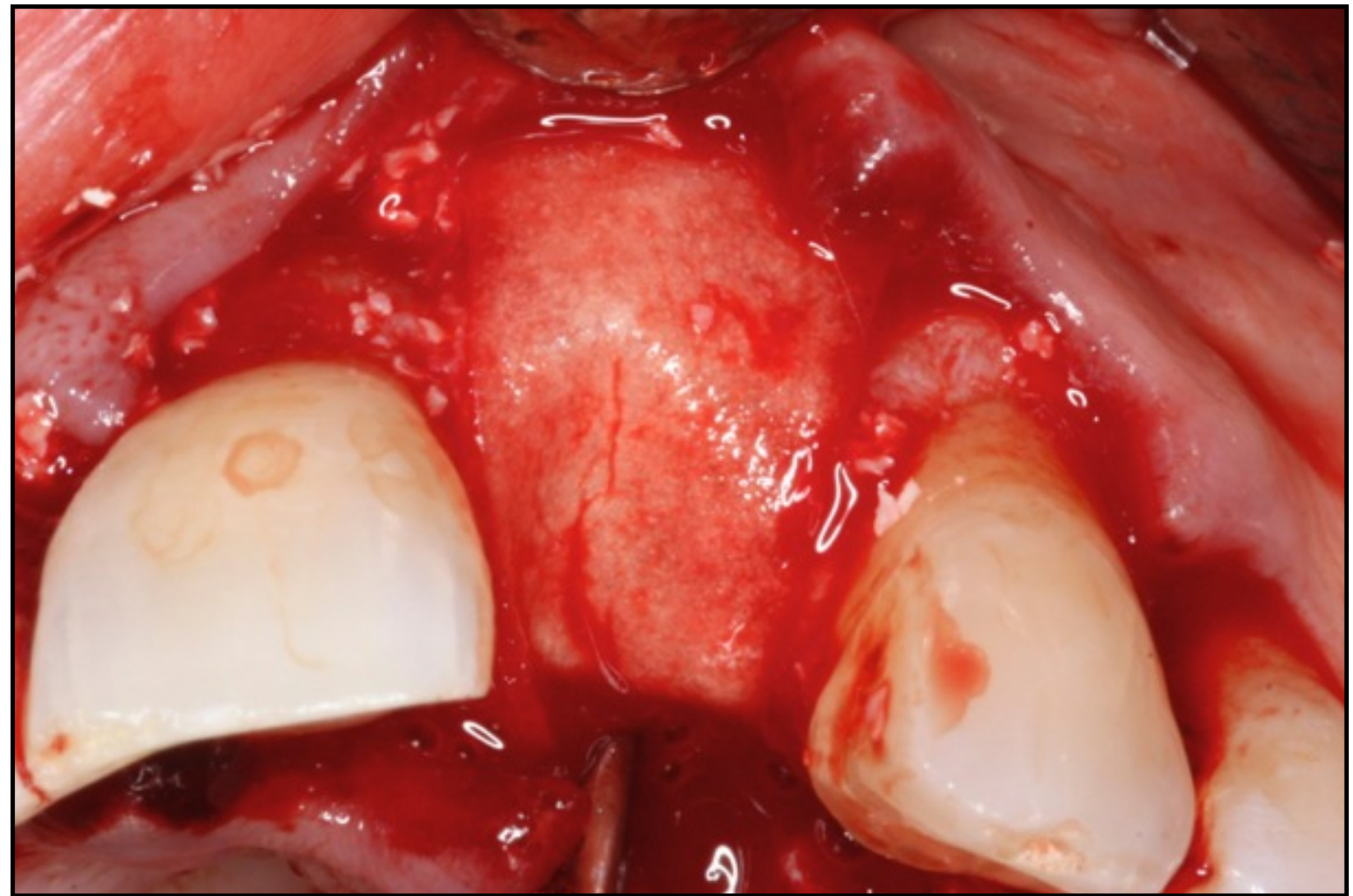
Atraumatic Extraction





# Clinical Applications

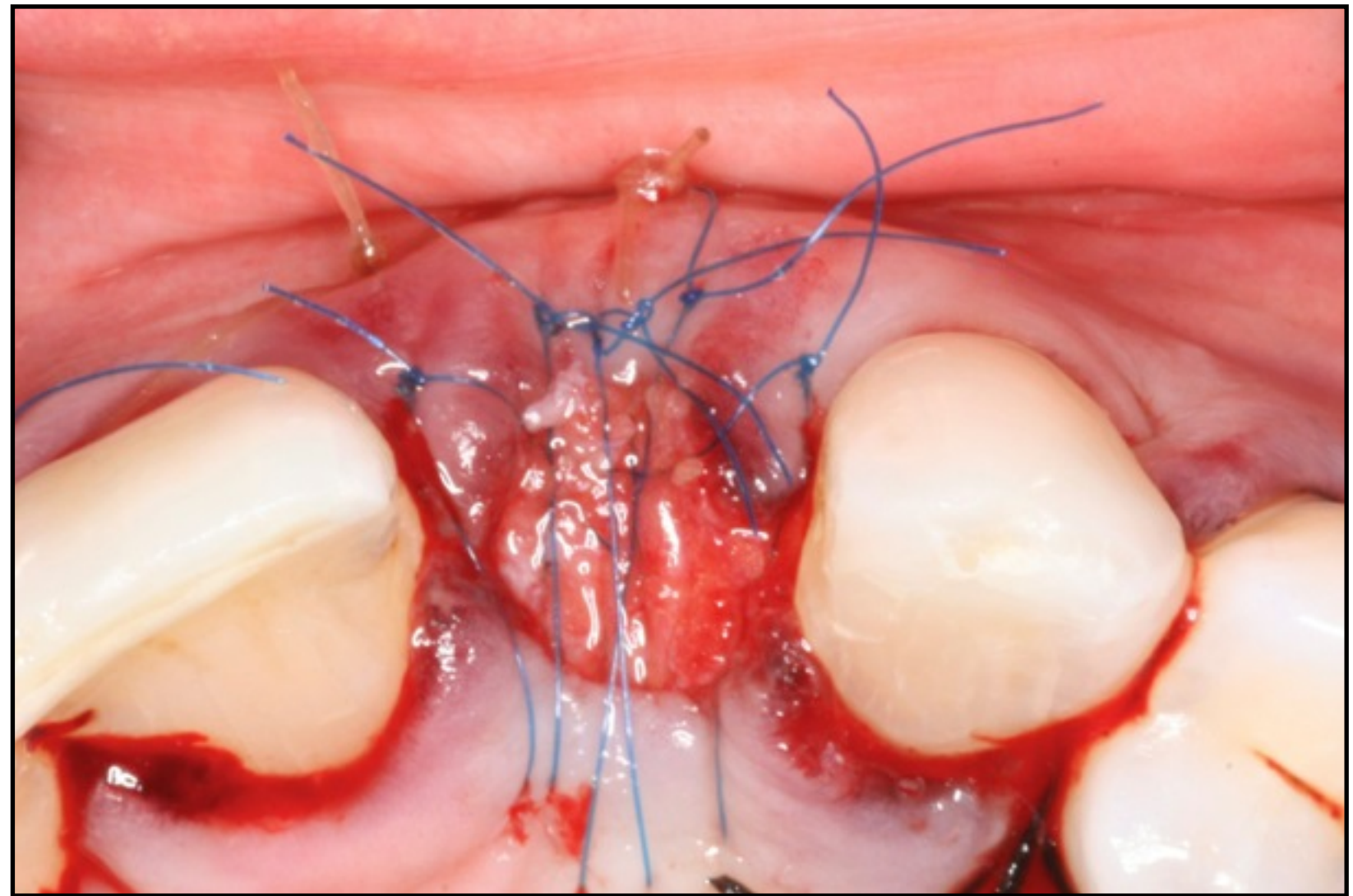
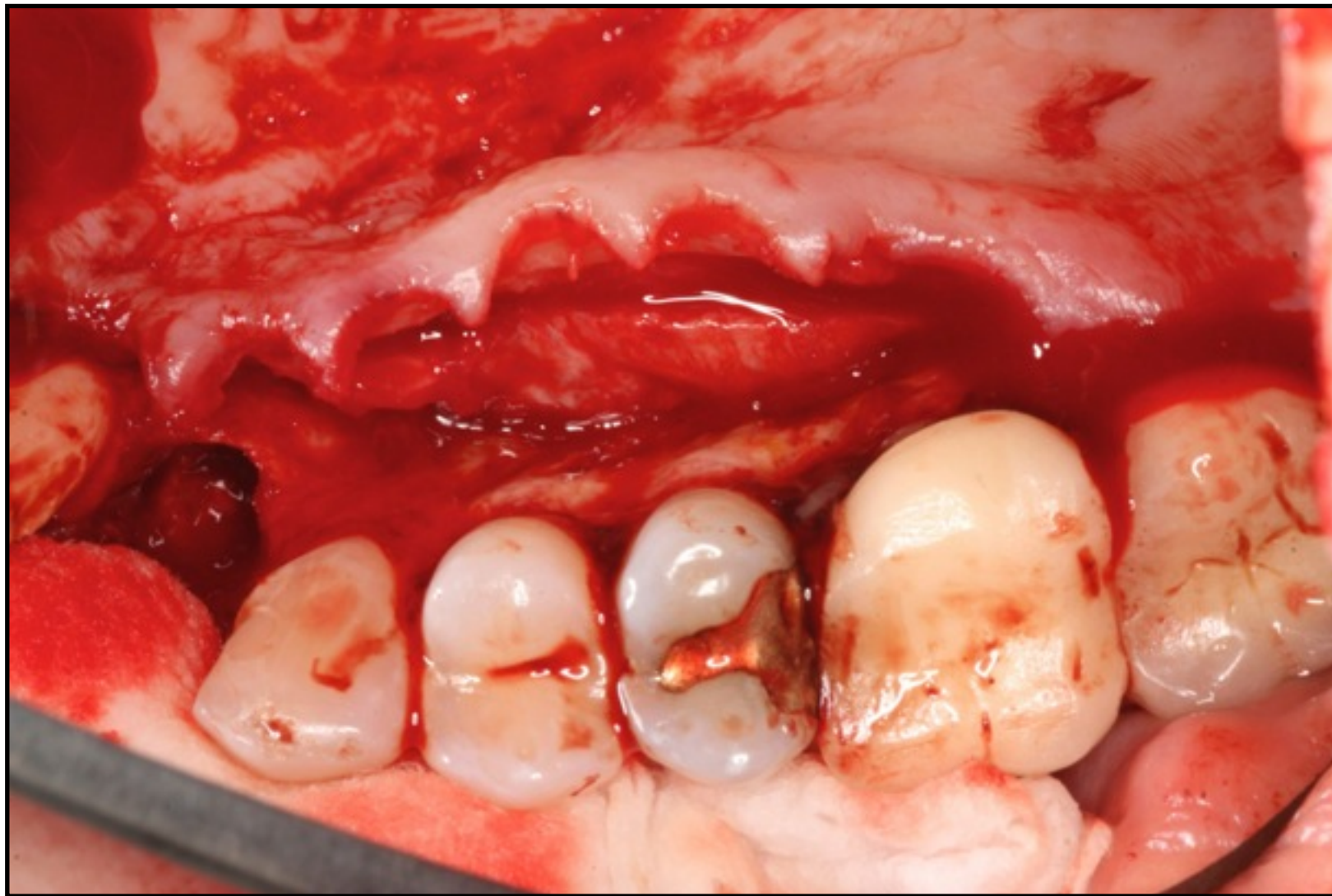
Atraumatic Extraction





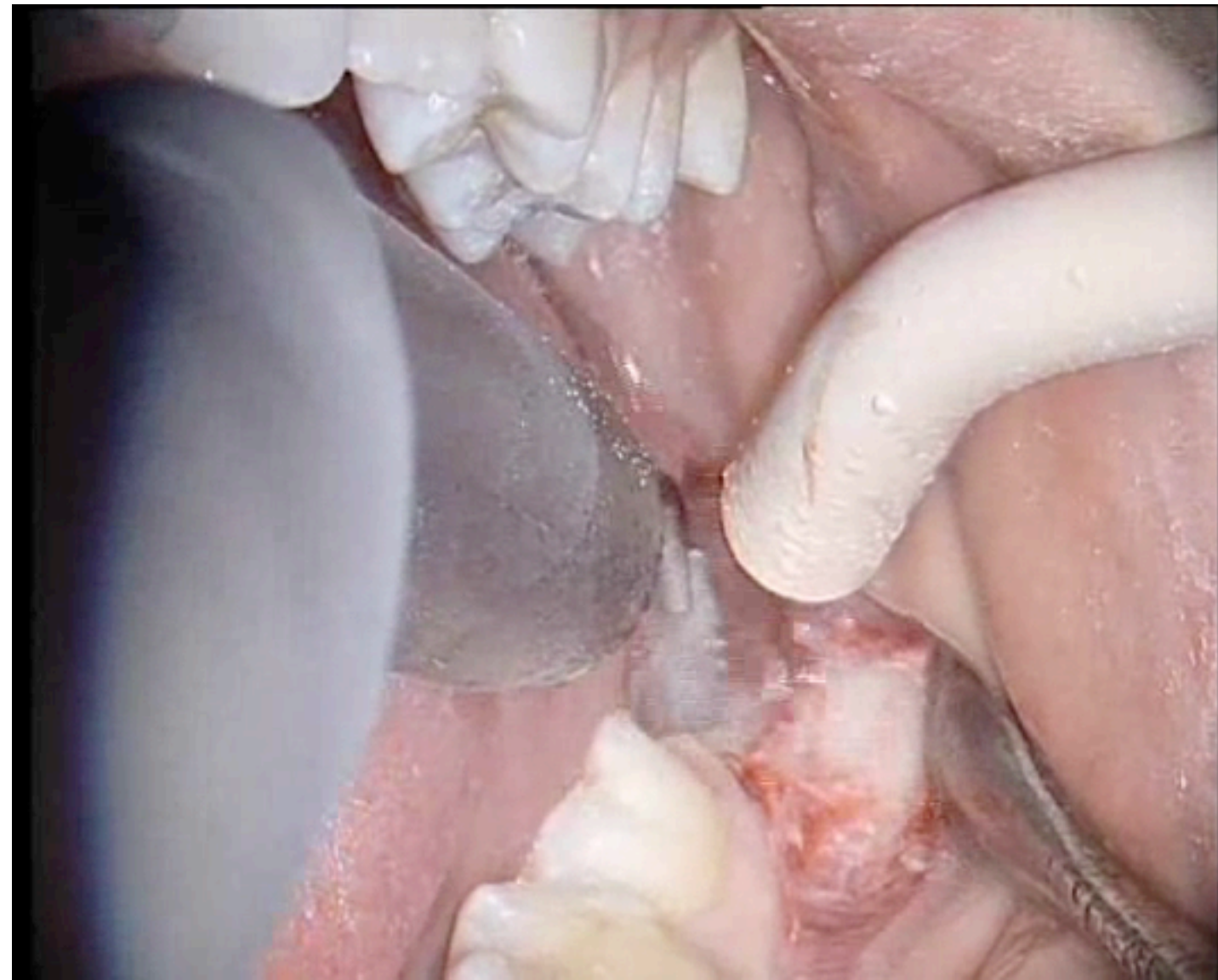
# Clinical Applications

Atraumatic Extraction



# Clinical Applications

Atraumatic Extraction





# Clinical Applications

Extraction & Immediate Implant

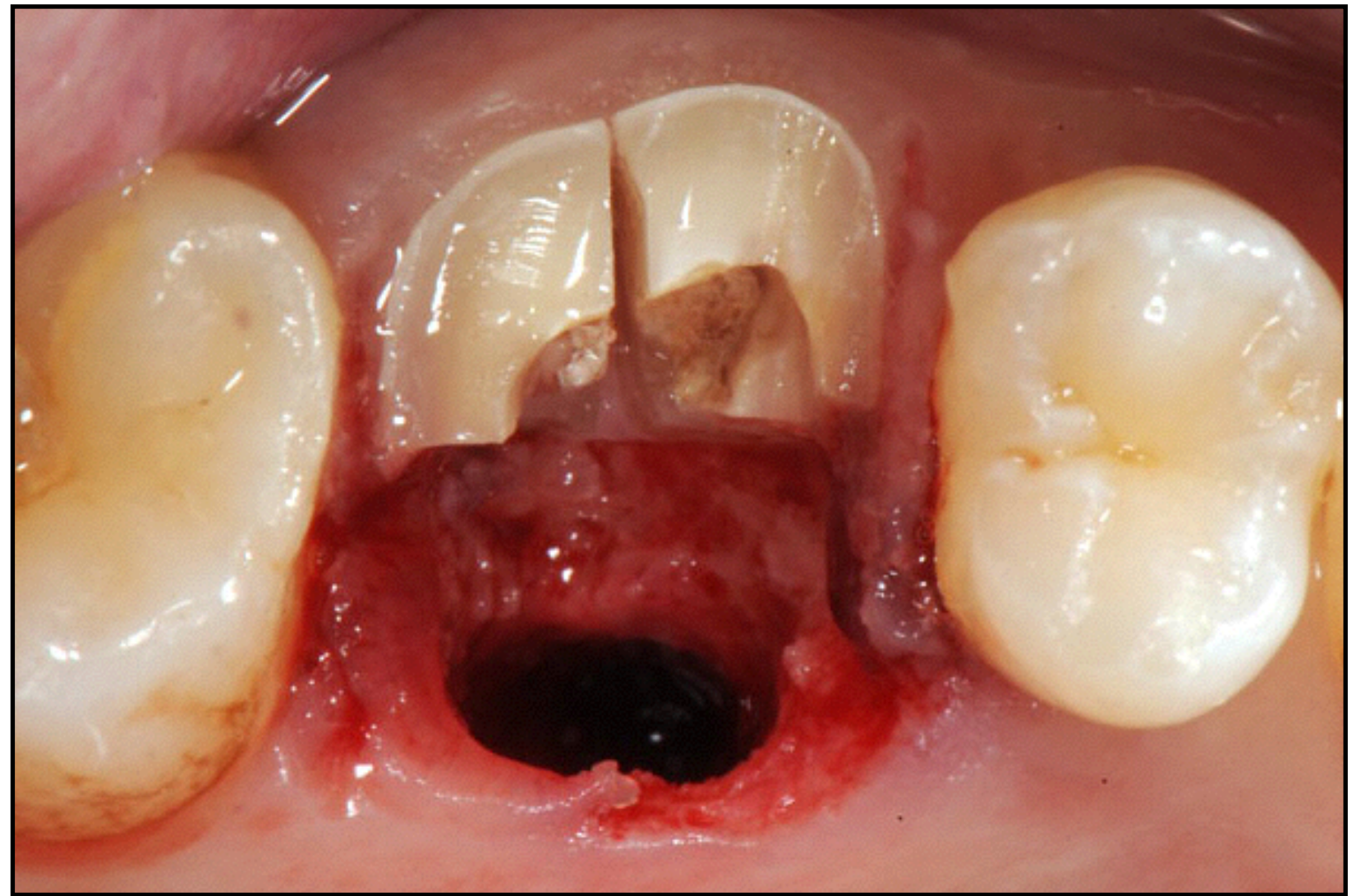
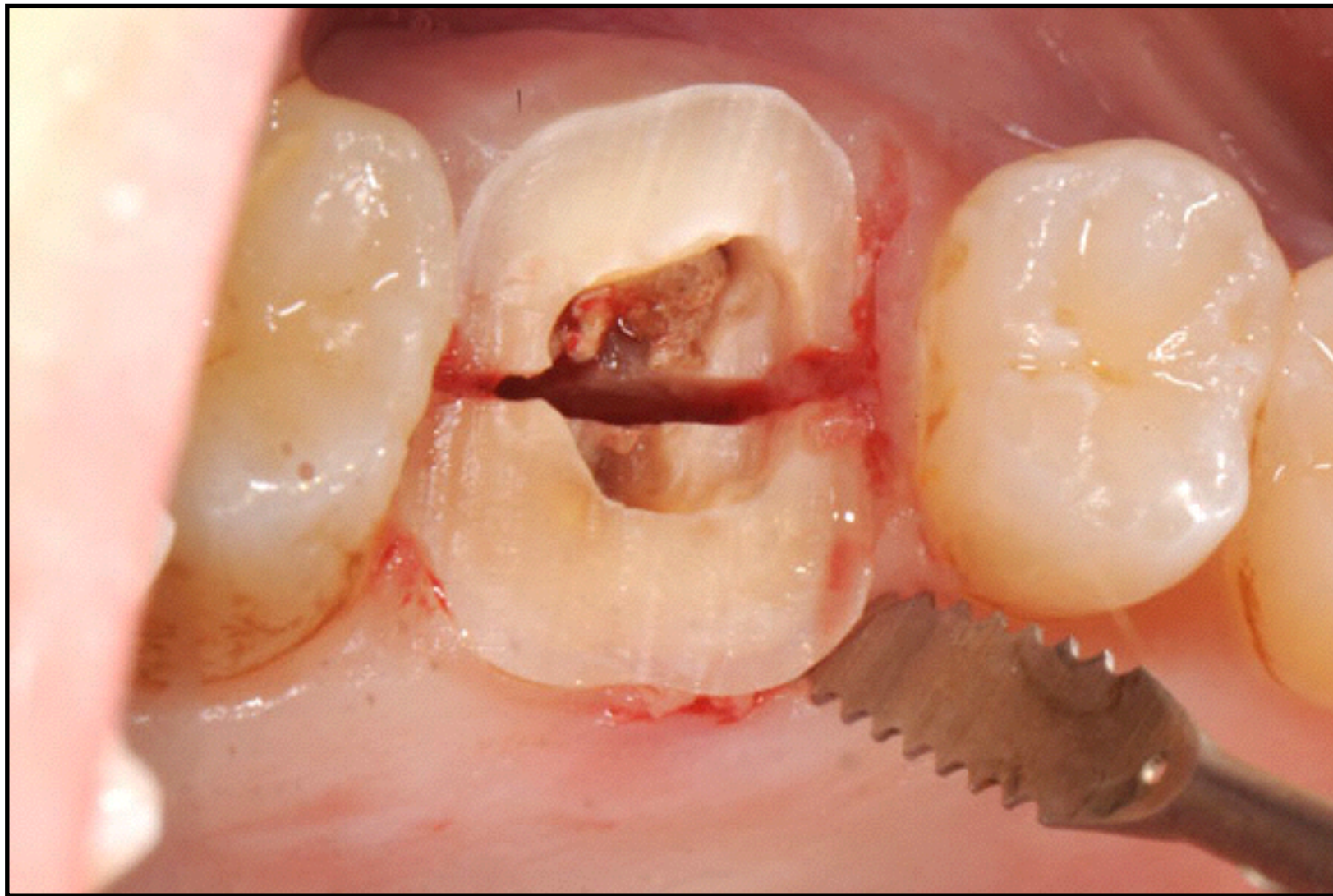


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# Clinical Applications

Extraction & Immediate Implant

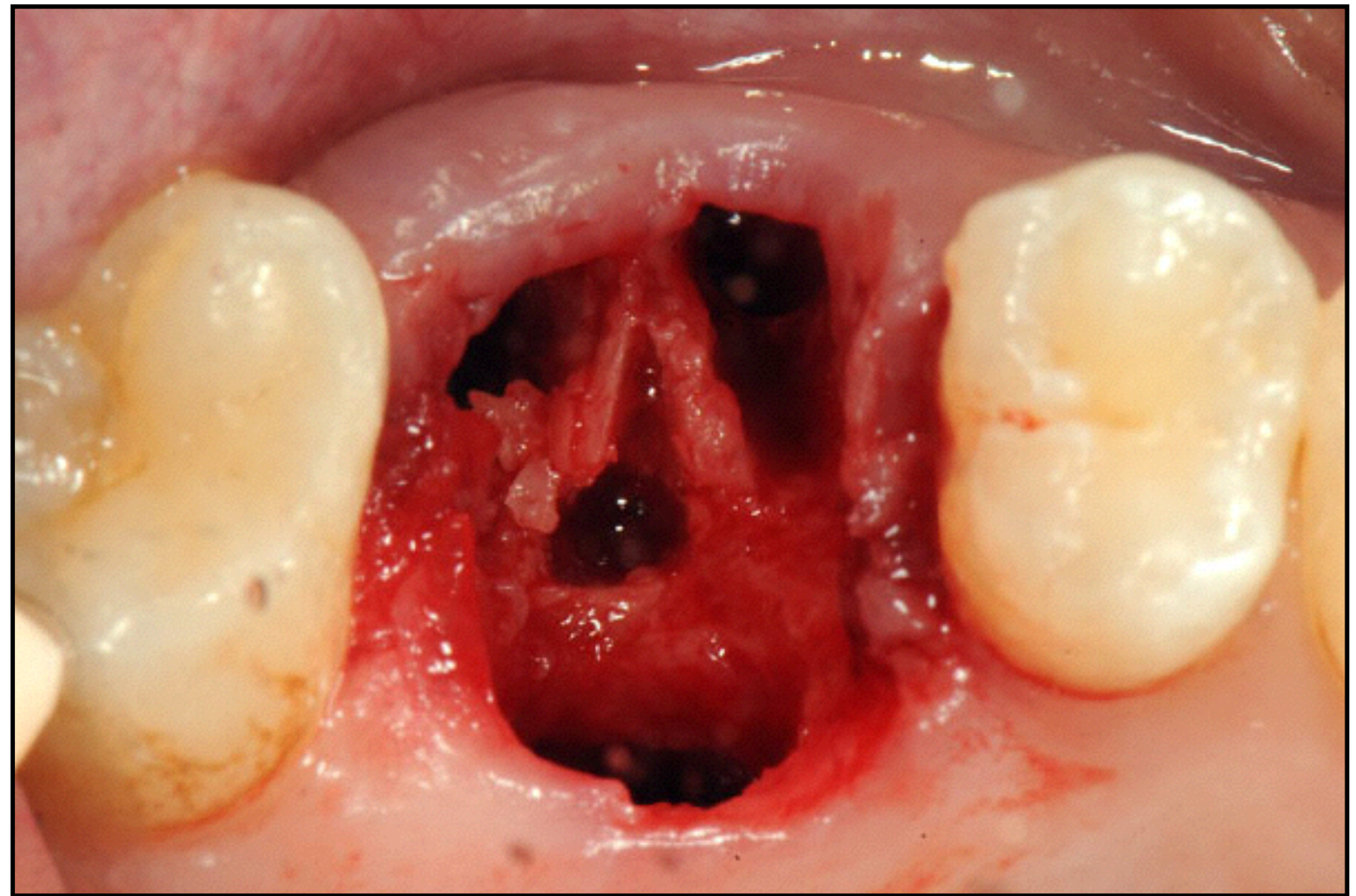
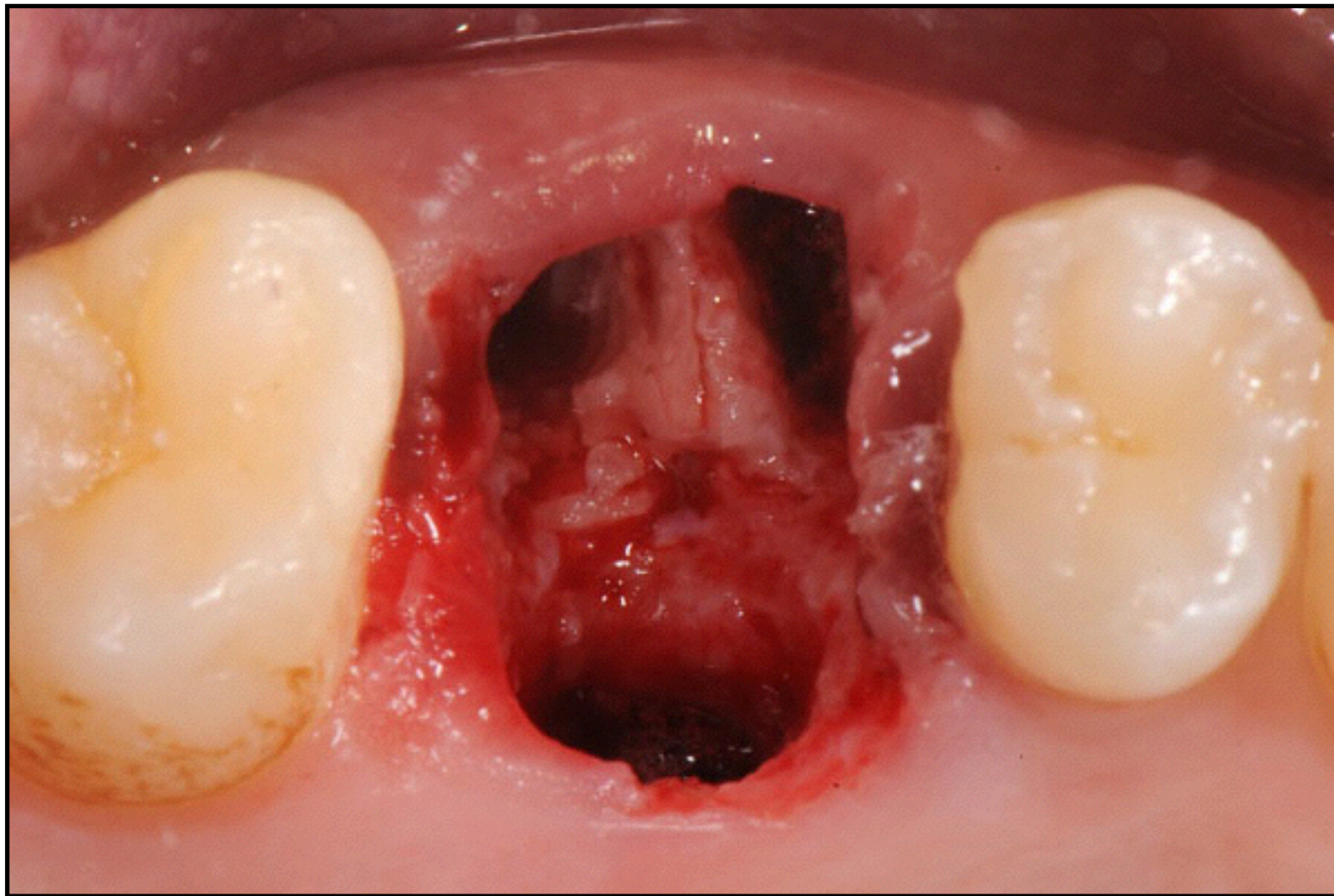


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# Clinical Applications

Extraction & Immediate Implant



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# Clinical Applications

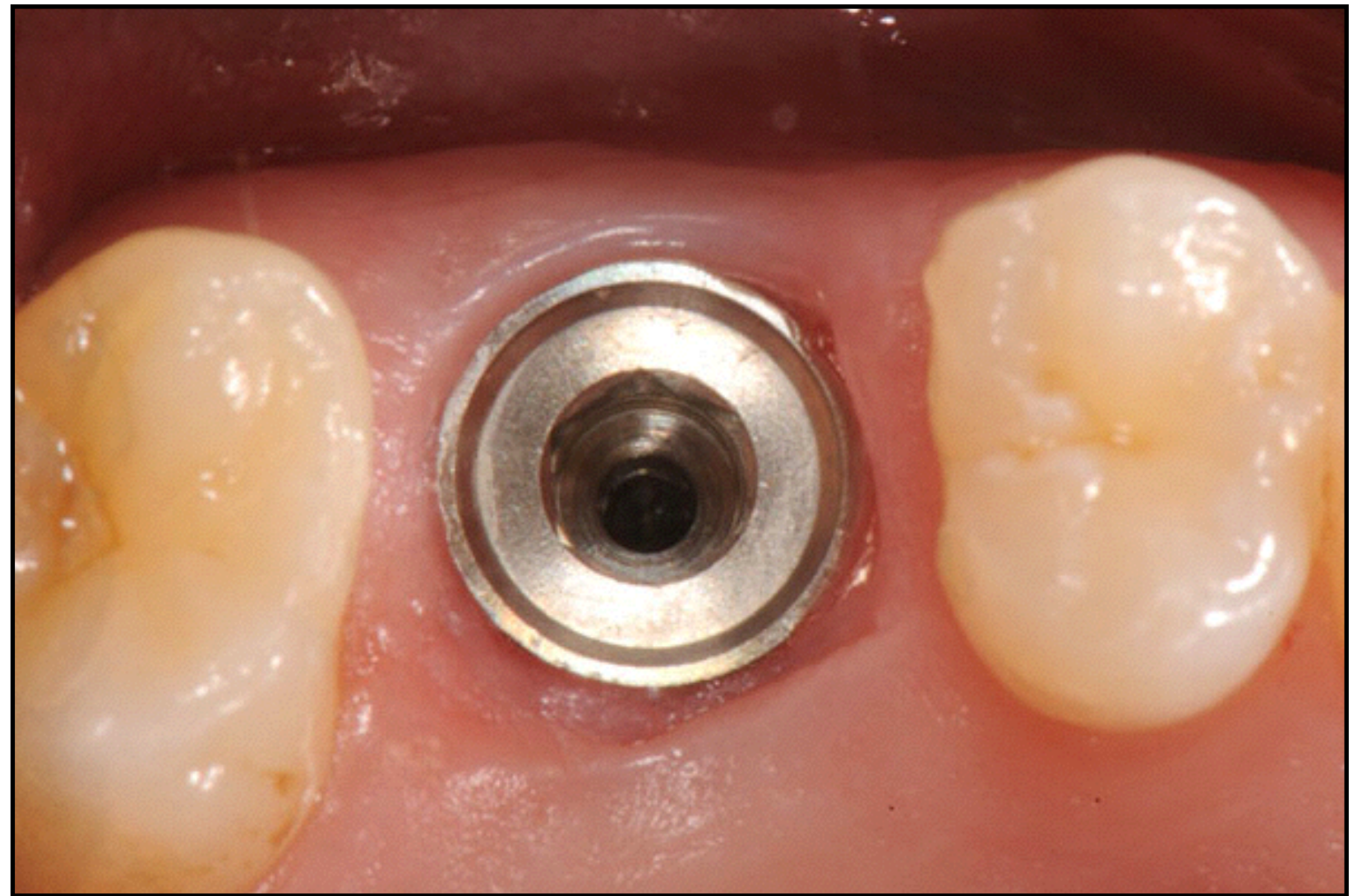
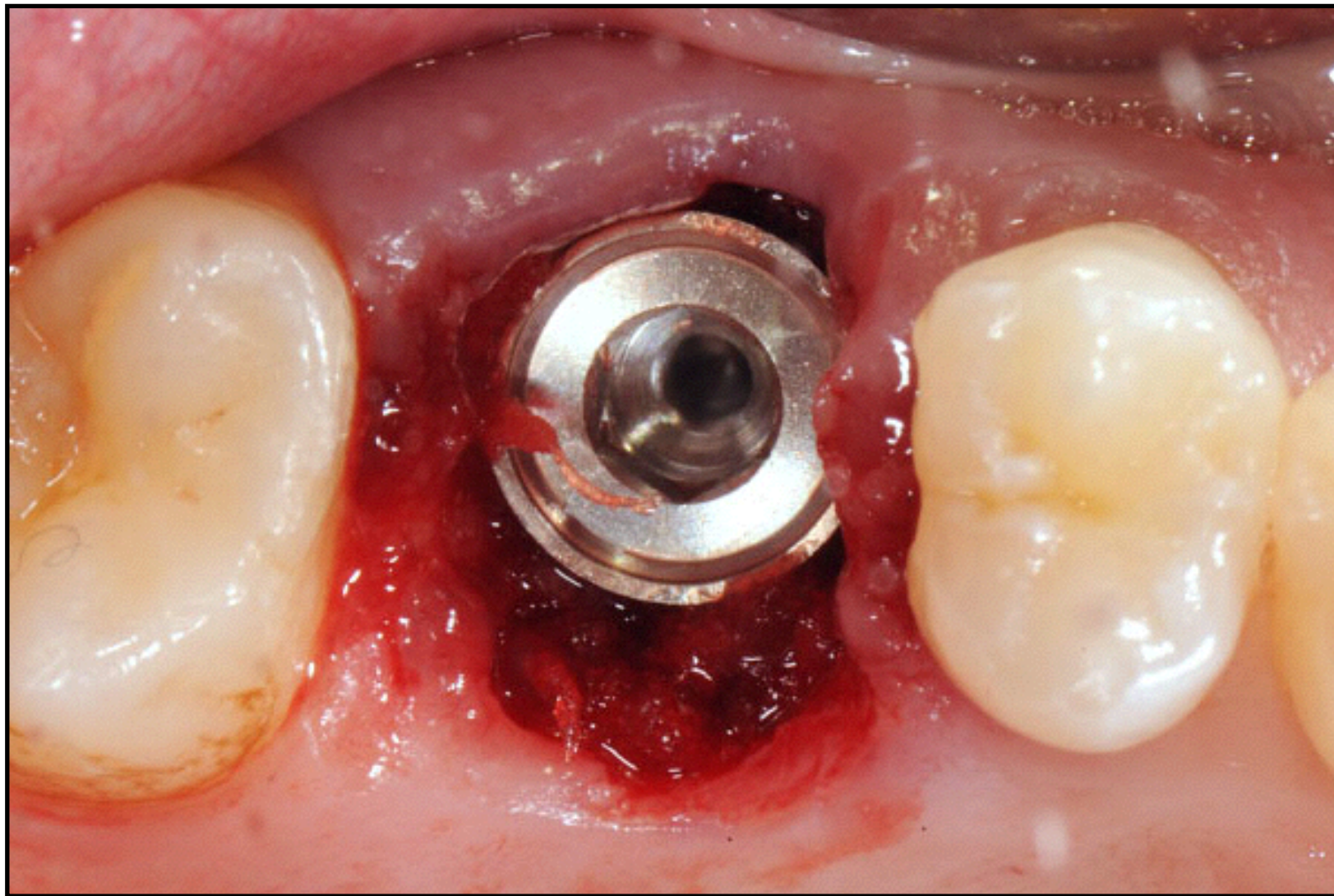
Atraumatic Extraction





# Clinical Applications

Extraction & Immediate Implant



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# Clinical Applications

Extraction & Immediate Implant

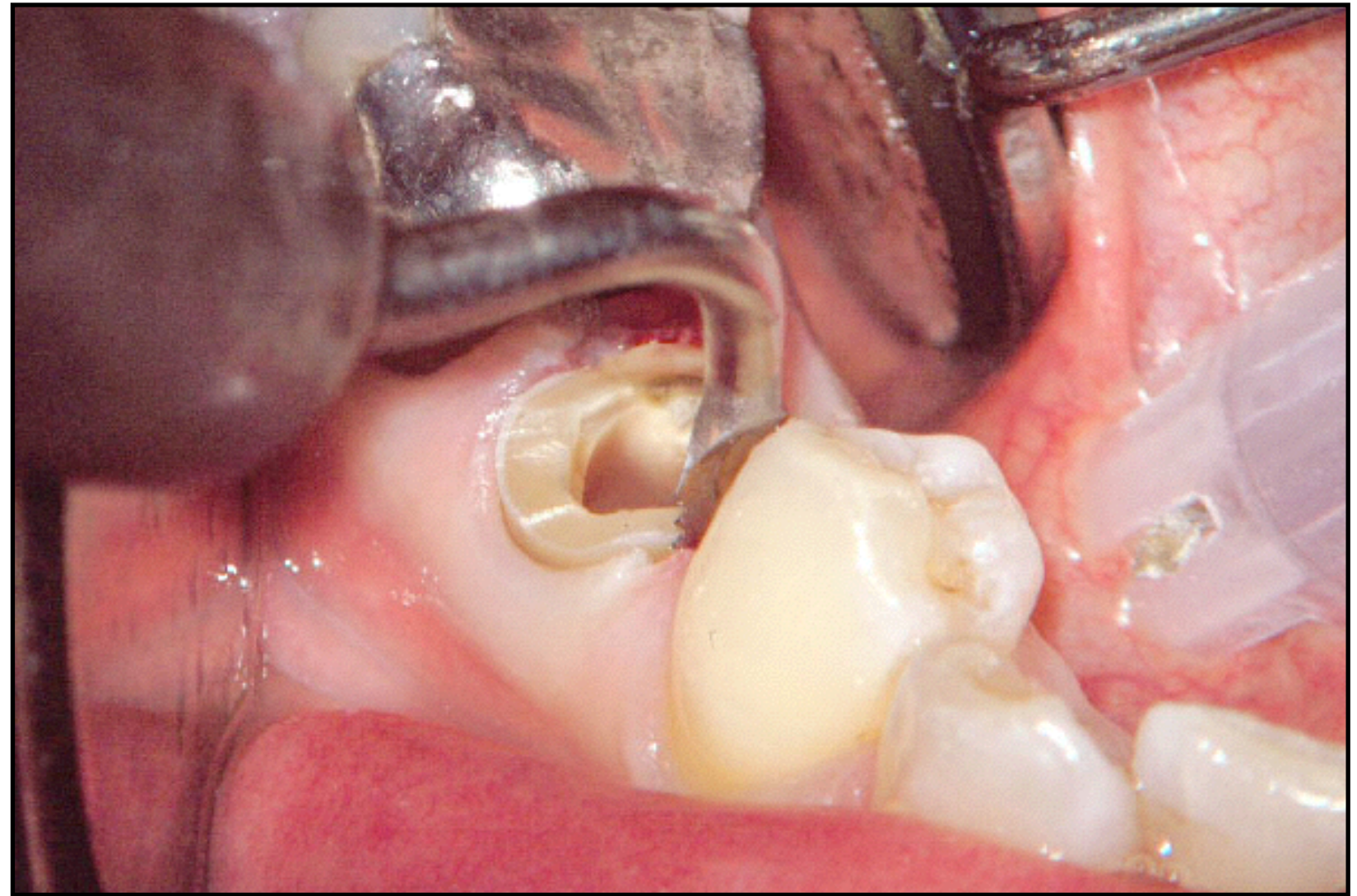
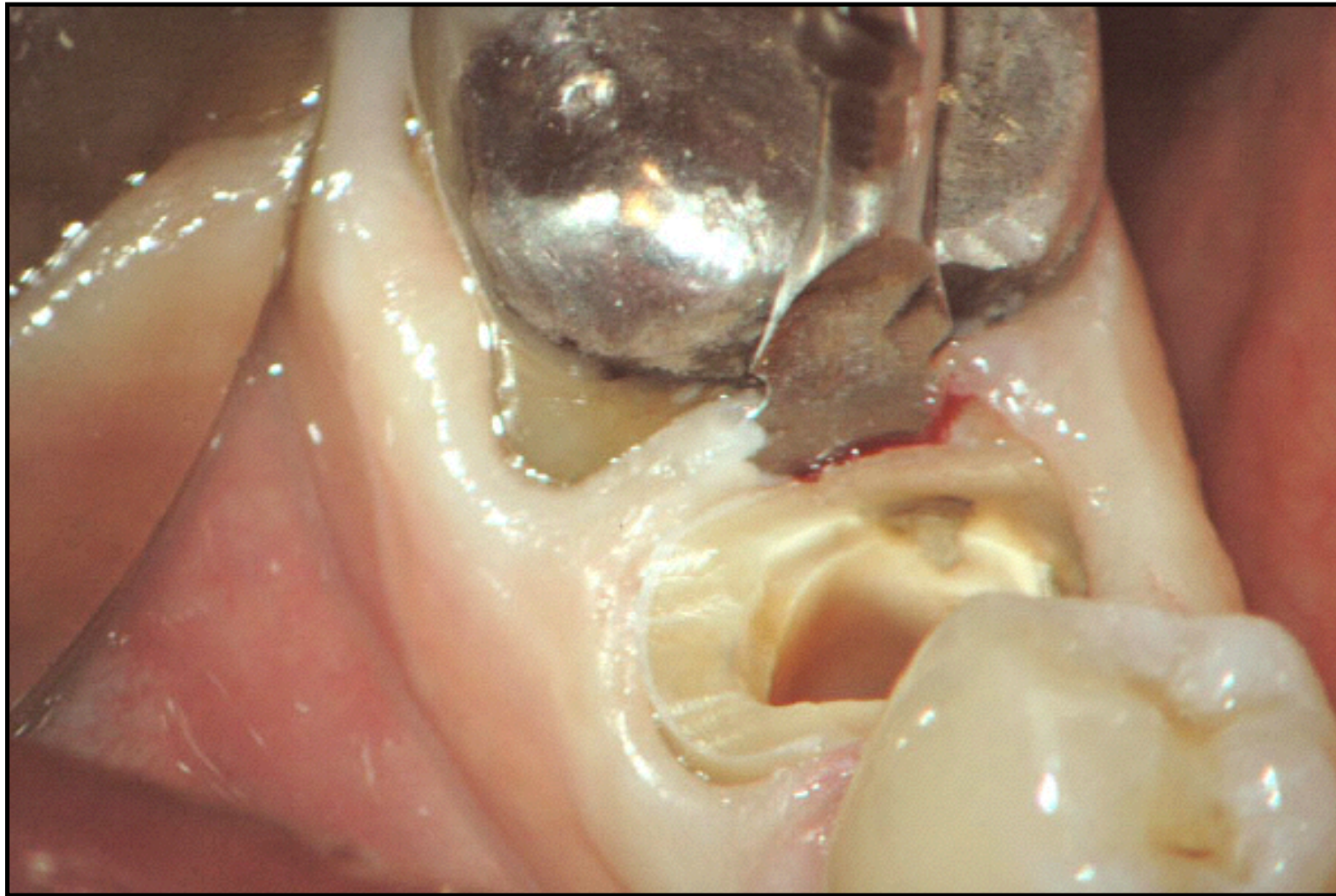


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# Clinical Applications

Extraction & Immediate Implant

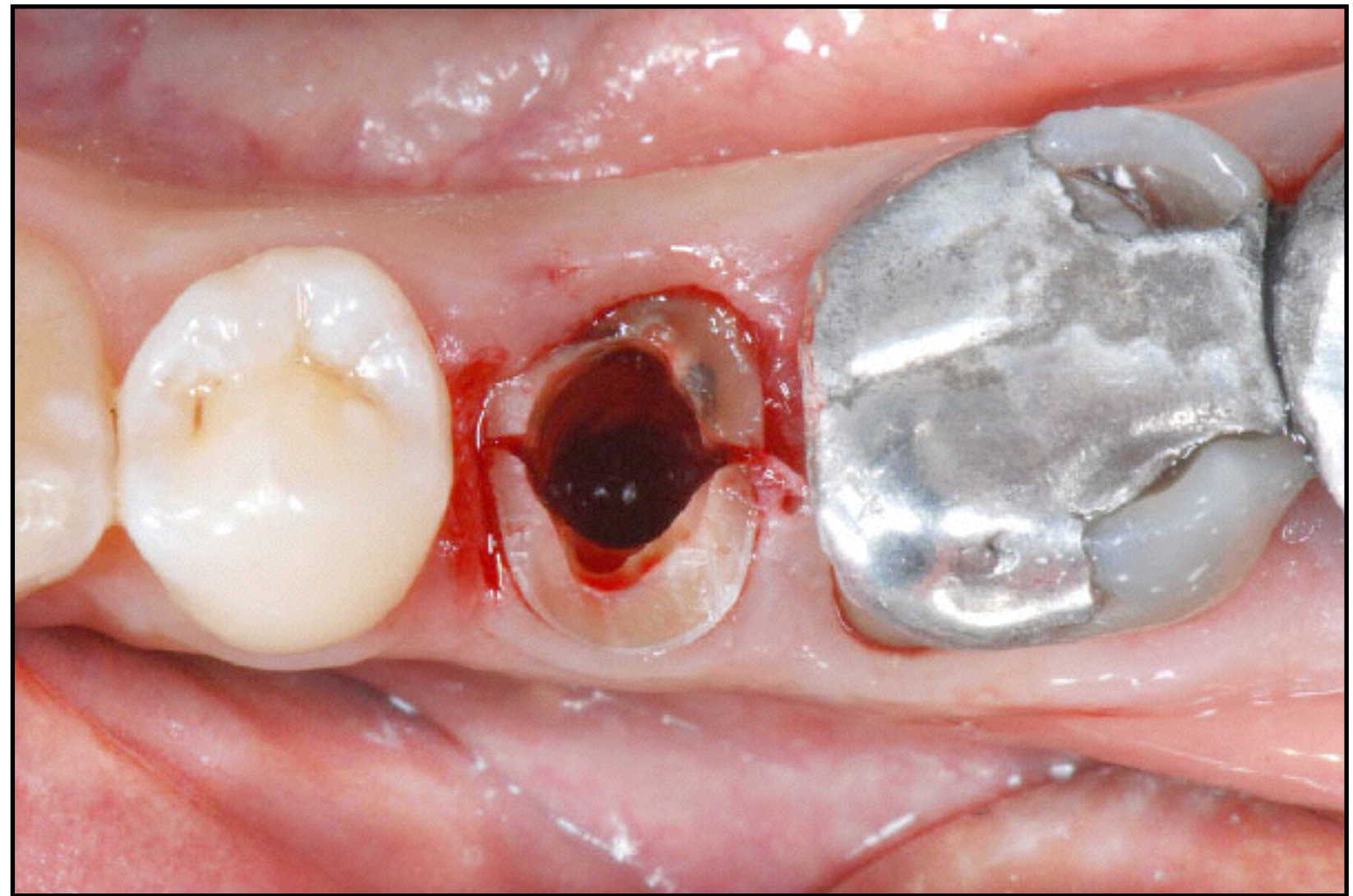
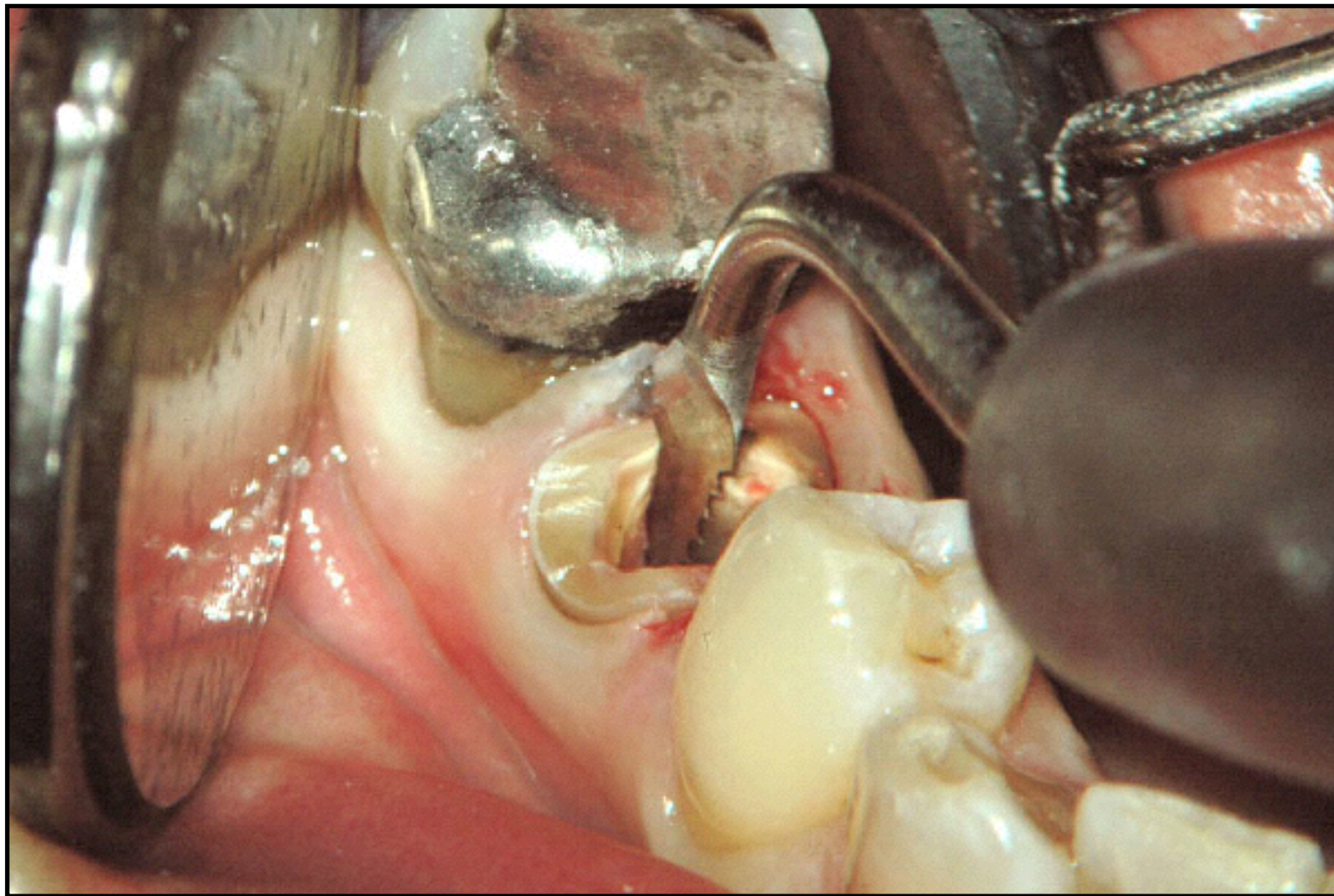


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# Clinical Applications

Extraction & Immediate Implant

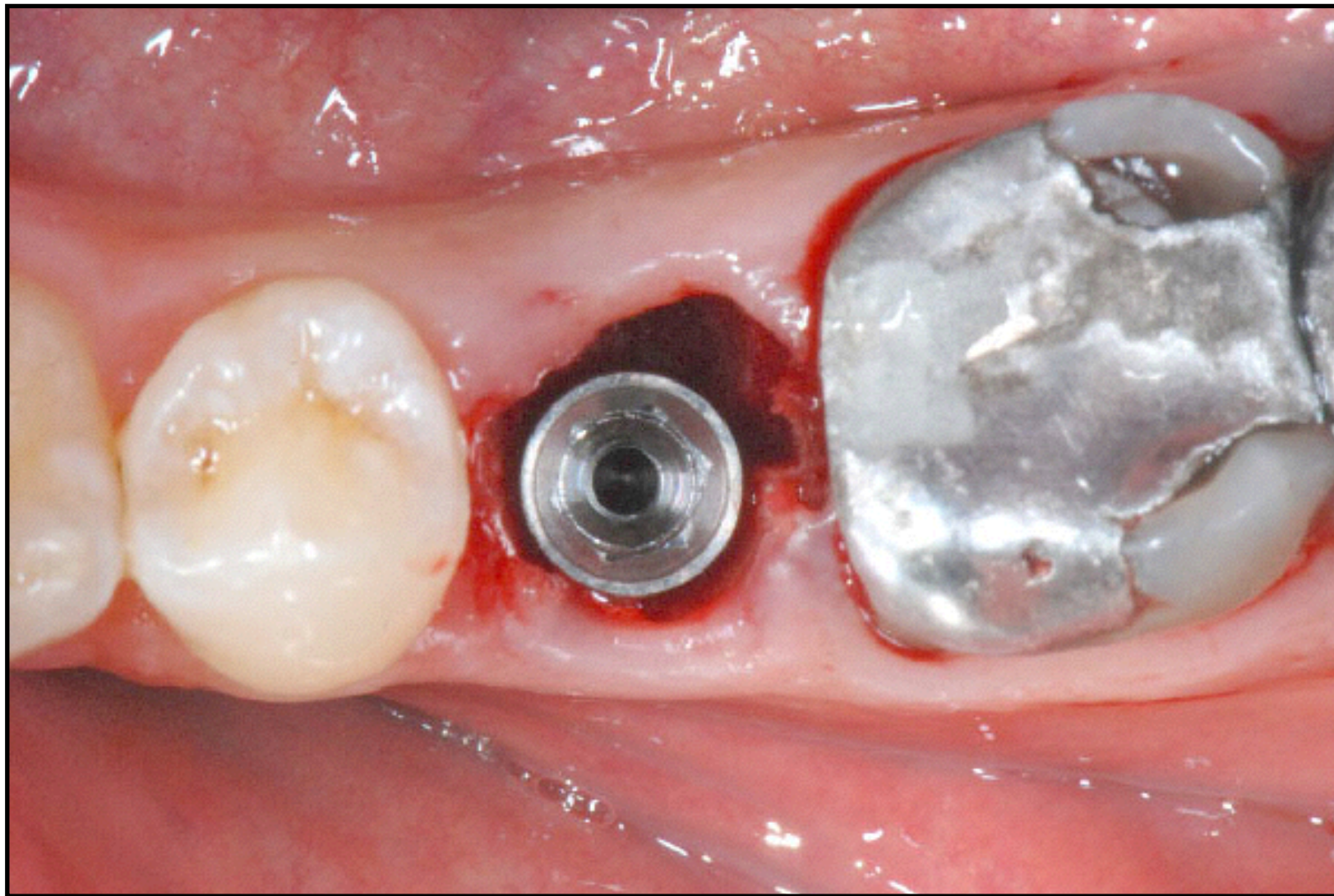


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# Clinical Applications

Extraction & Immediate Implant

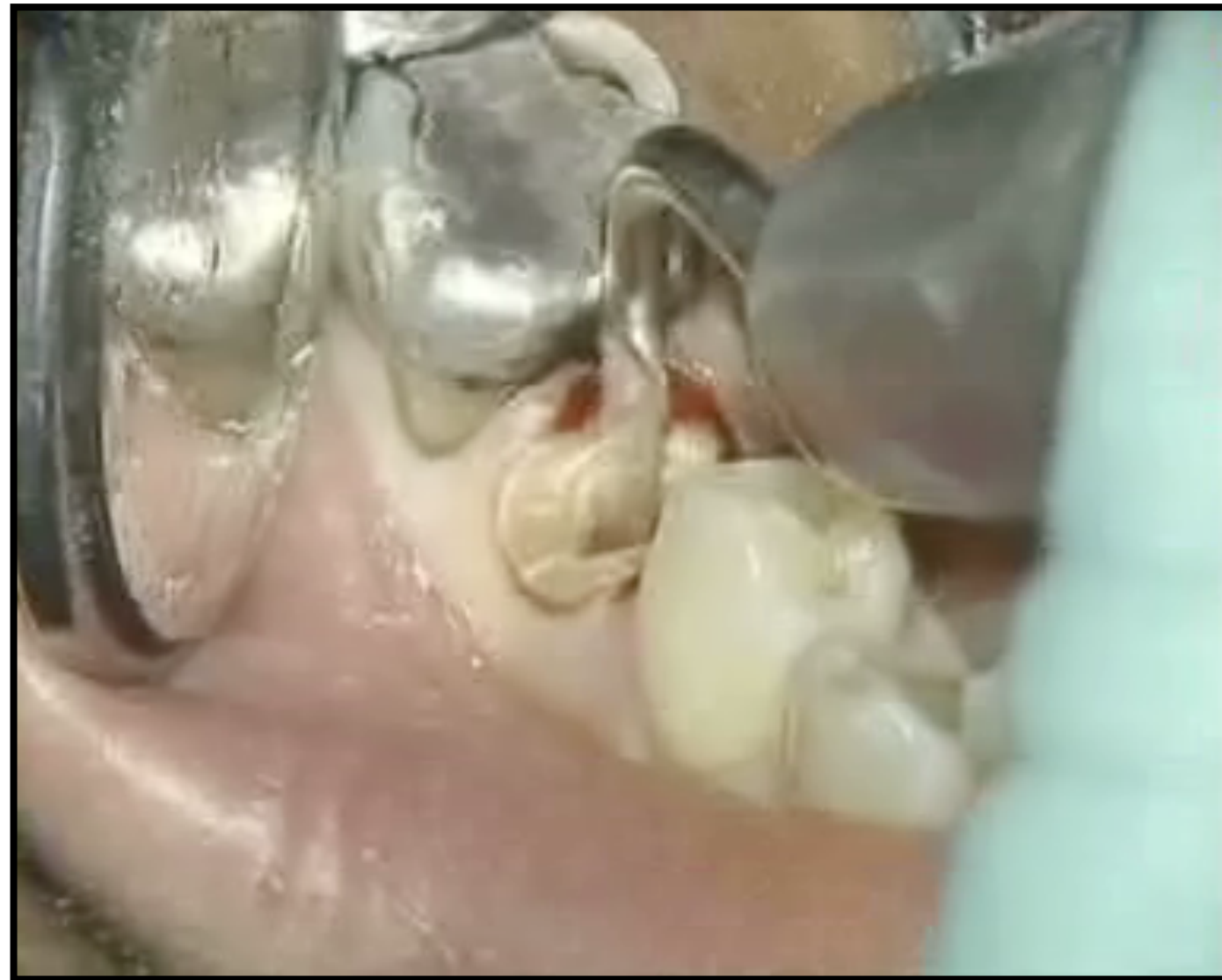


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# Clinical Applications

Extraction & Immediate Implant

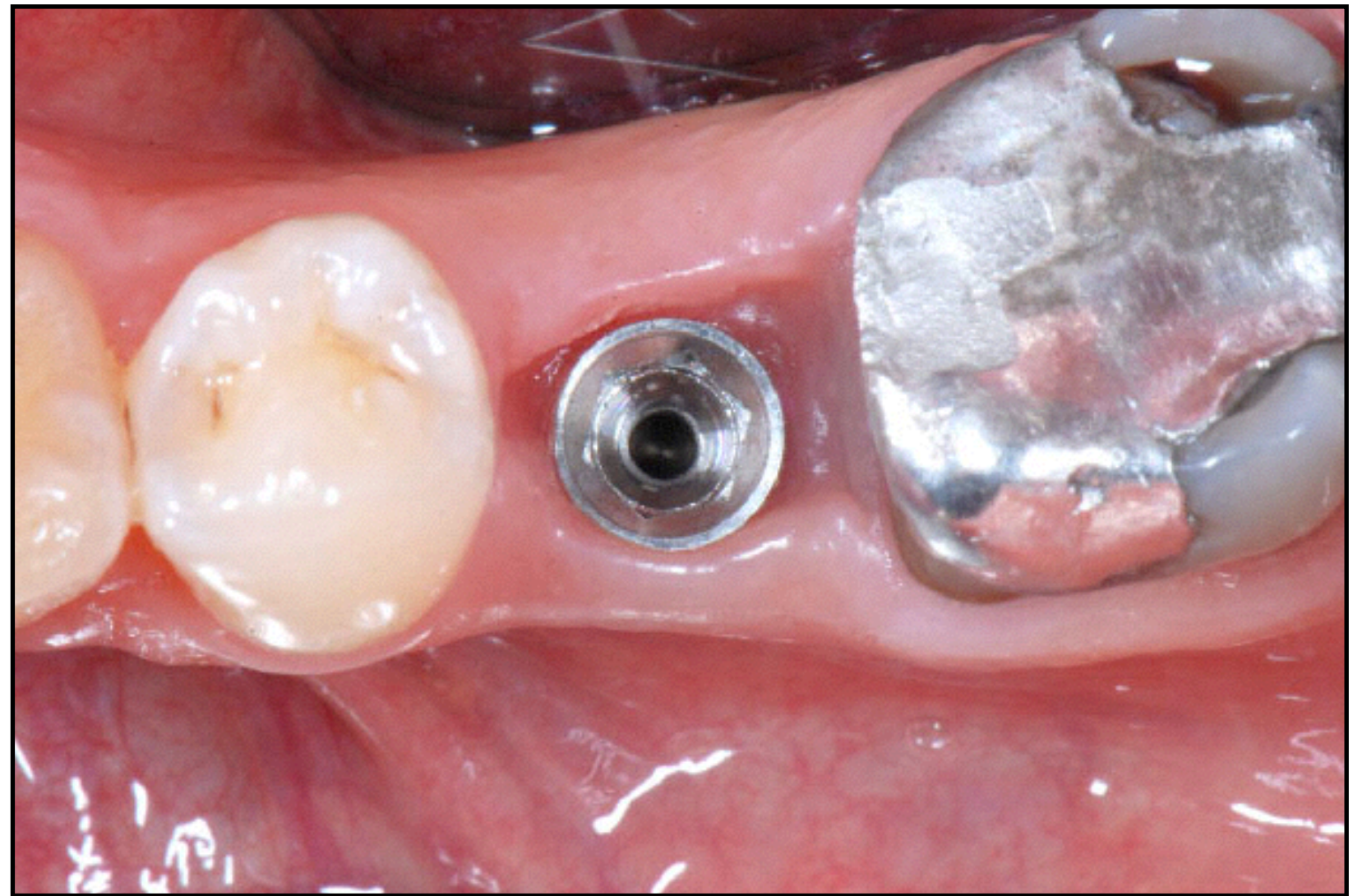


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# Clinical Applications

Extraction & Immediate Implant

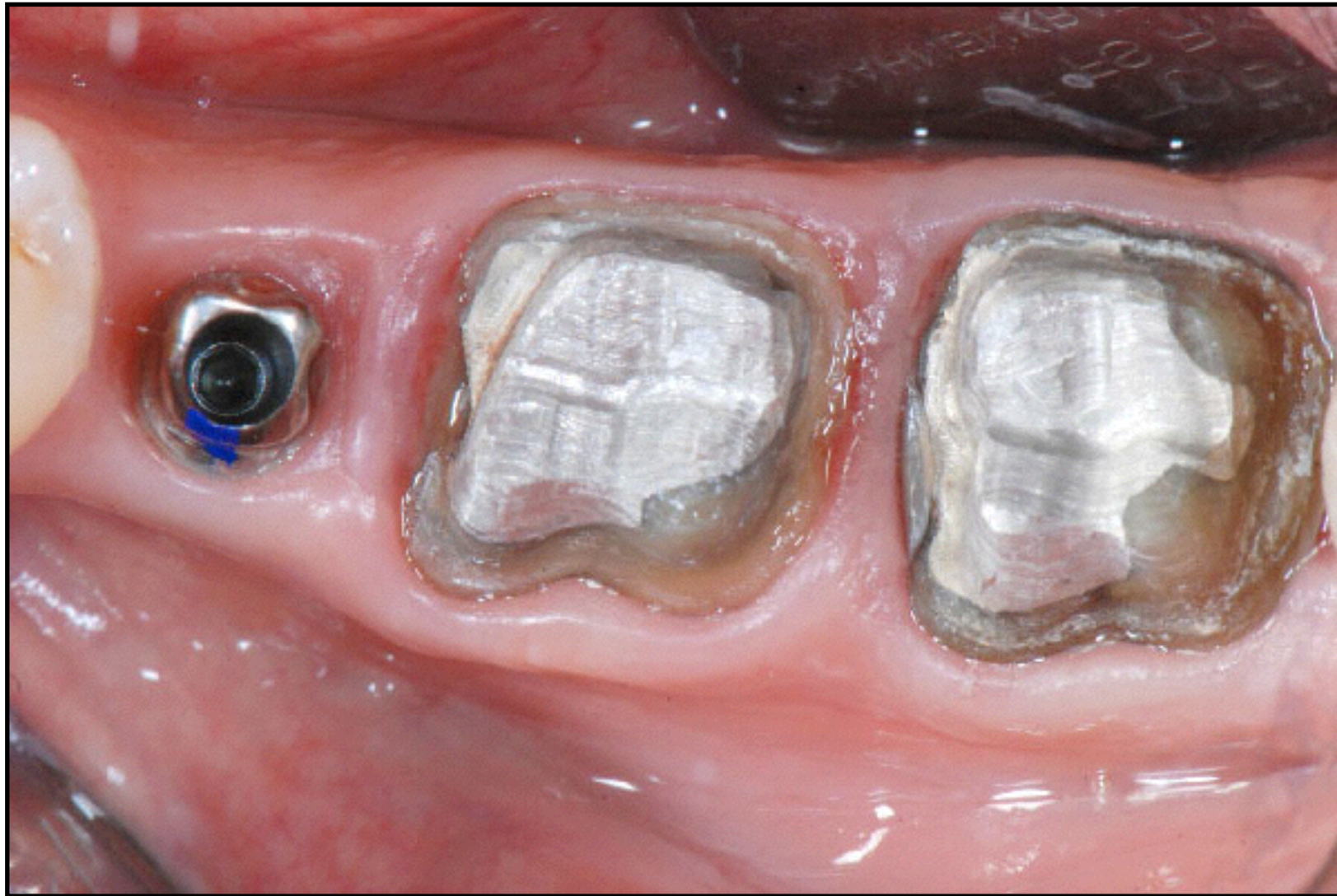


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# Clinical Applications

Extraction & Immediate Implant

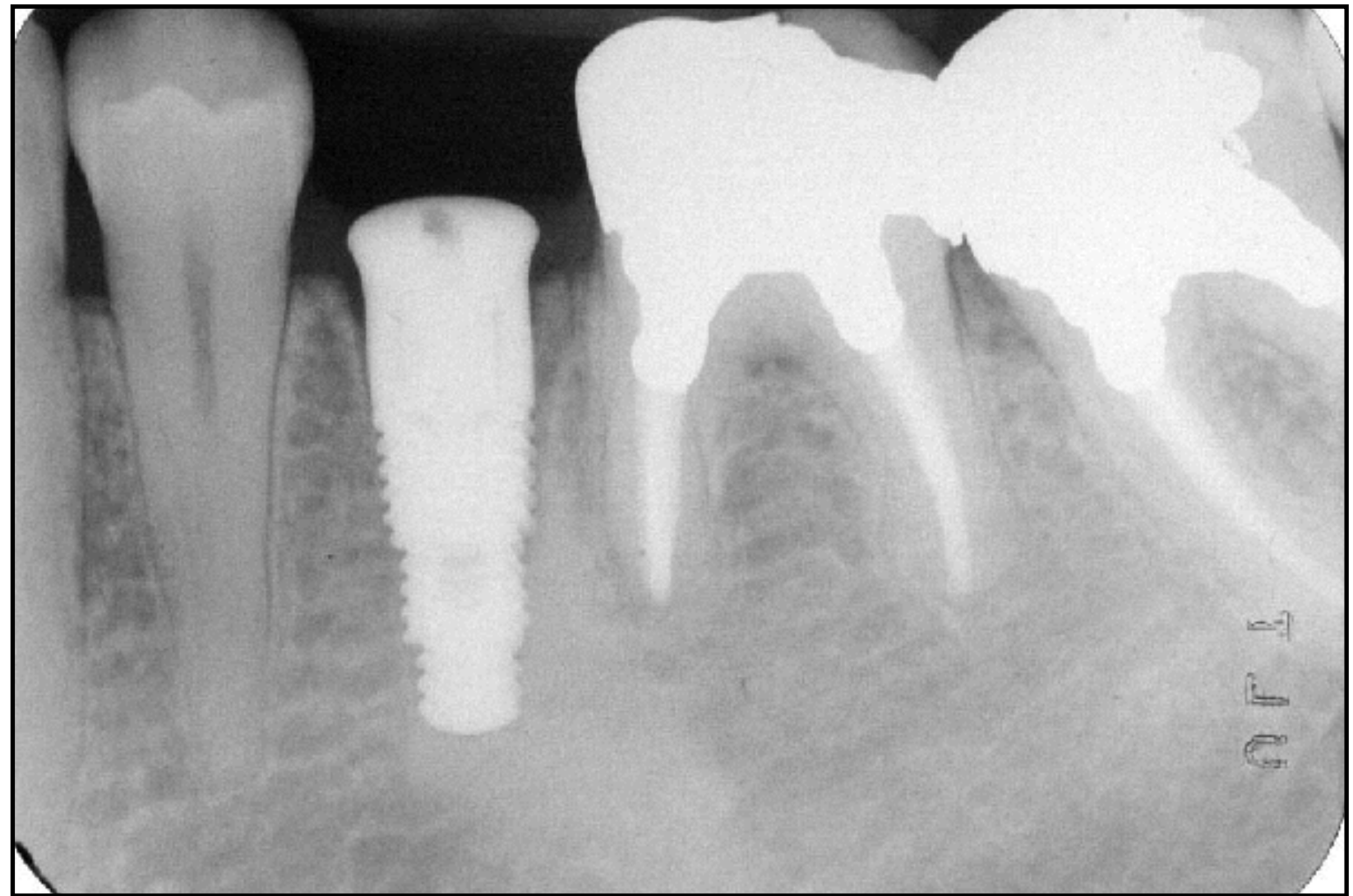


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# Clinical Applications

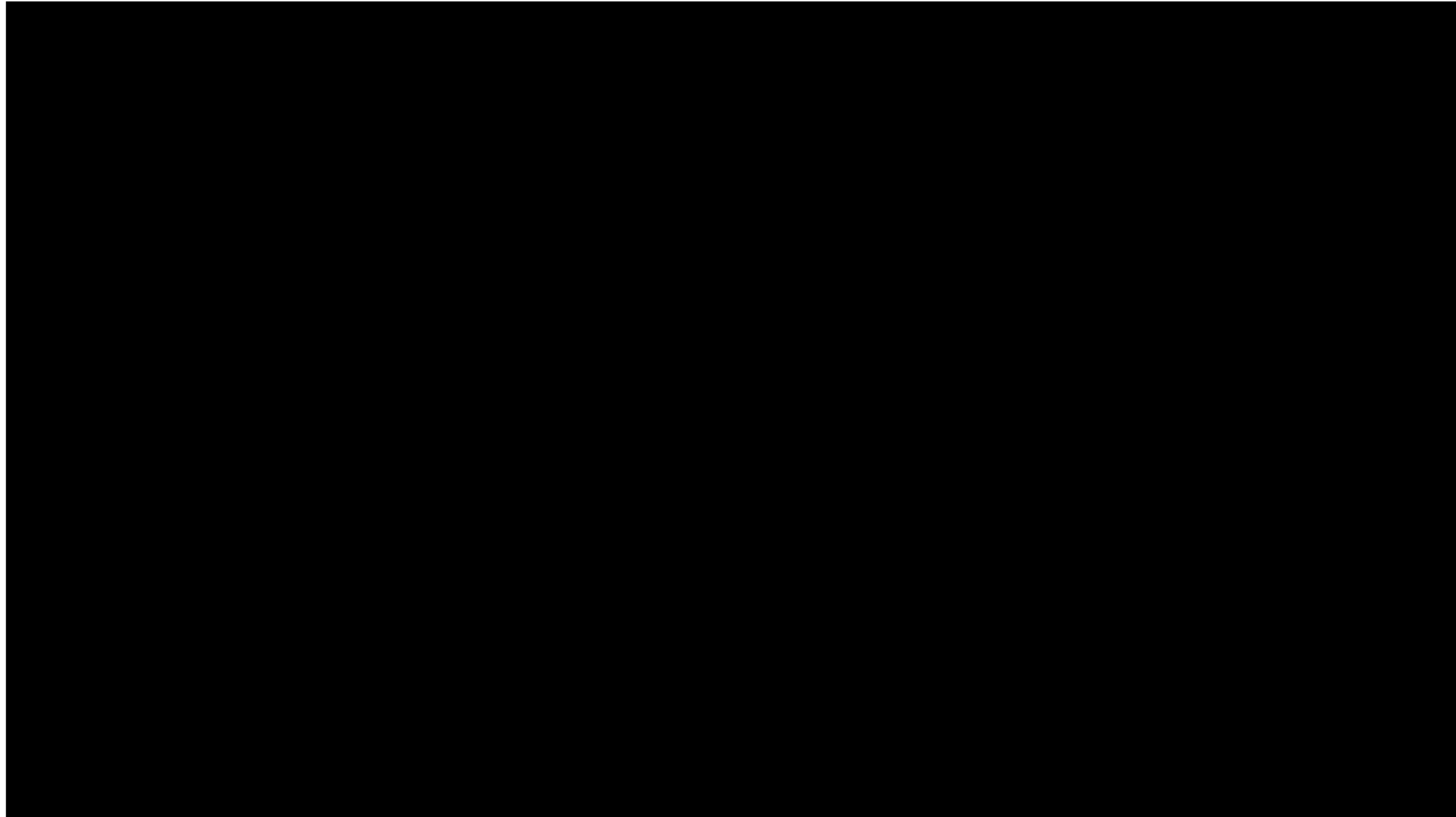
Extraction & Immediate Implant



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# Clinical Applications

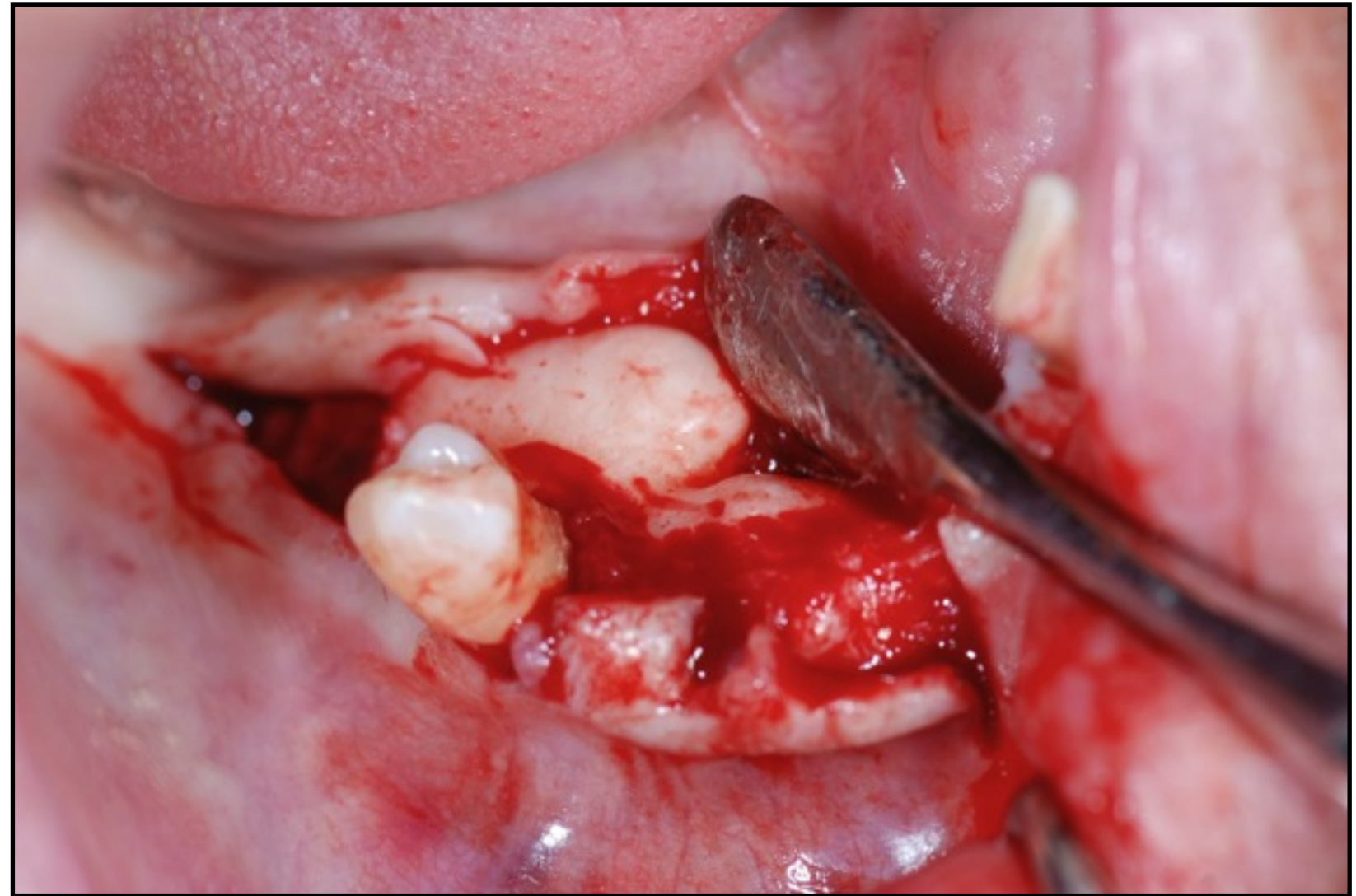
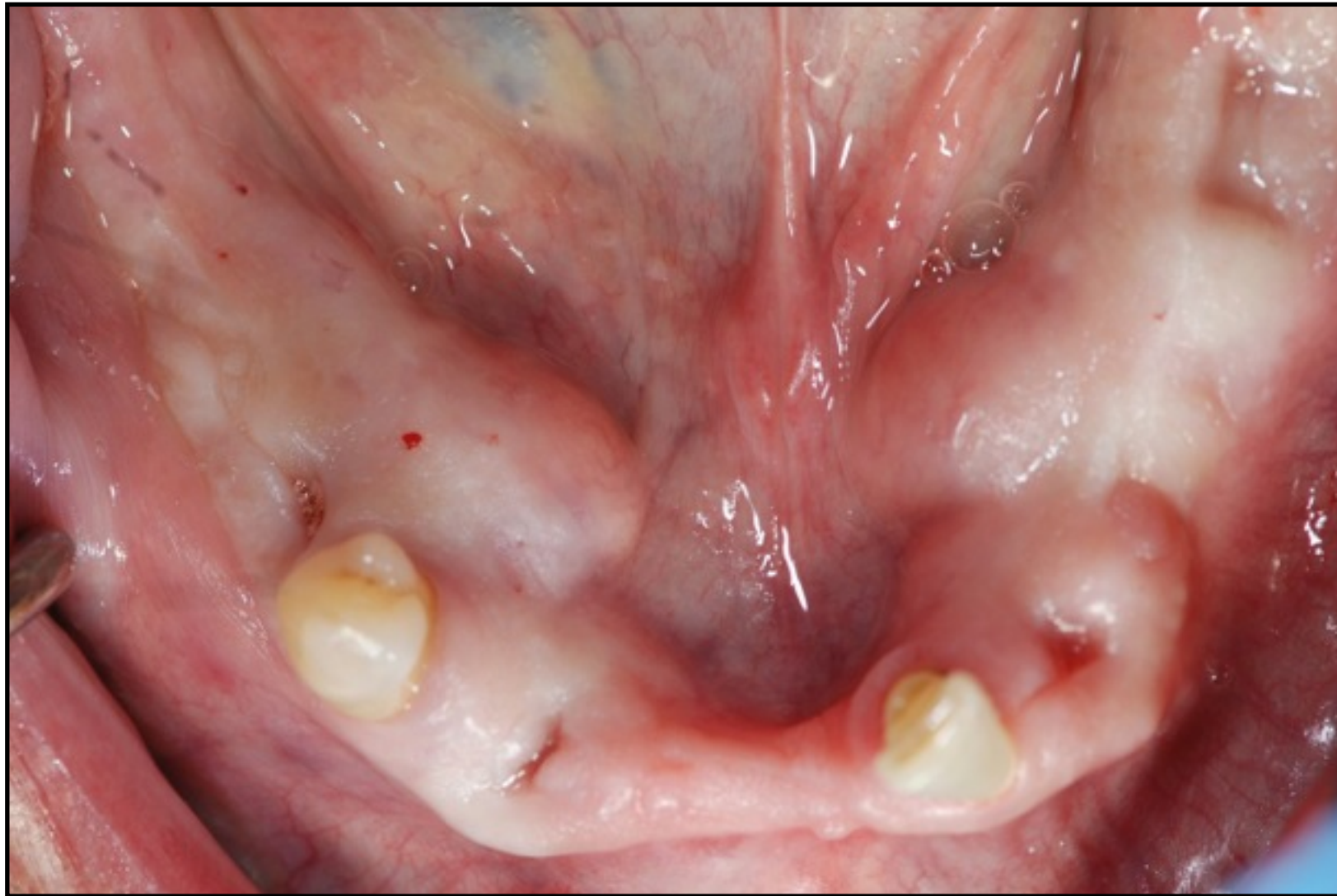
Extraction, Immediate Implant & Loading





# Clinical Applications

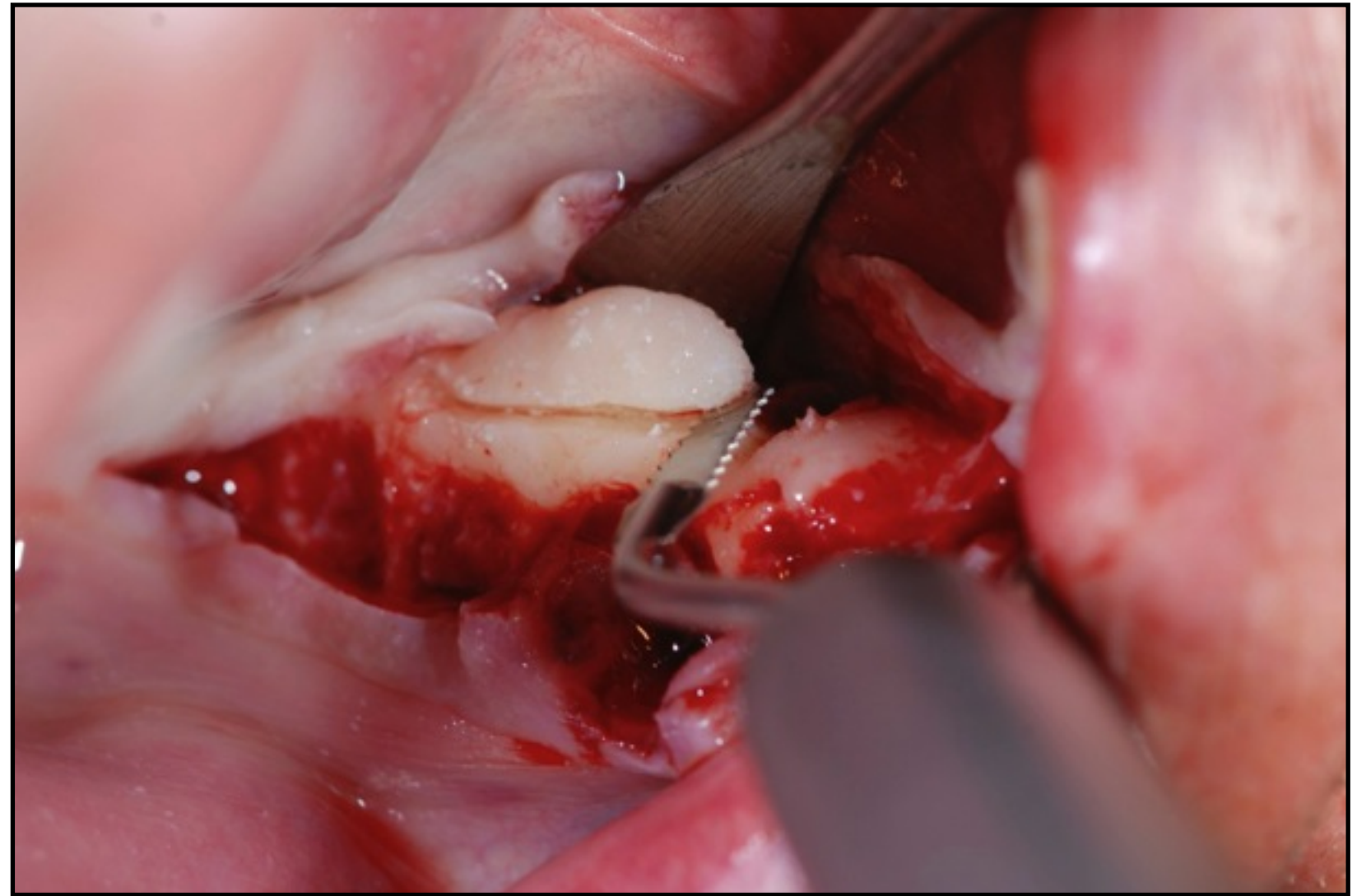
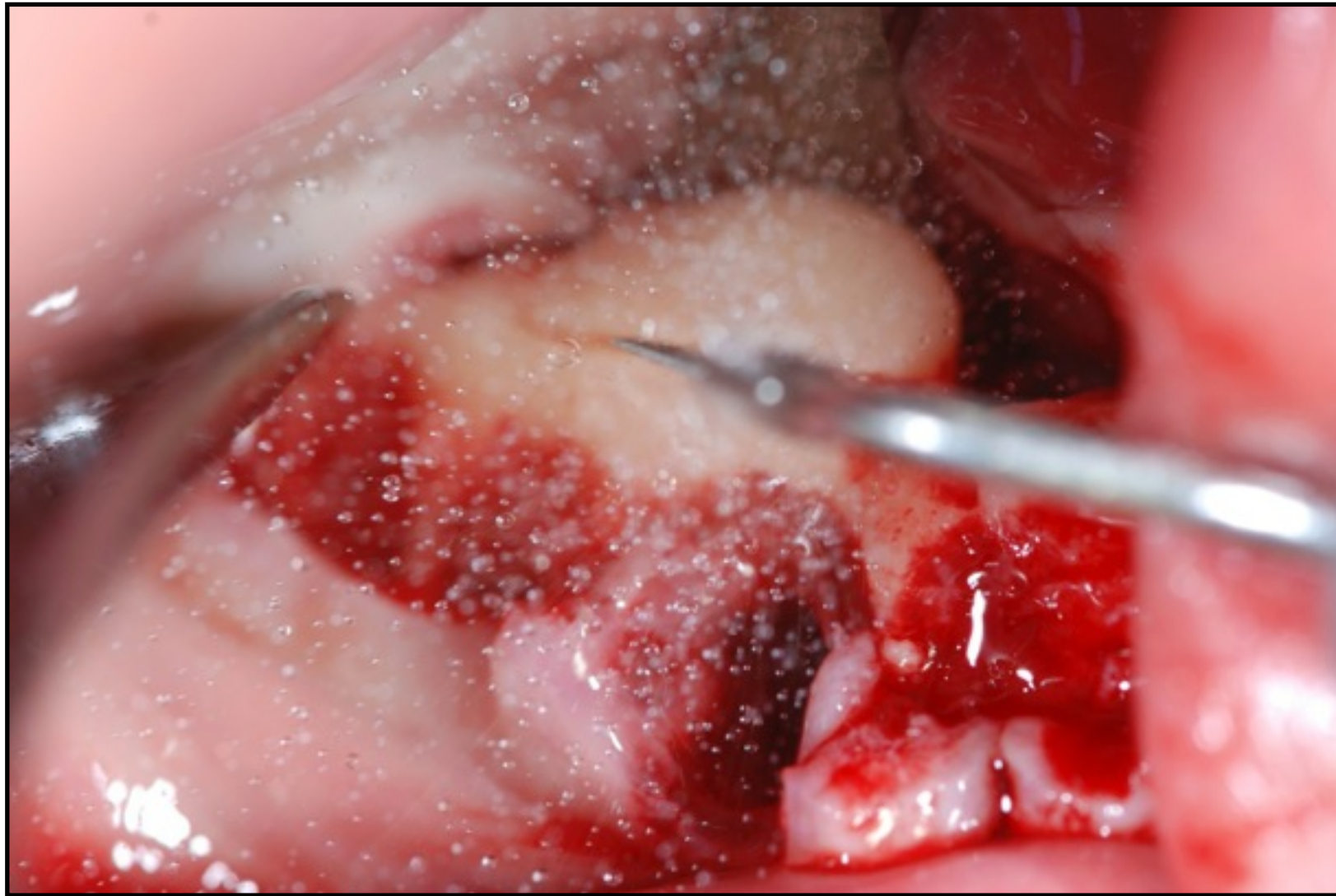
Removal of Exostosis





# Clinical Applications

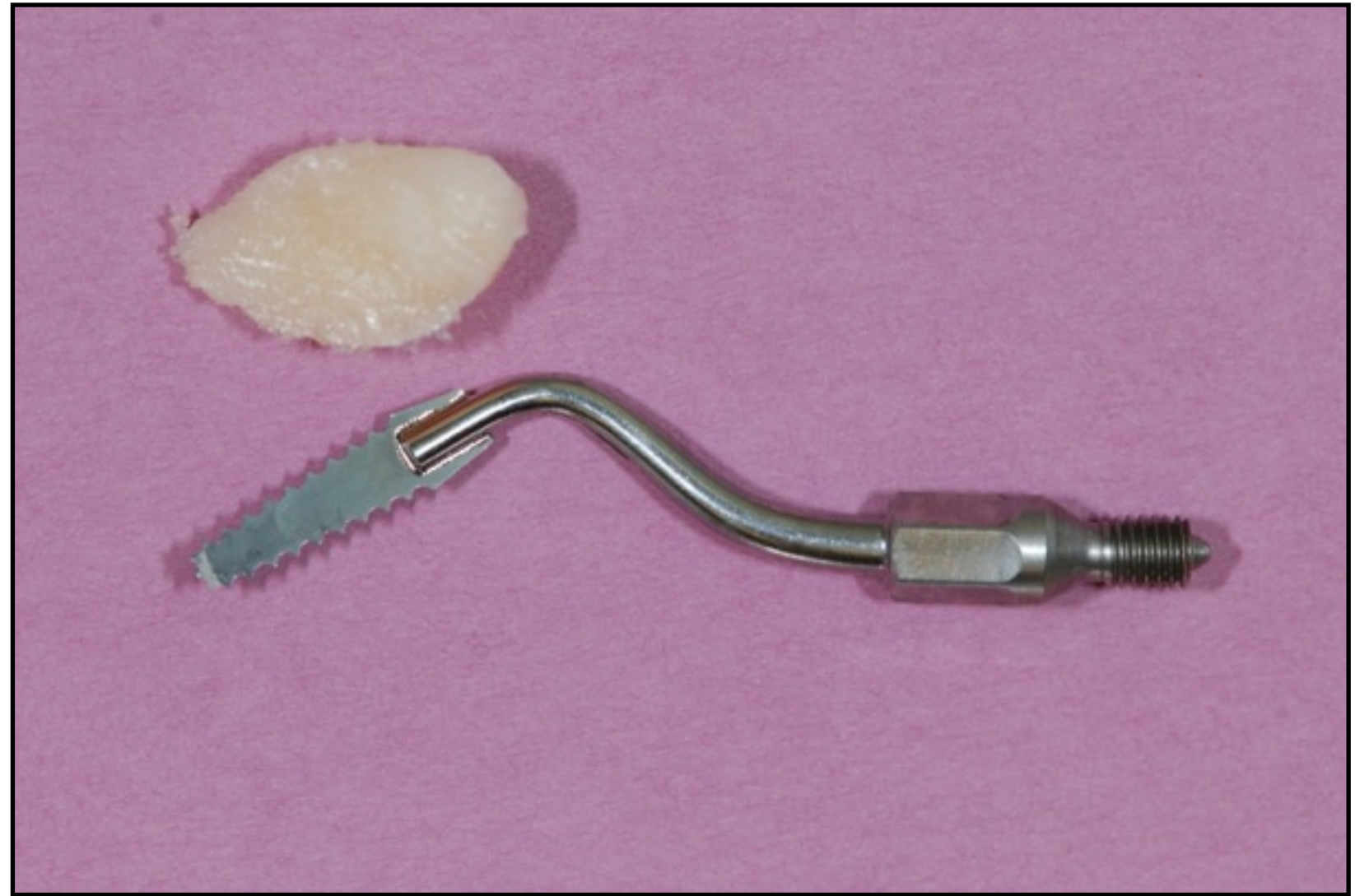
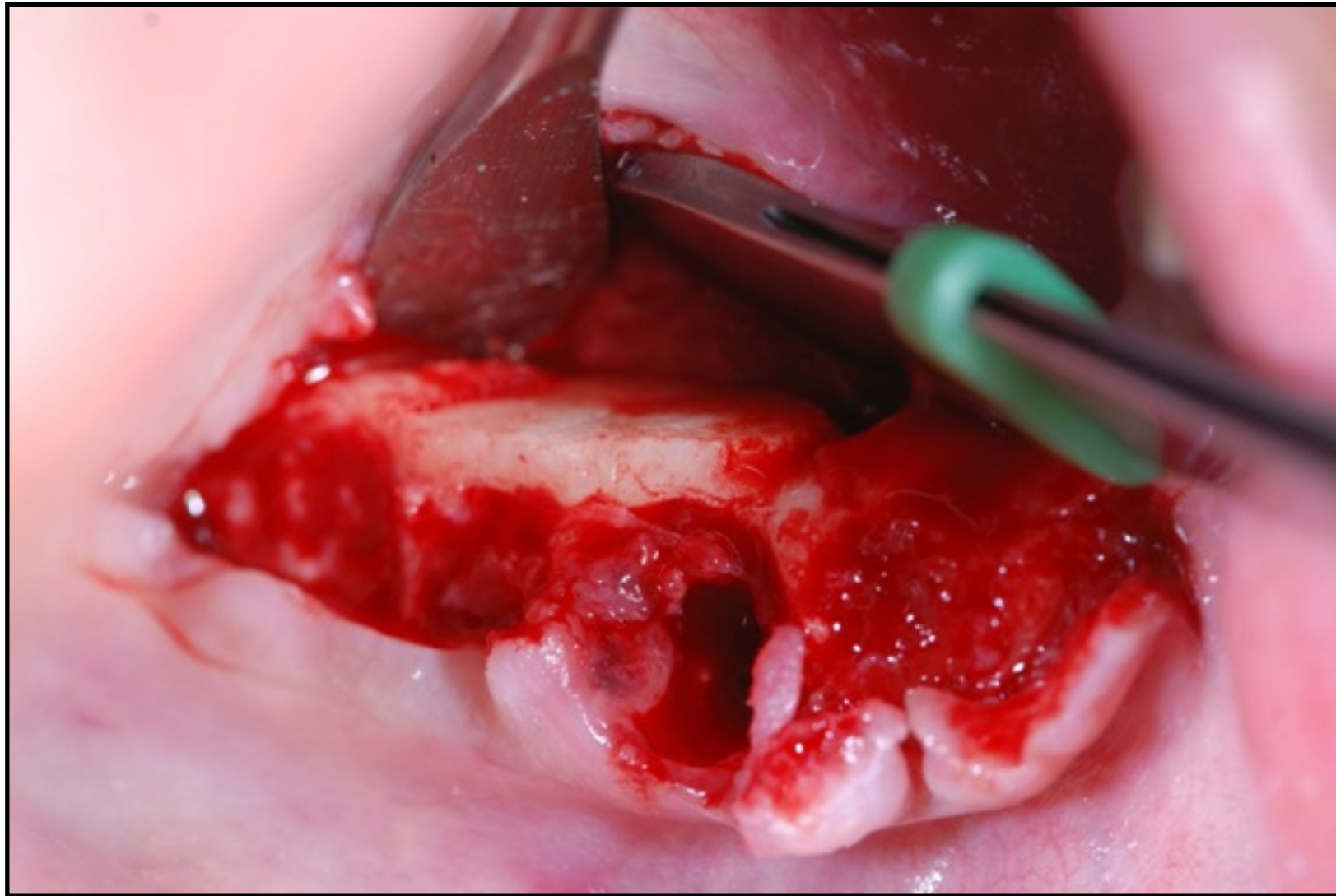
Removal of Exostosis





# Clinical Applications

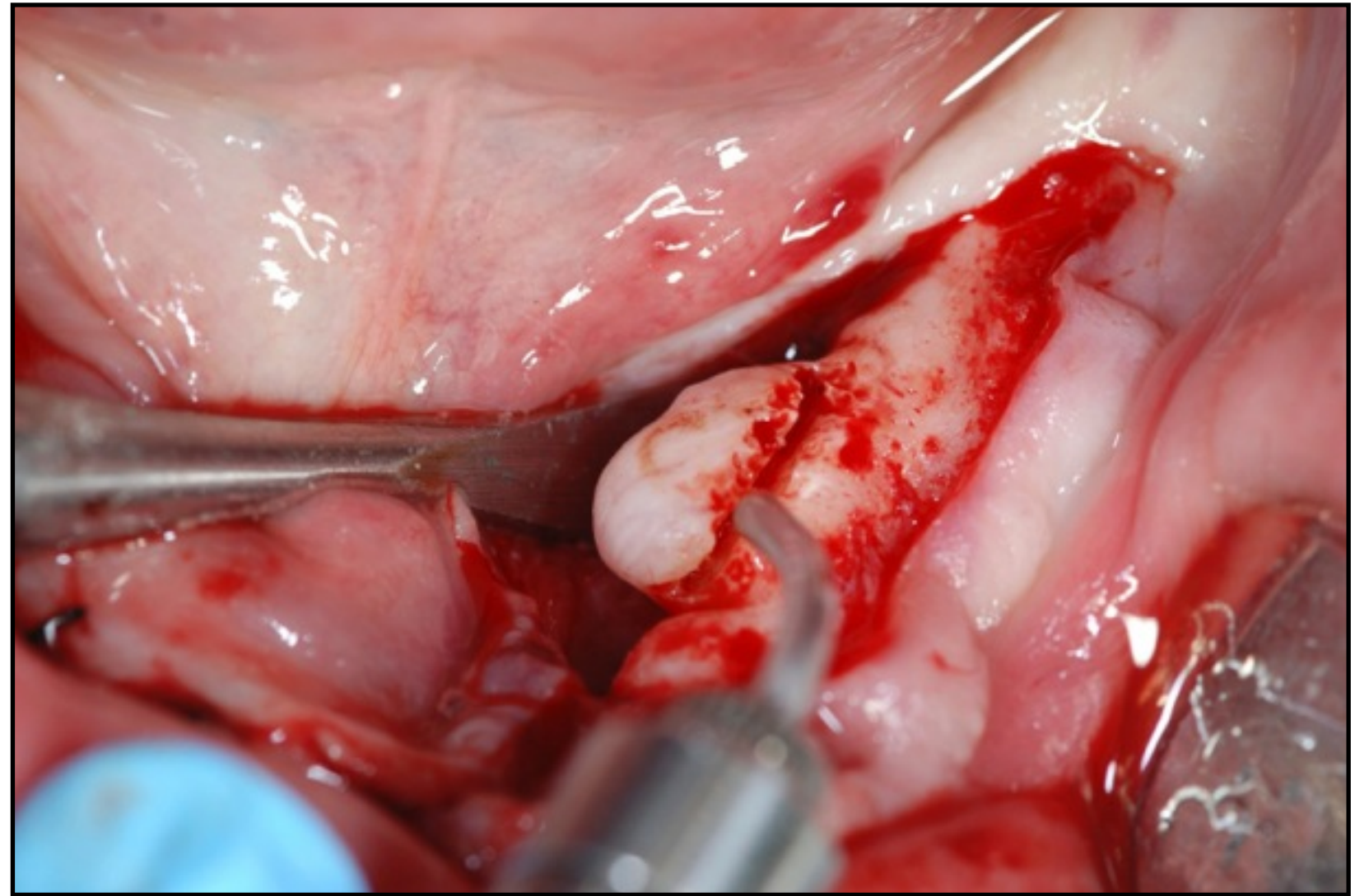
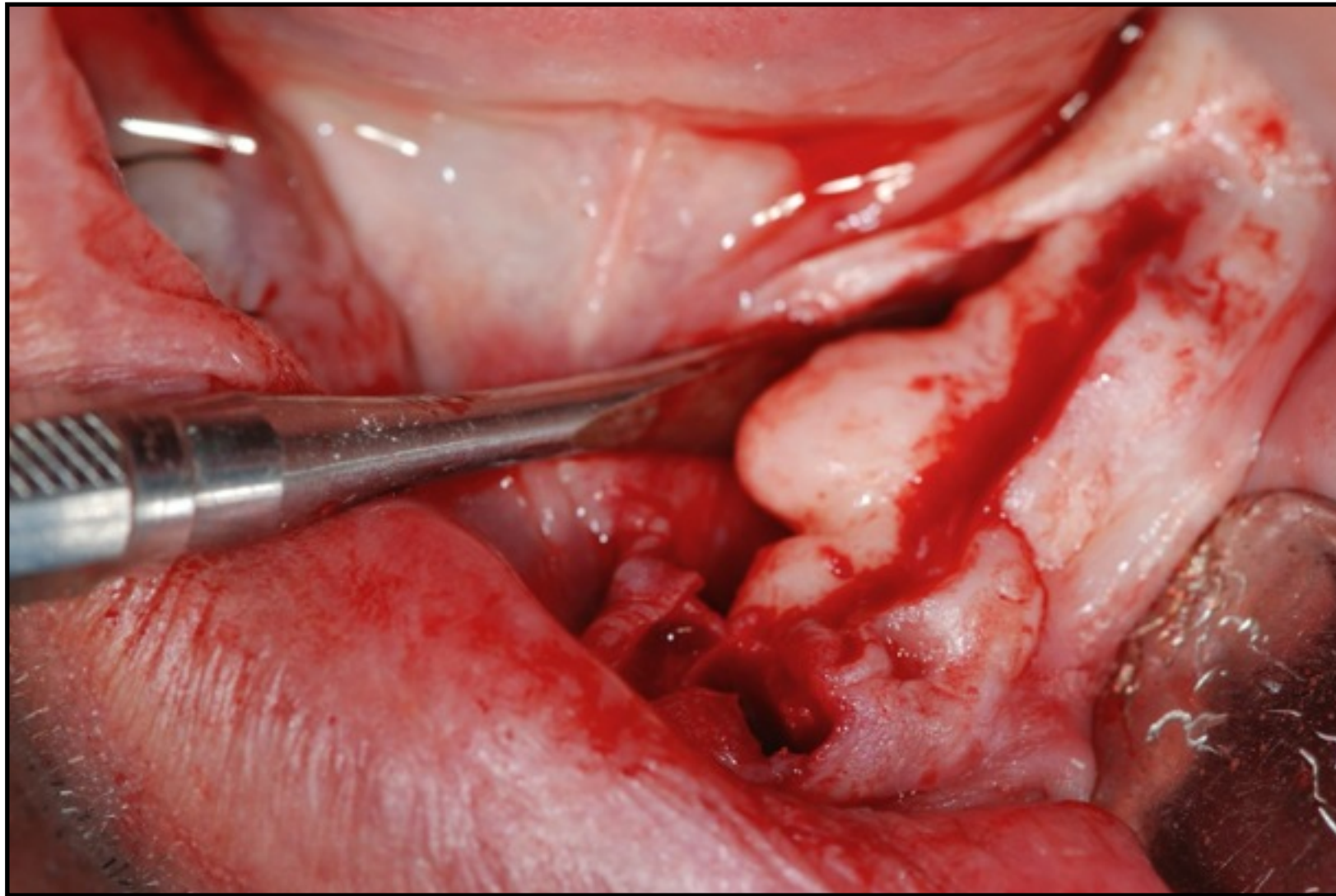
Removal of Exostosis





# Clinical Applications

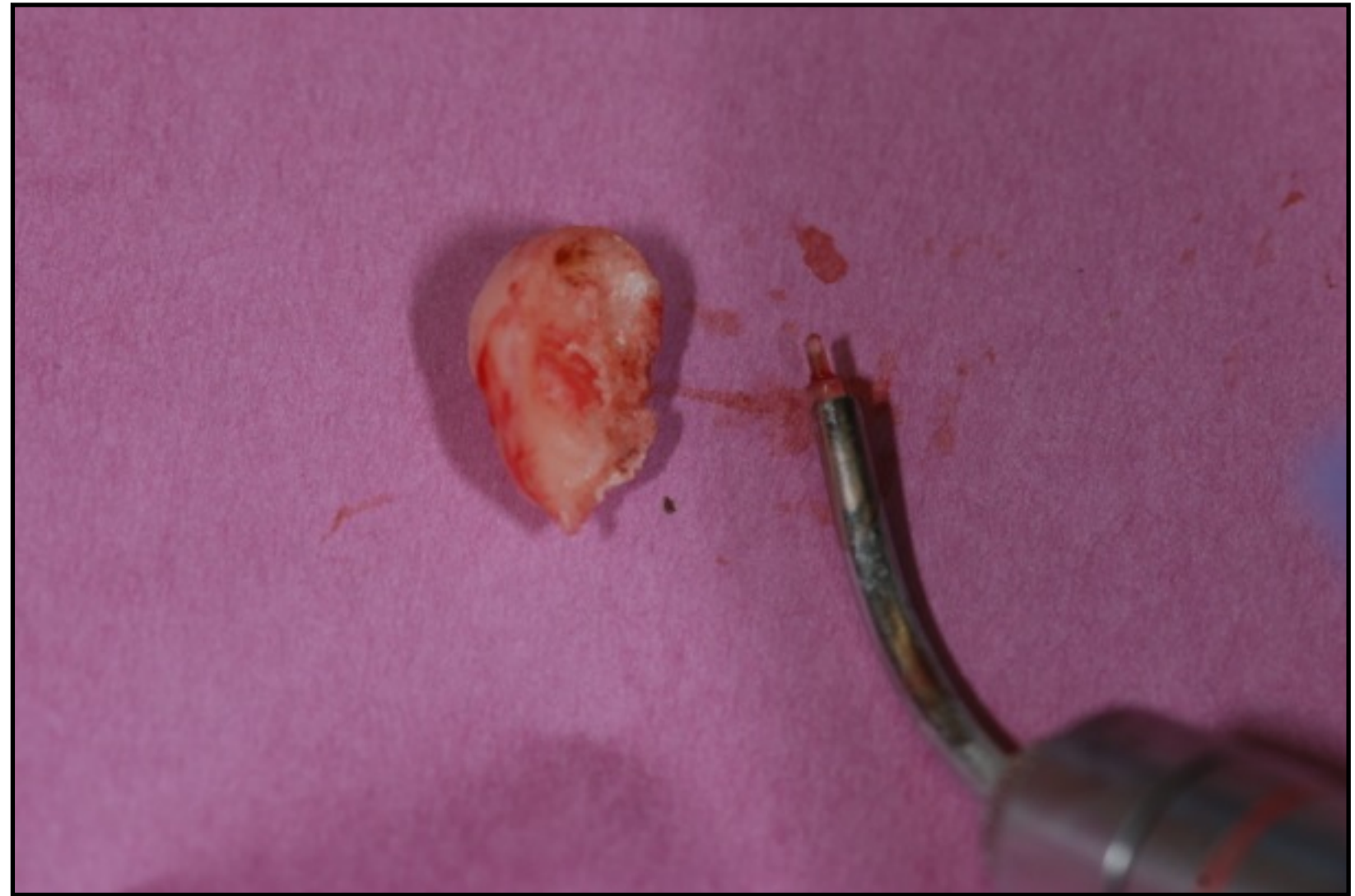
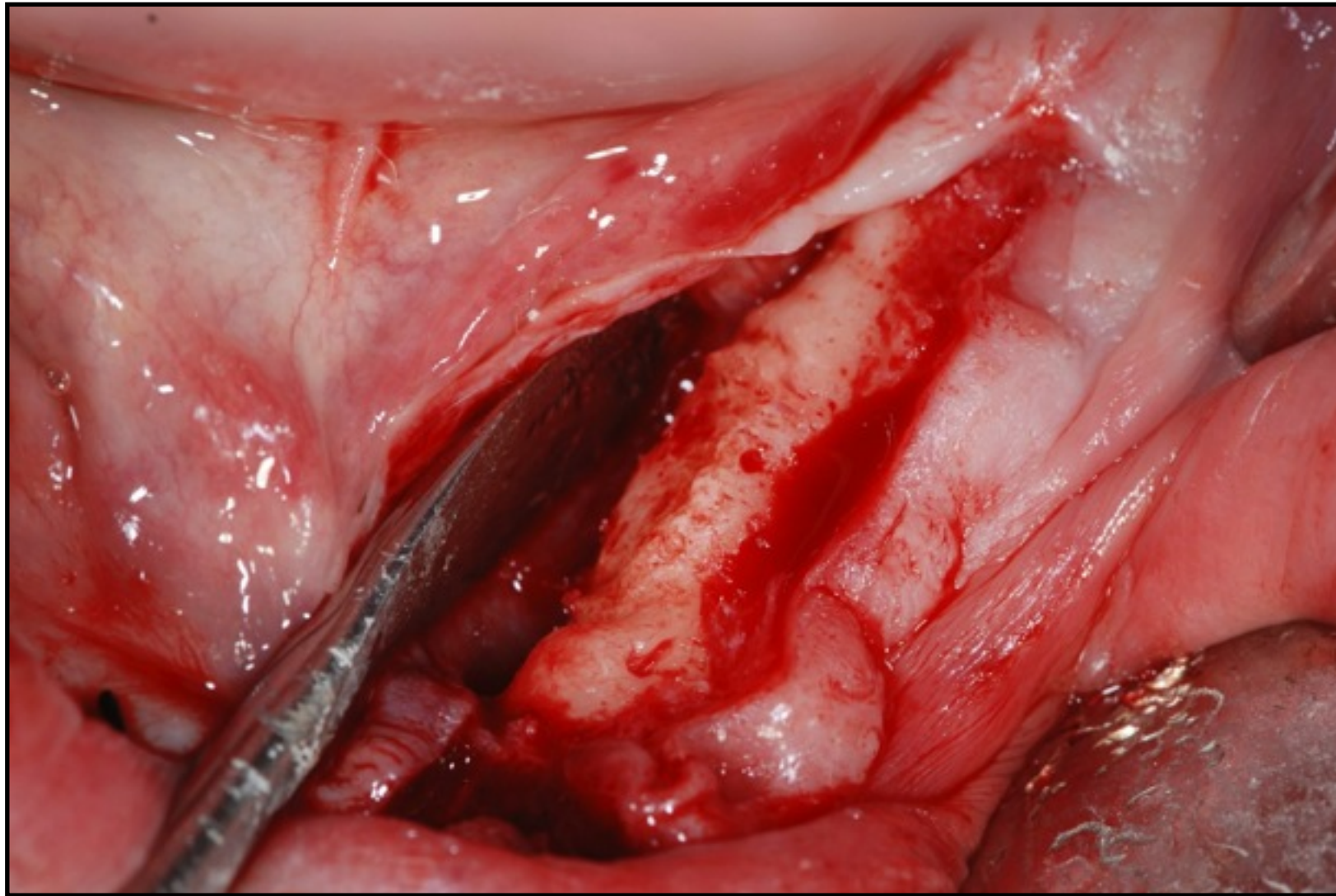
Removal of Exostosis





# Clinical Applications

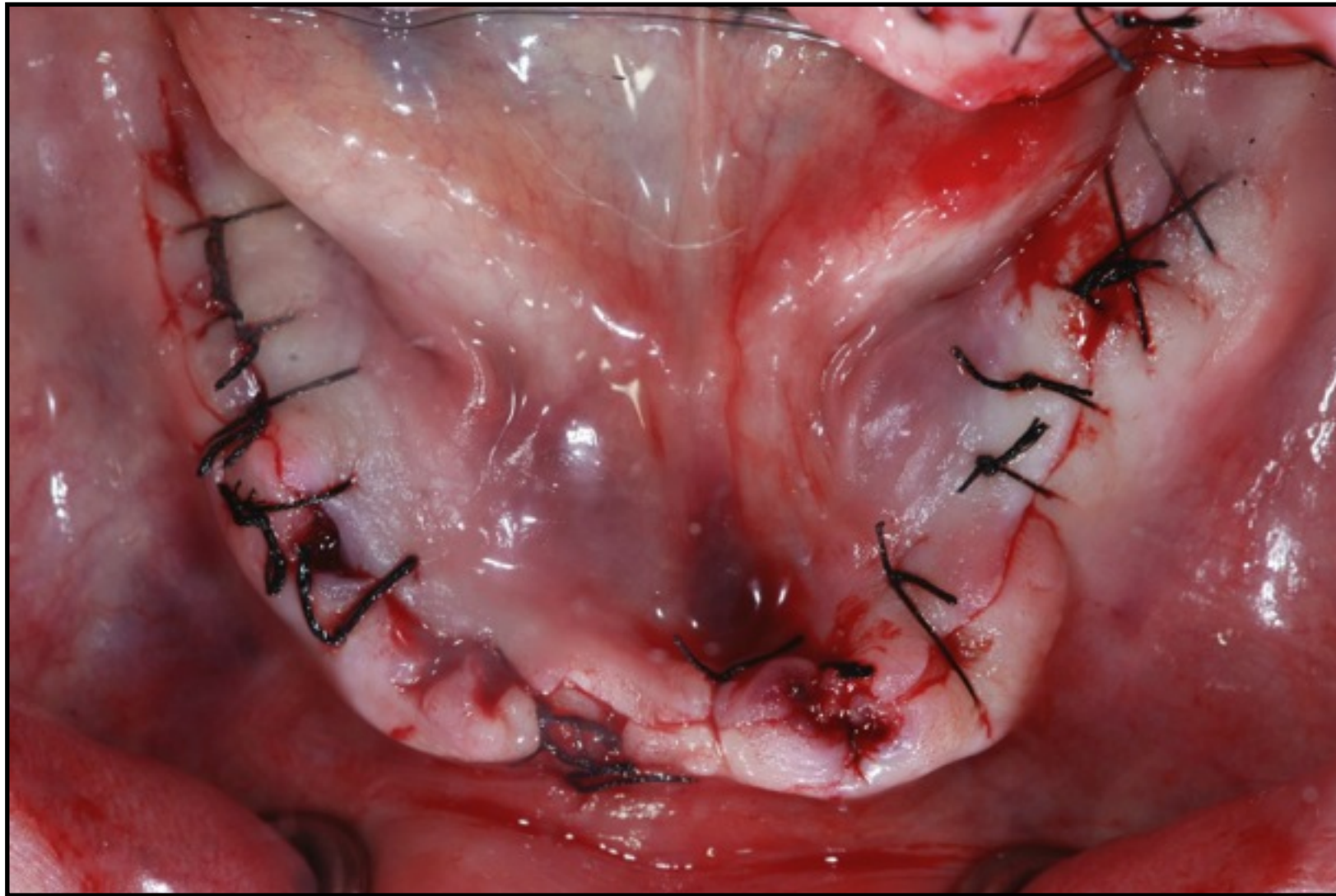
Removal of Exostosis





# Clinical Applications

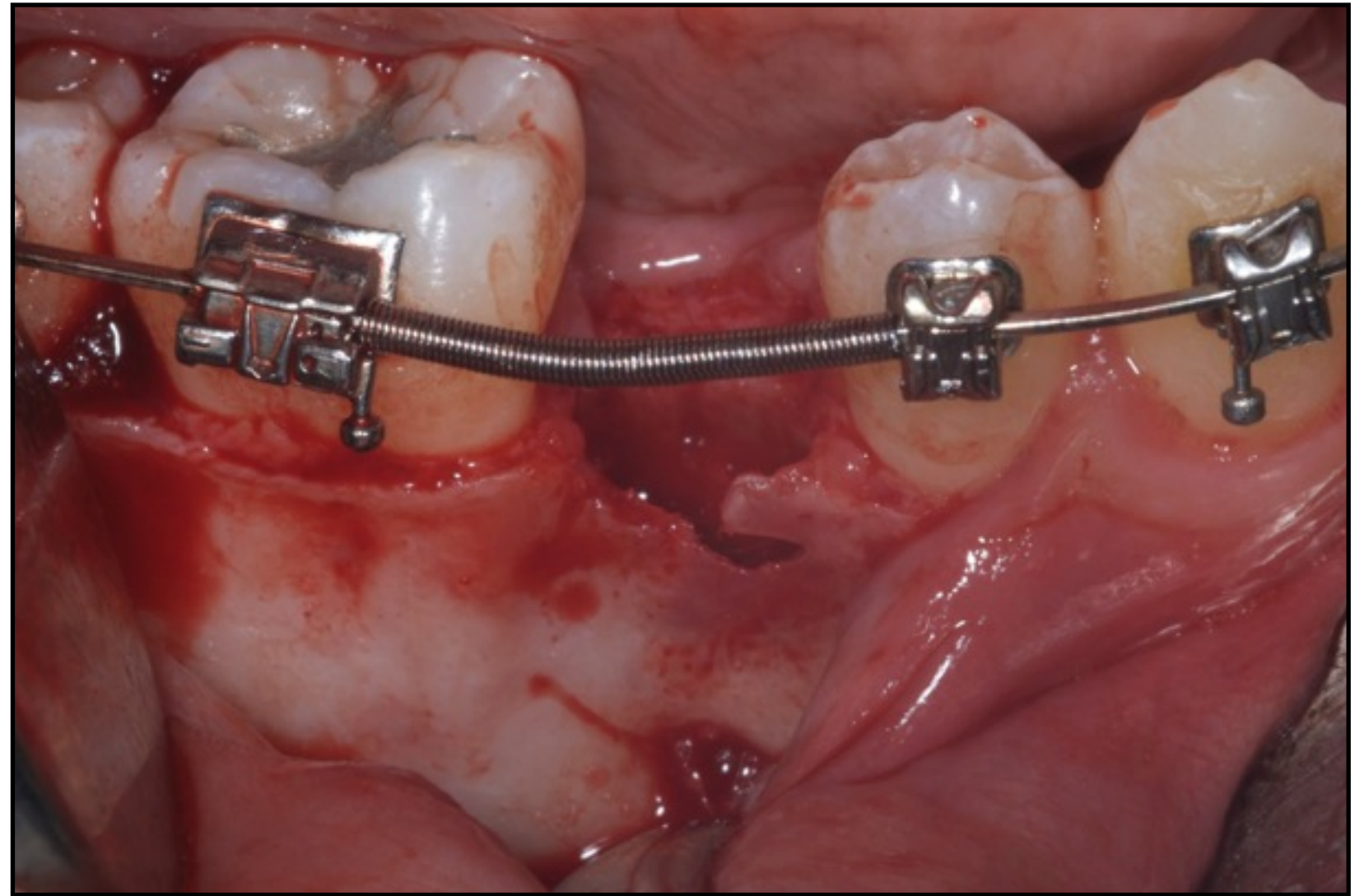
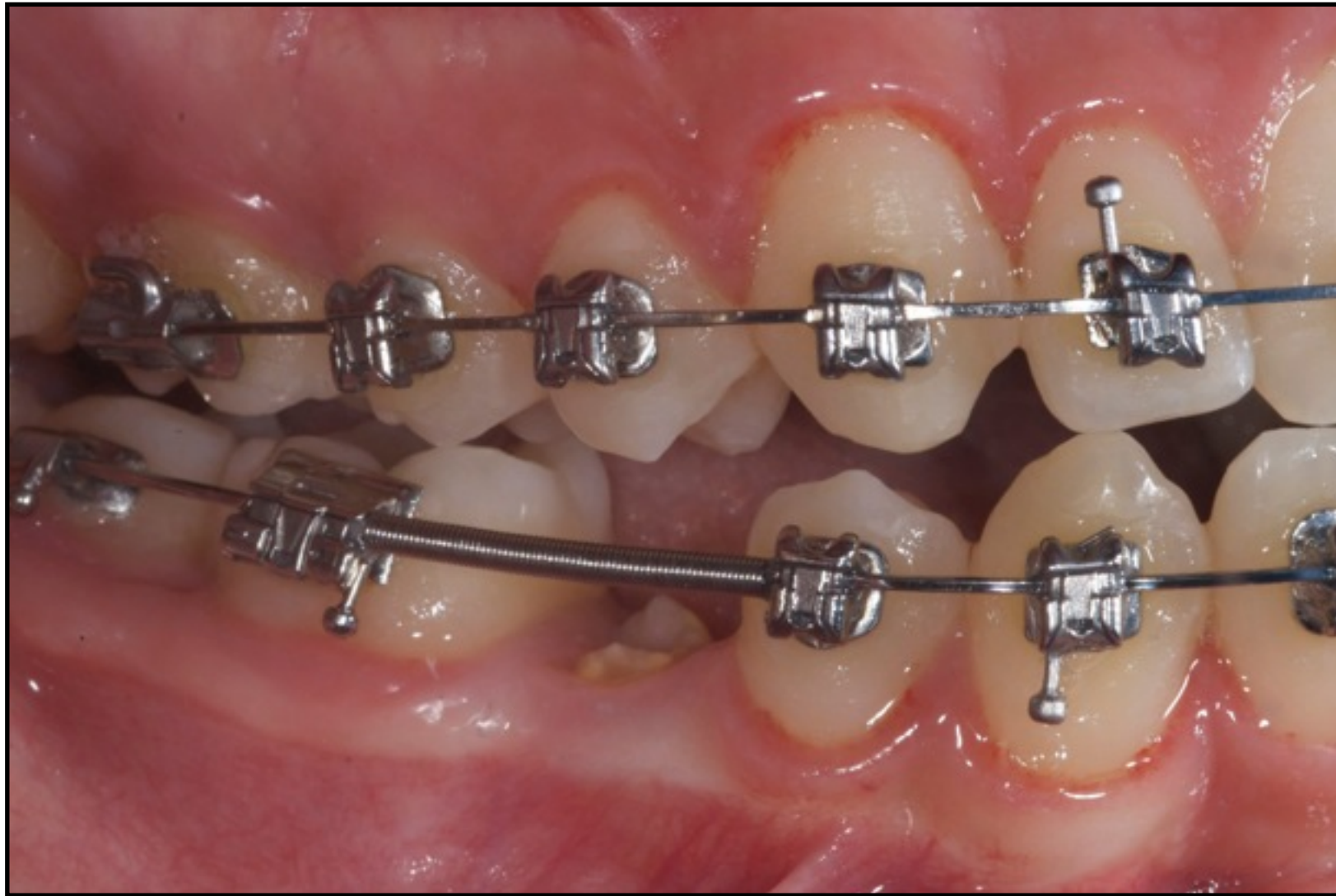
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# Clinical Applications

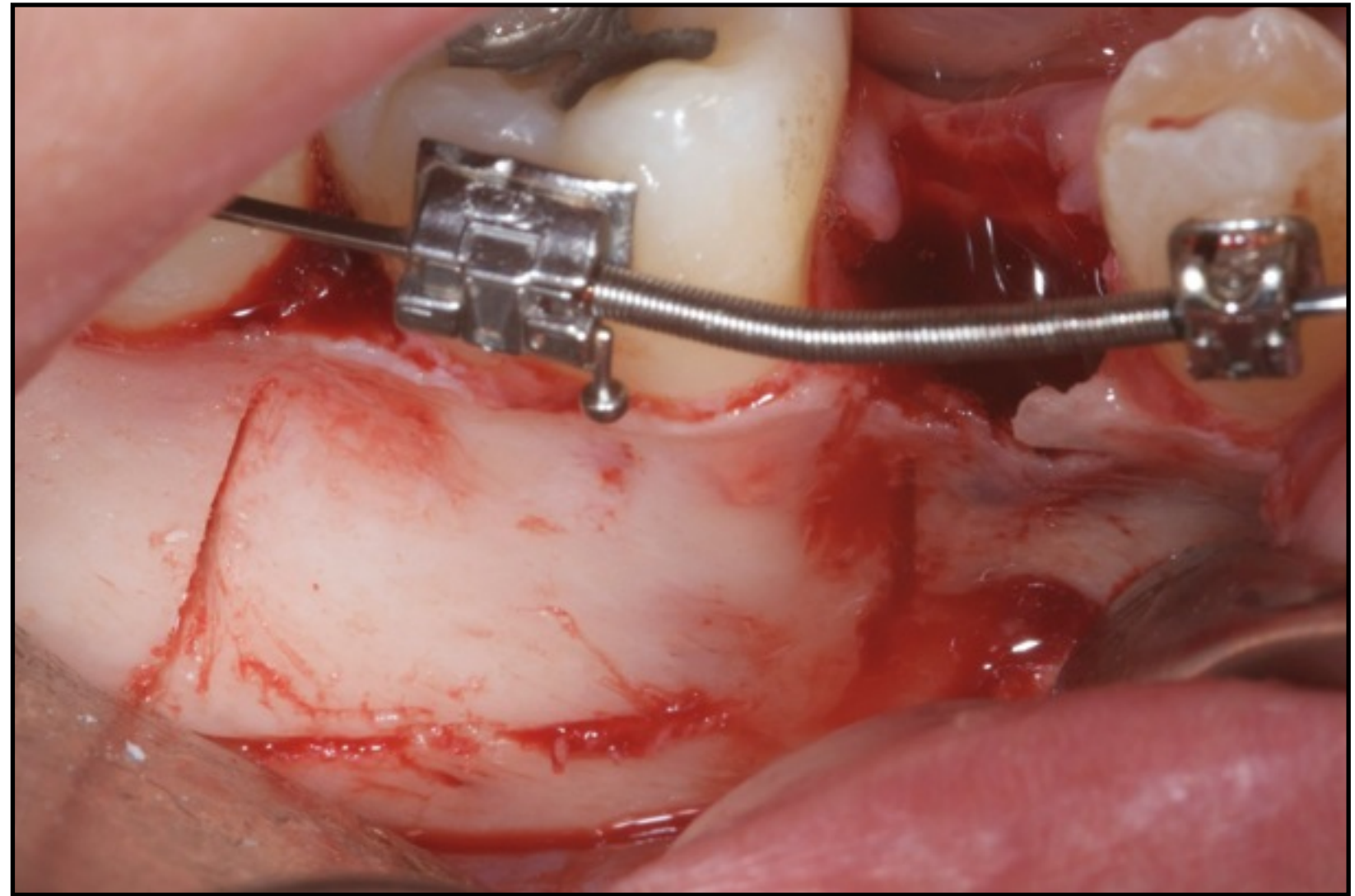
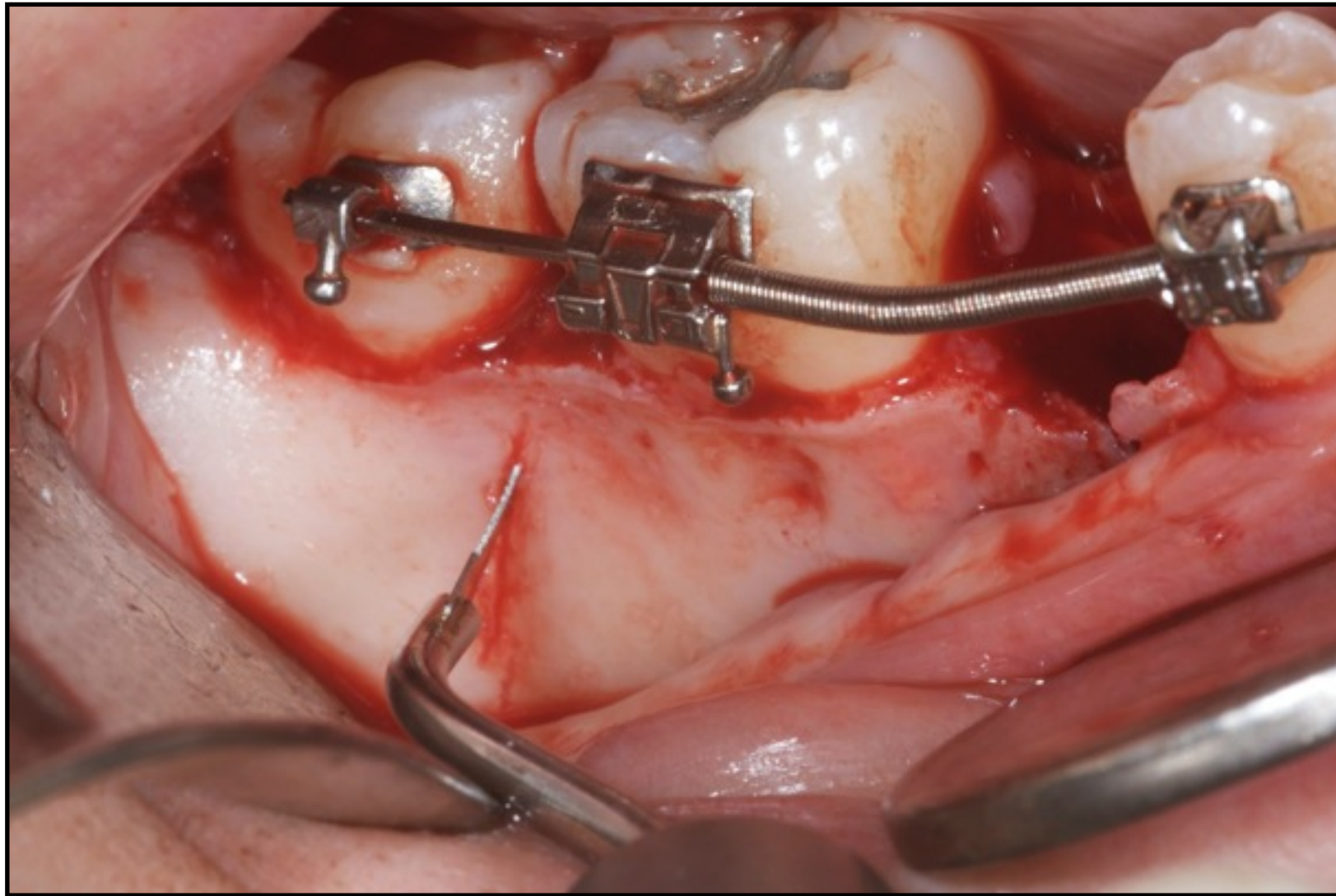
Corticotomy





# Clinical Applications

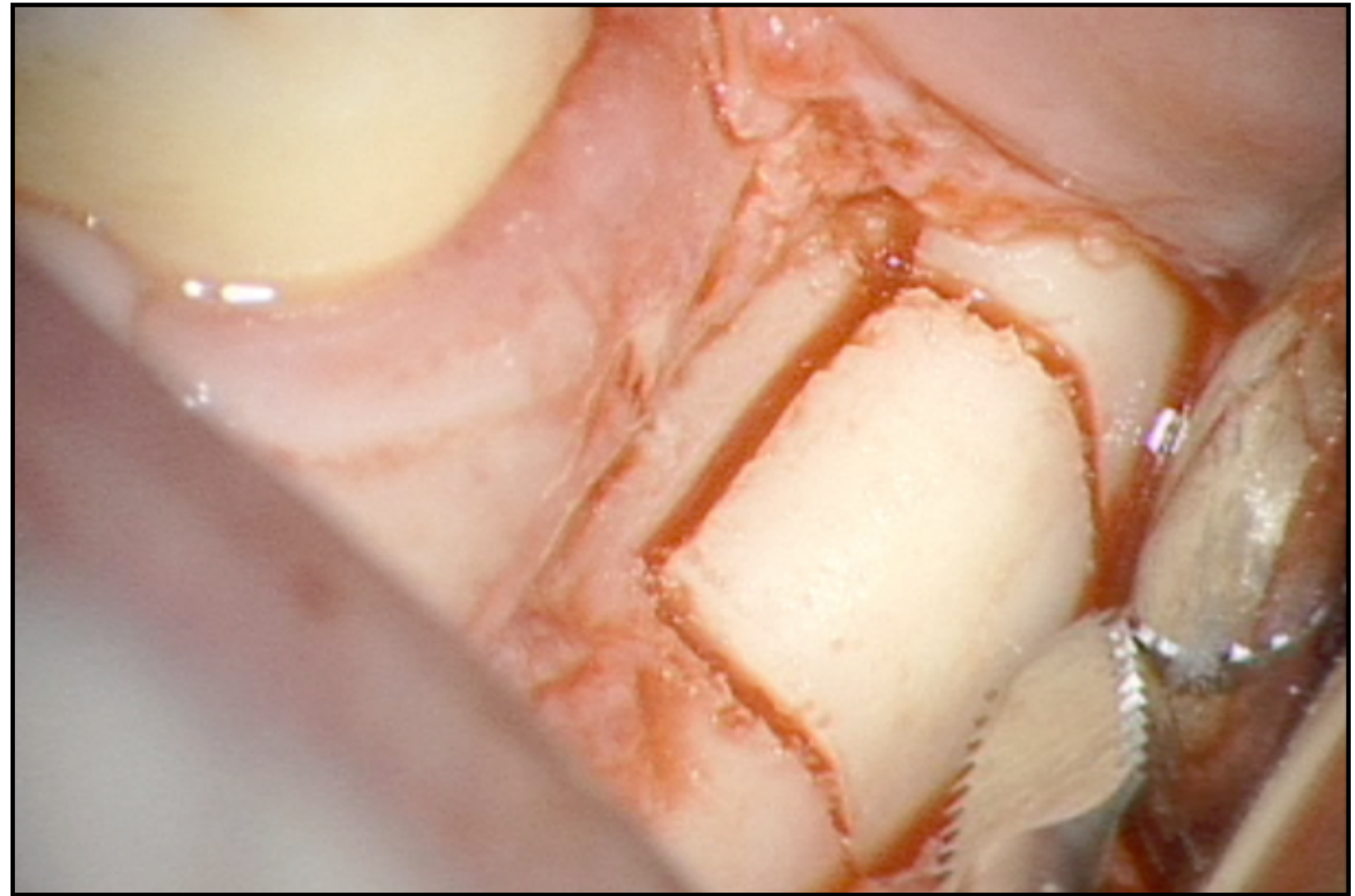
Corticotomy





# Clinical Applications

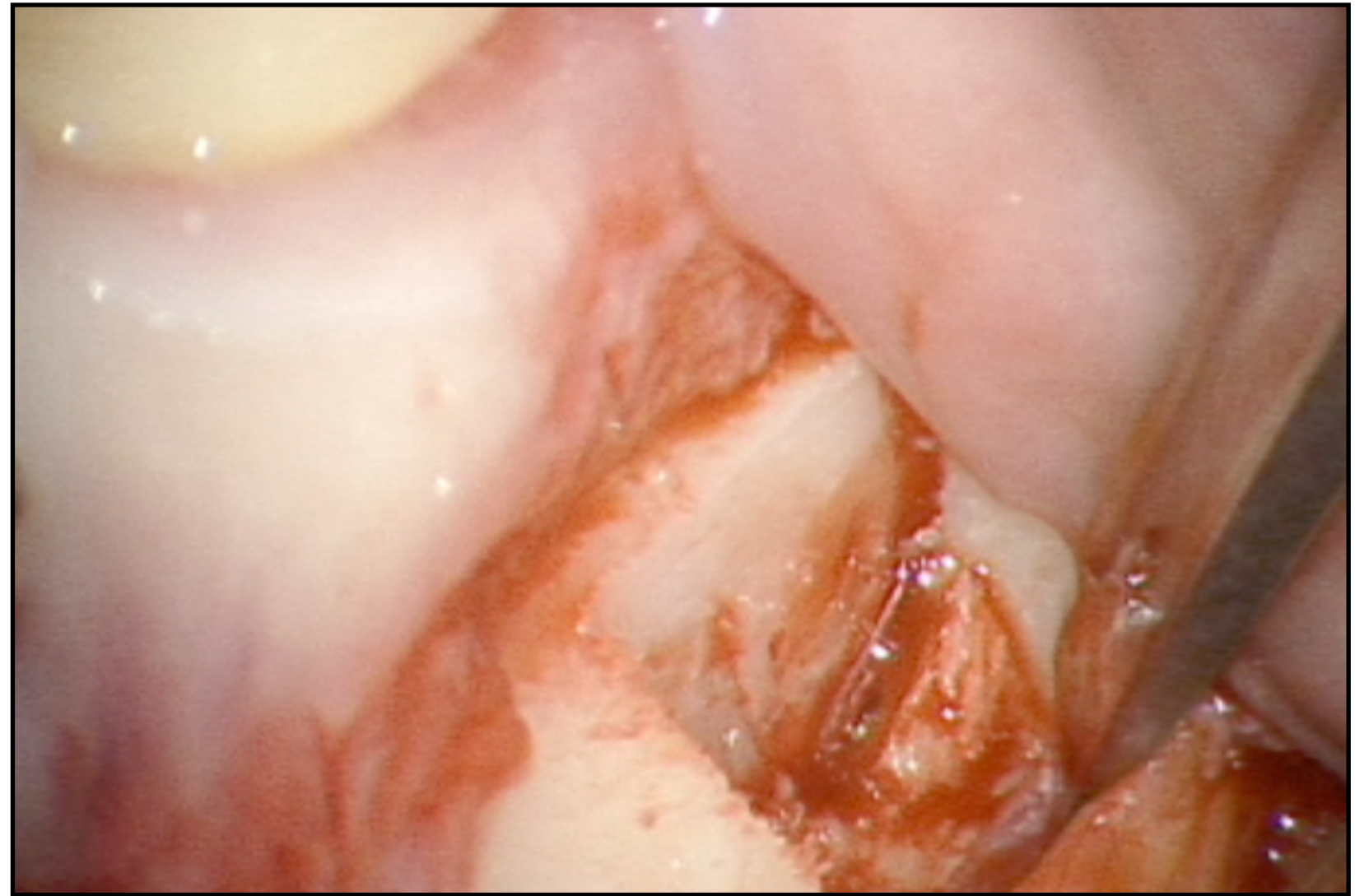
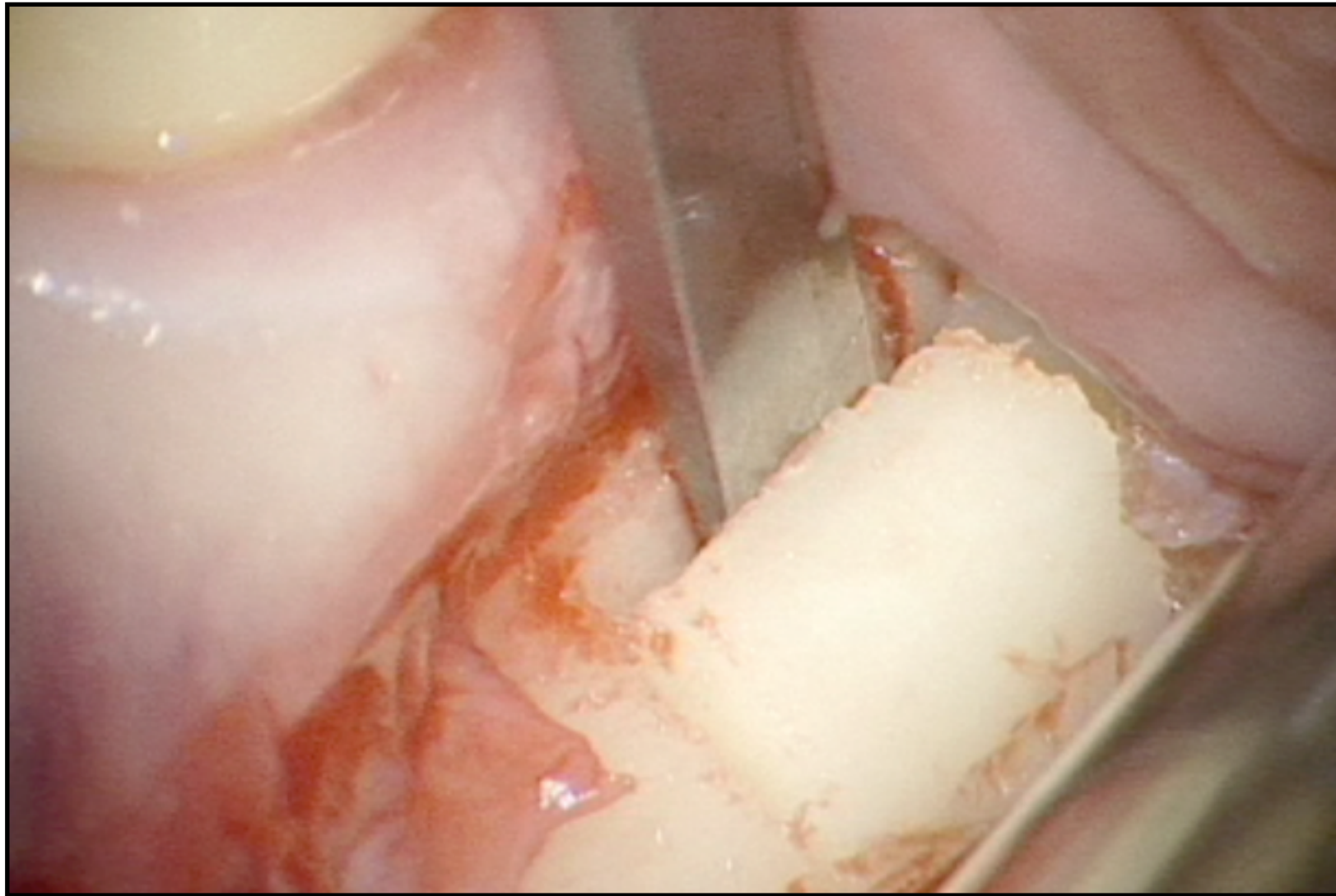
Bone Harvesting





# Clinical Applications

Bone Harvesting



# Clinical Applications

## Bone Harvesting

- Quantity of vital bone cells similar to conventional methods (particulate)

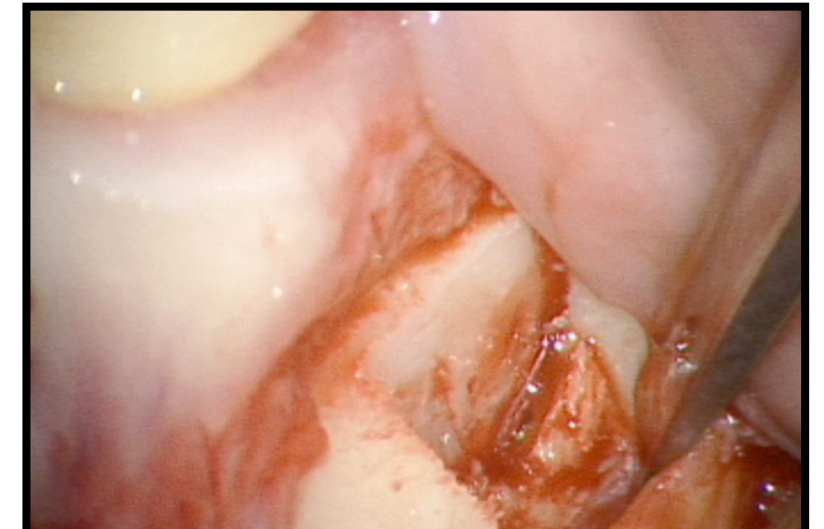
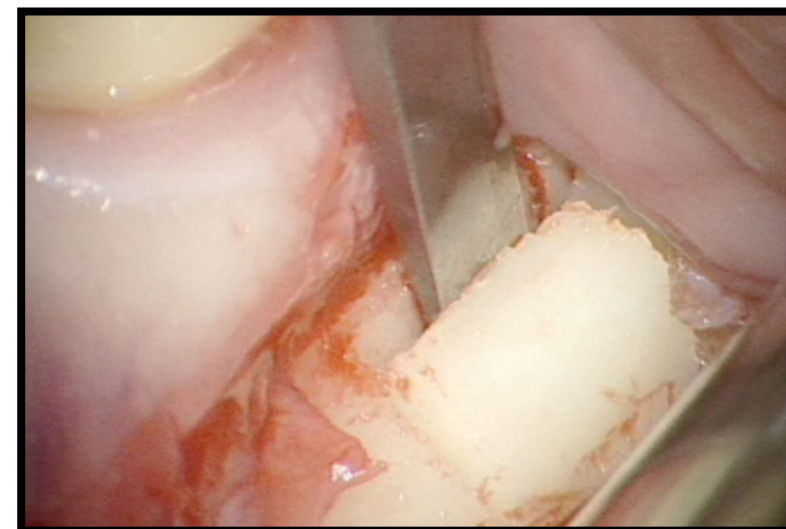
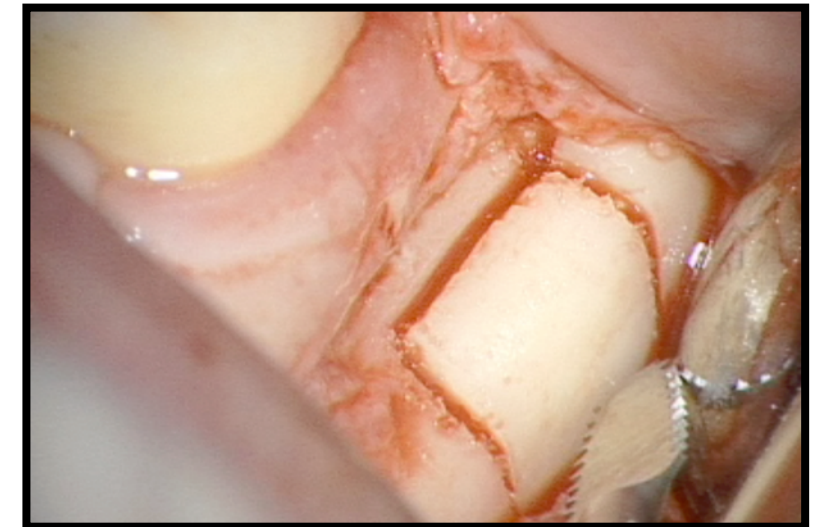
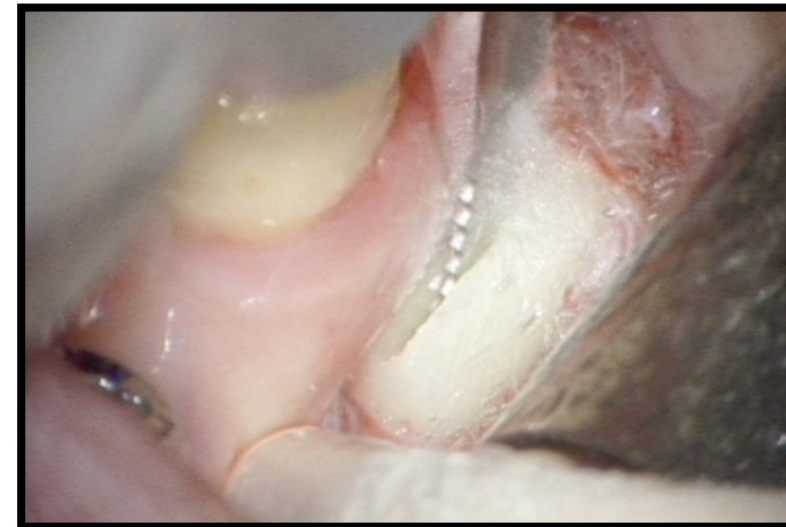
Berengo et al. 2006

- OIBS harvested particles of larger size

Chiriac et al. 2005

- Level of scientific evidence:  
longitudinal studies (case series)

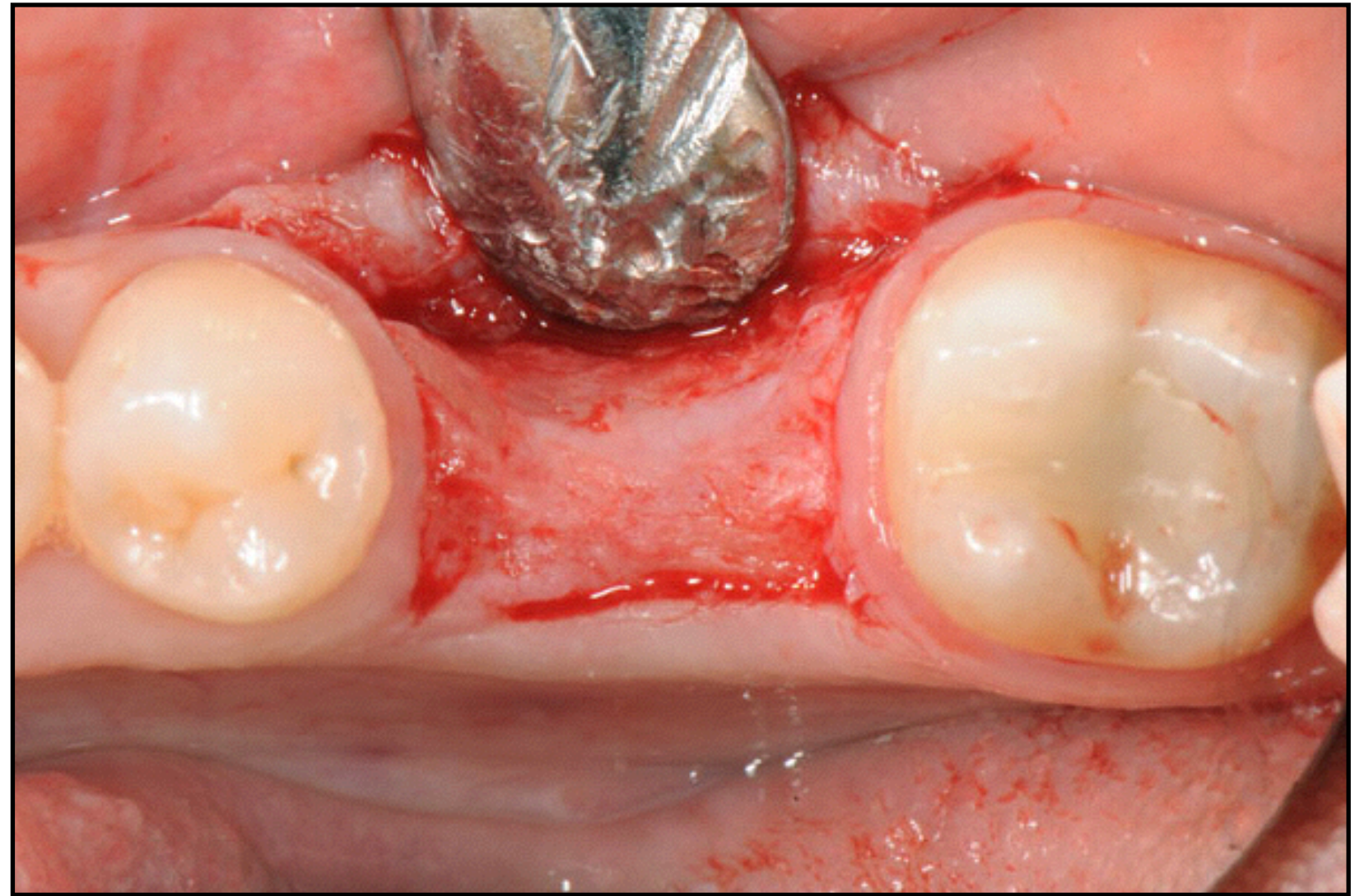
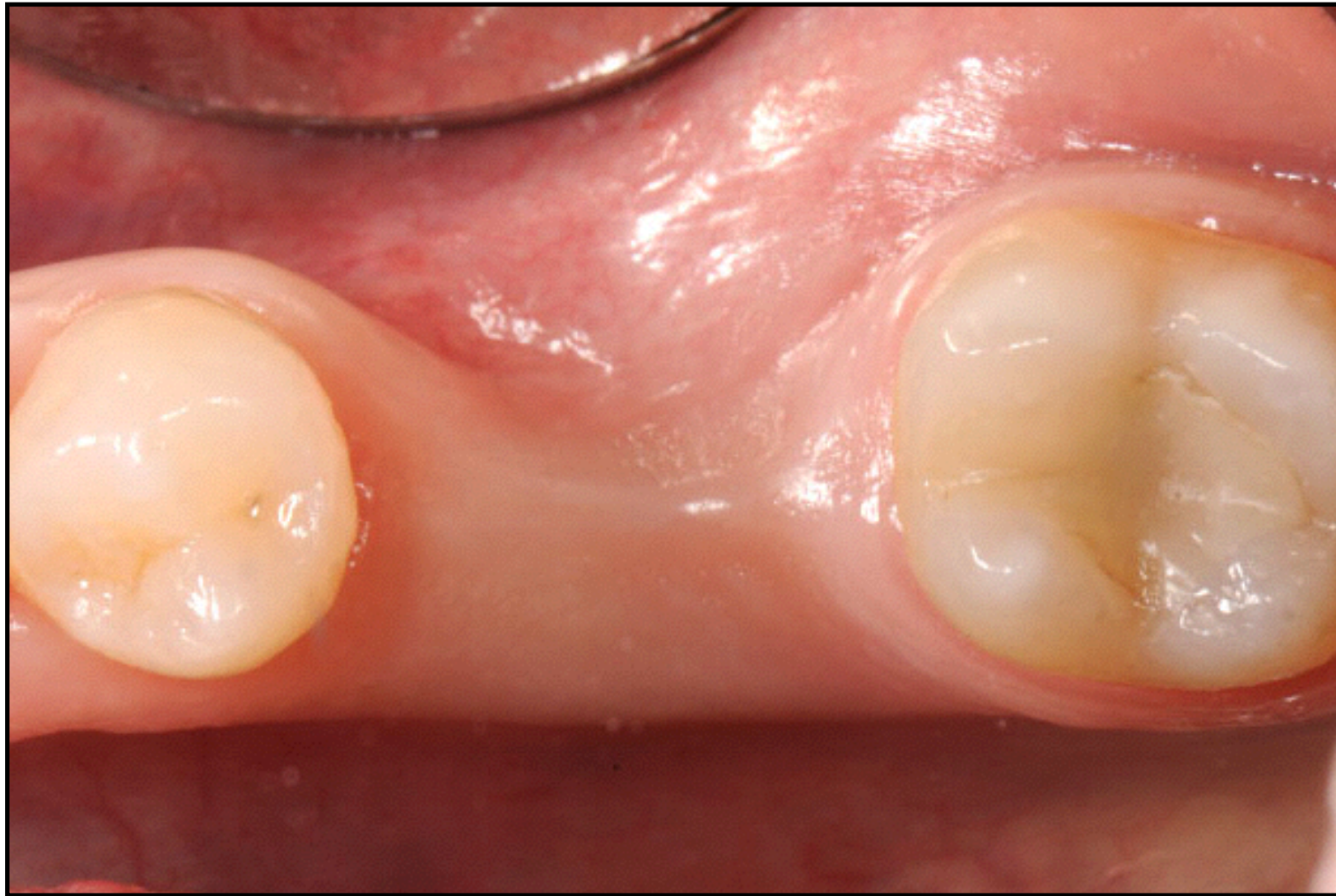
Happe et al. 2007





# Clinical Applications

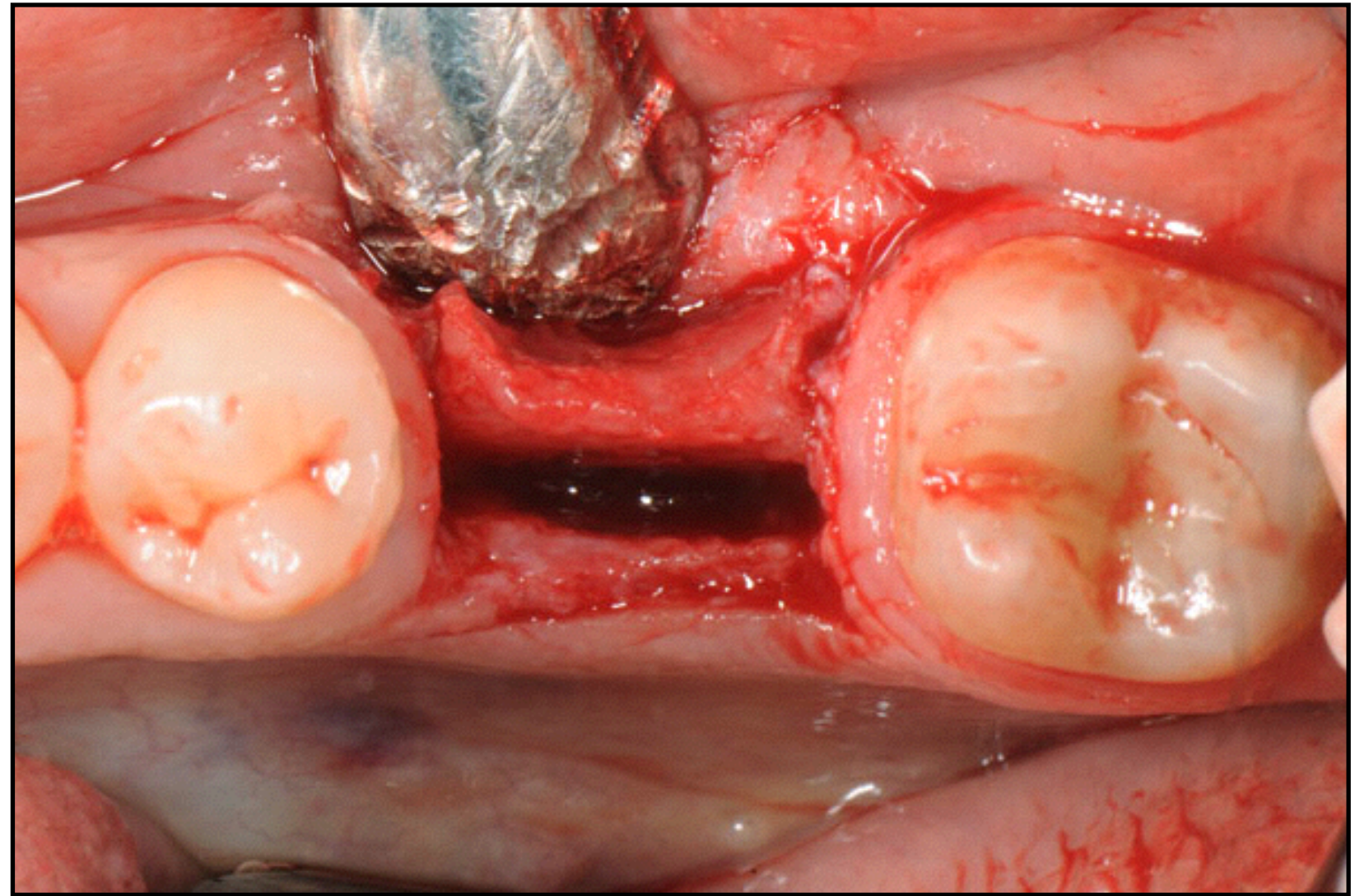
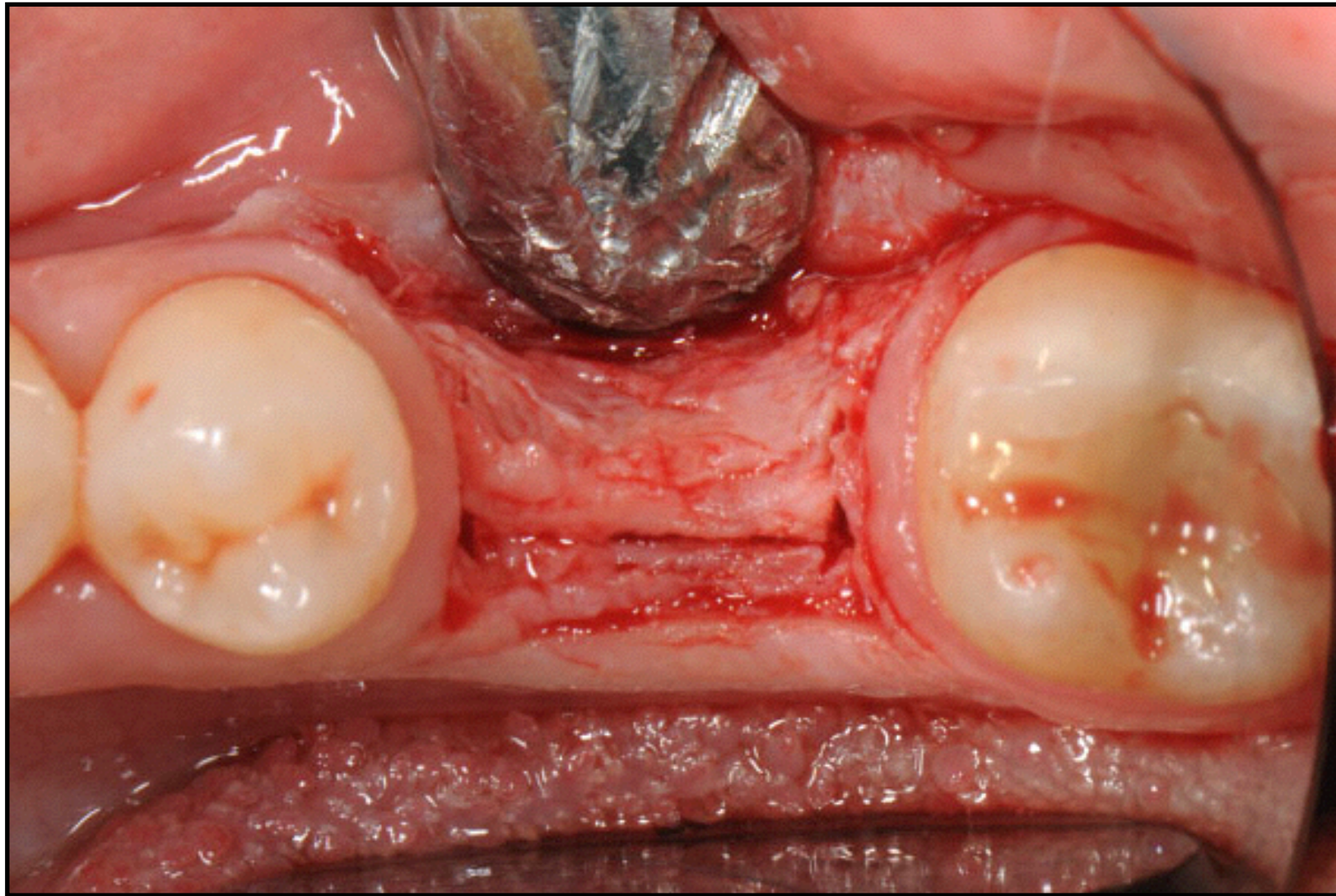
Ridge Splitting





# Clinical Applications

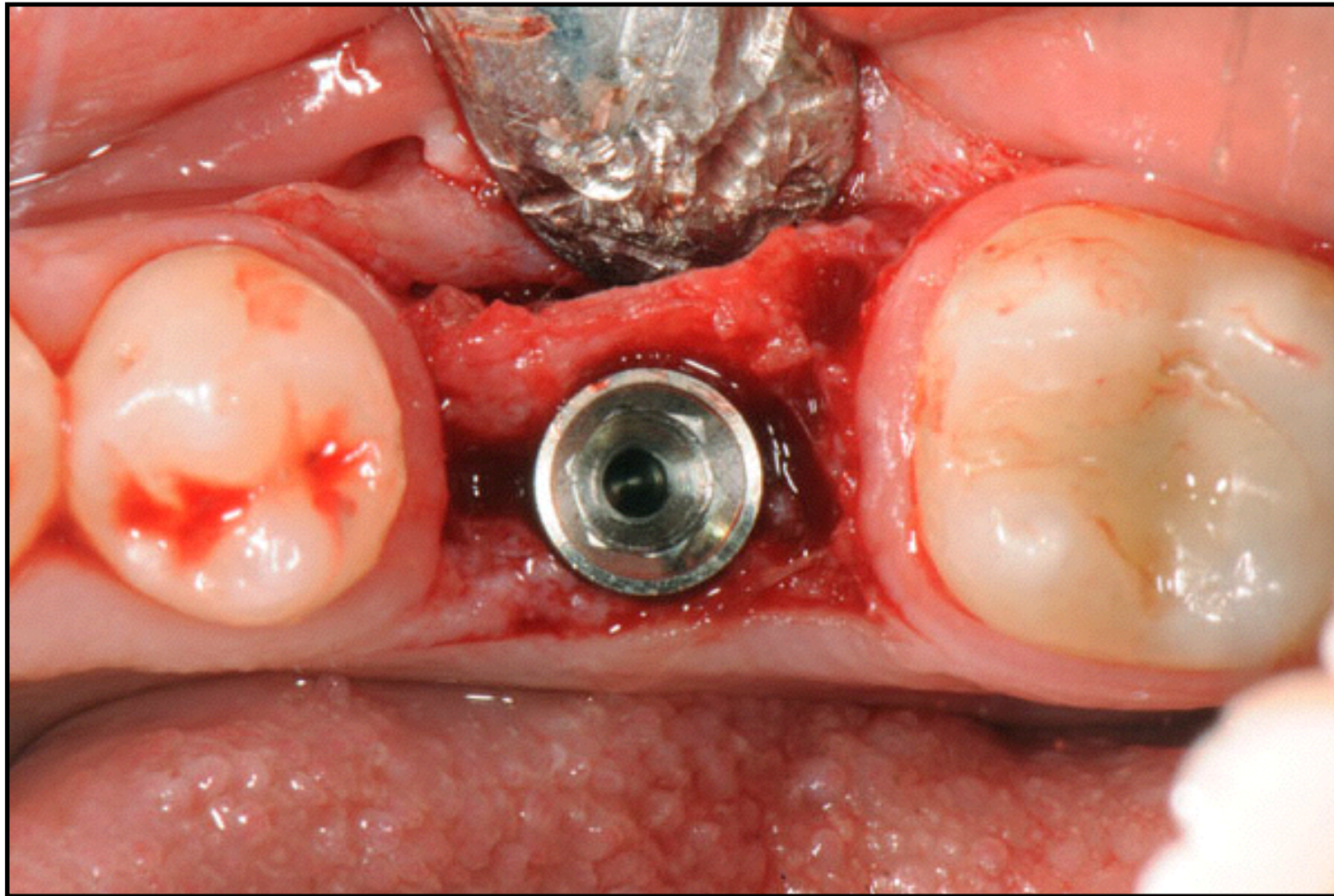
Ridge Splitting





# Clinical Applications

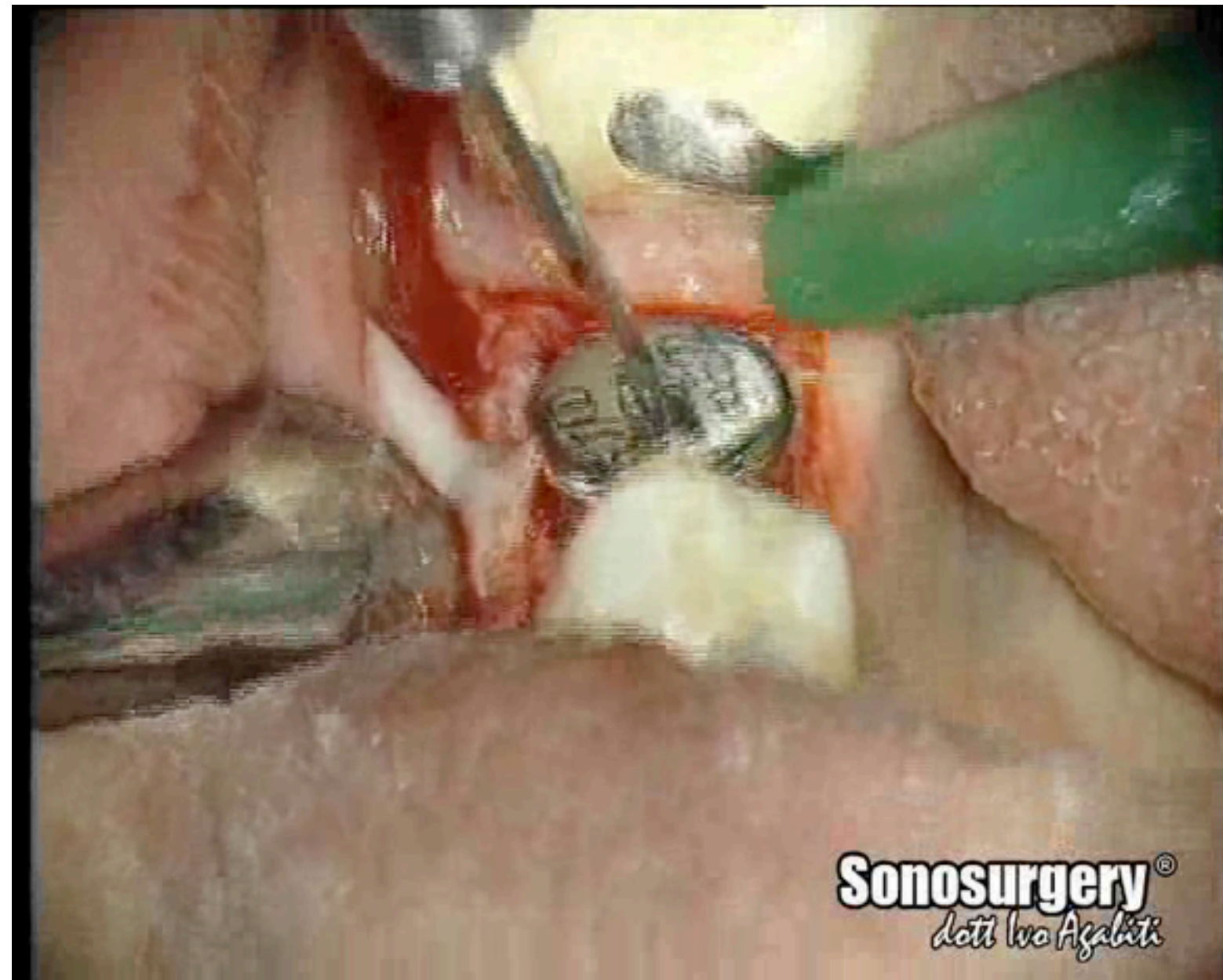
Ridge Splitting





# Clinical Applications

Ridge Splitting



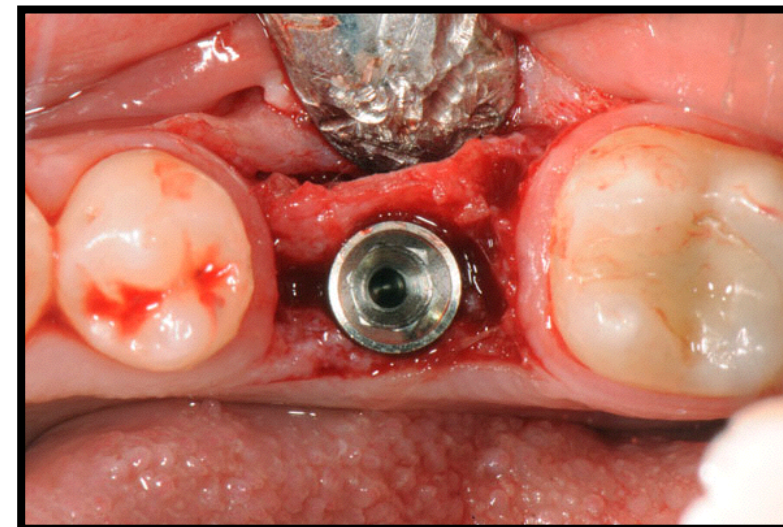
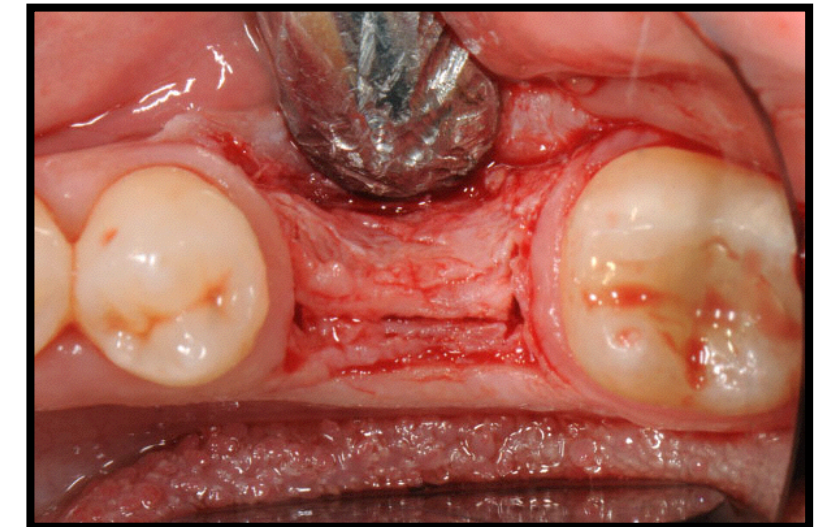
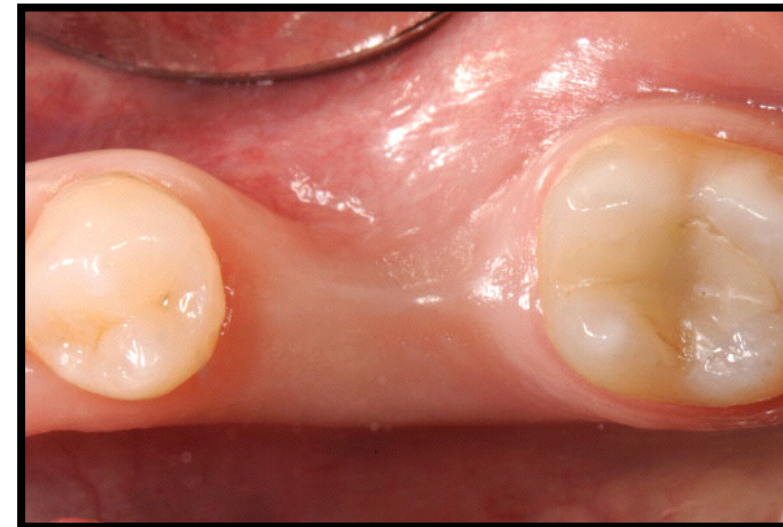
Dr. Ivo Agabiti



# Clinical Applications

## Ridge Splitting

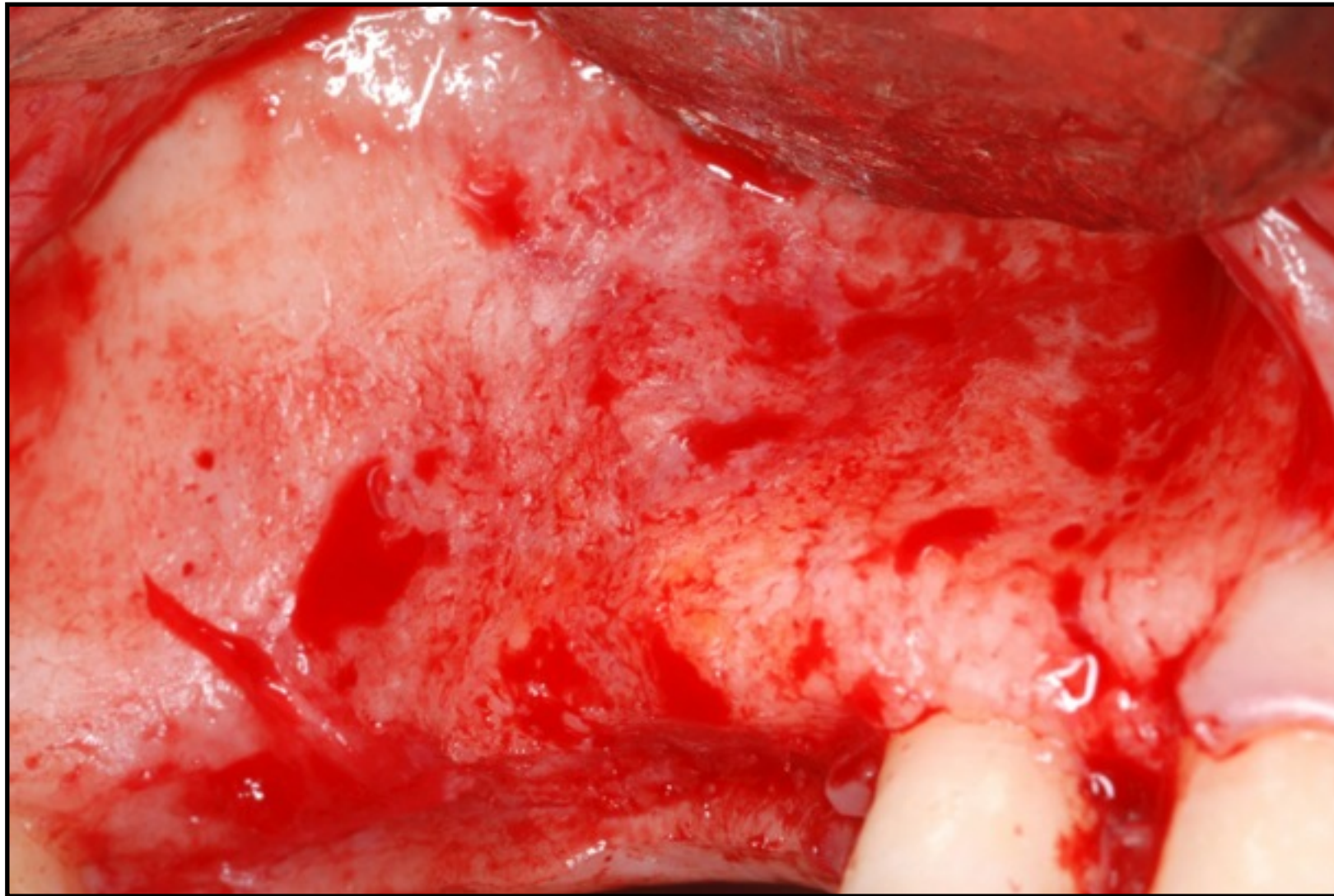
- One of the first application of OIBS  
Vercellotti 2000
- Proposed benefit: better control,  
reduced risk of soft tissue injuries
- Level of scientific evidence:  
longitudinal studies (case series)





# Clinical Applications

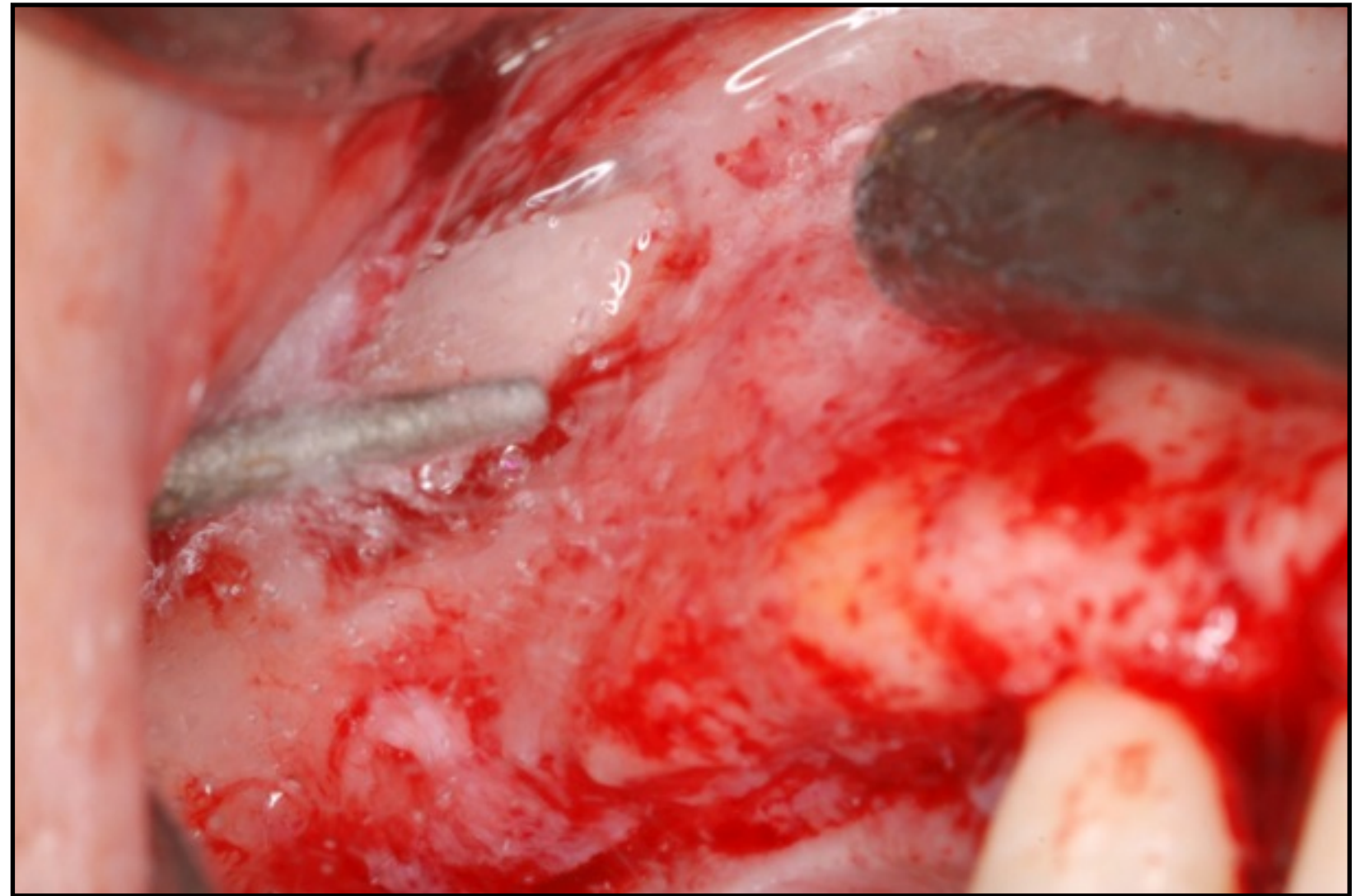
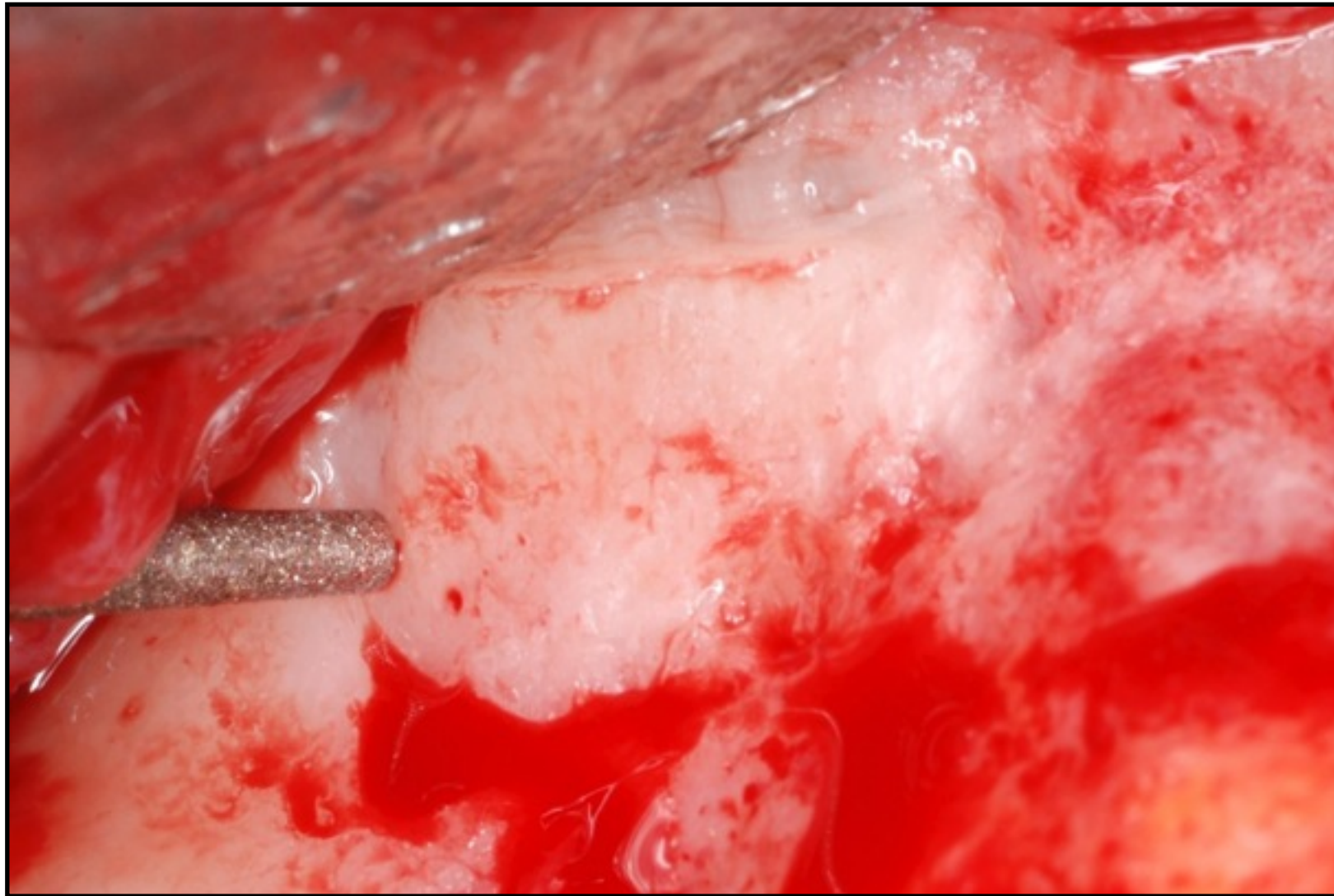
Maxillary Sinus Lift





# Clinical Applications

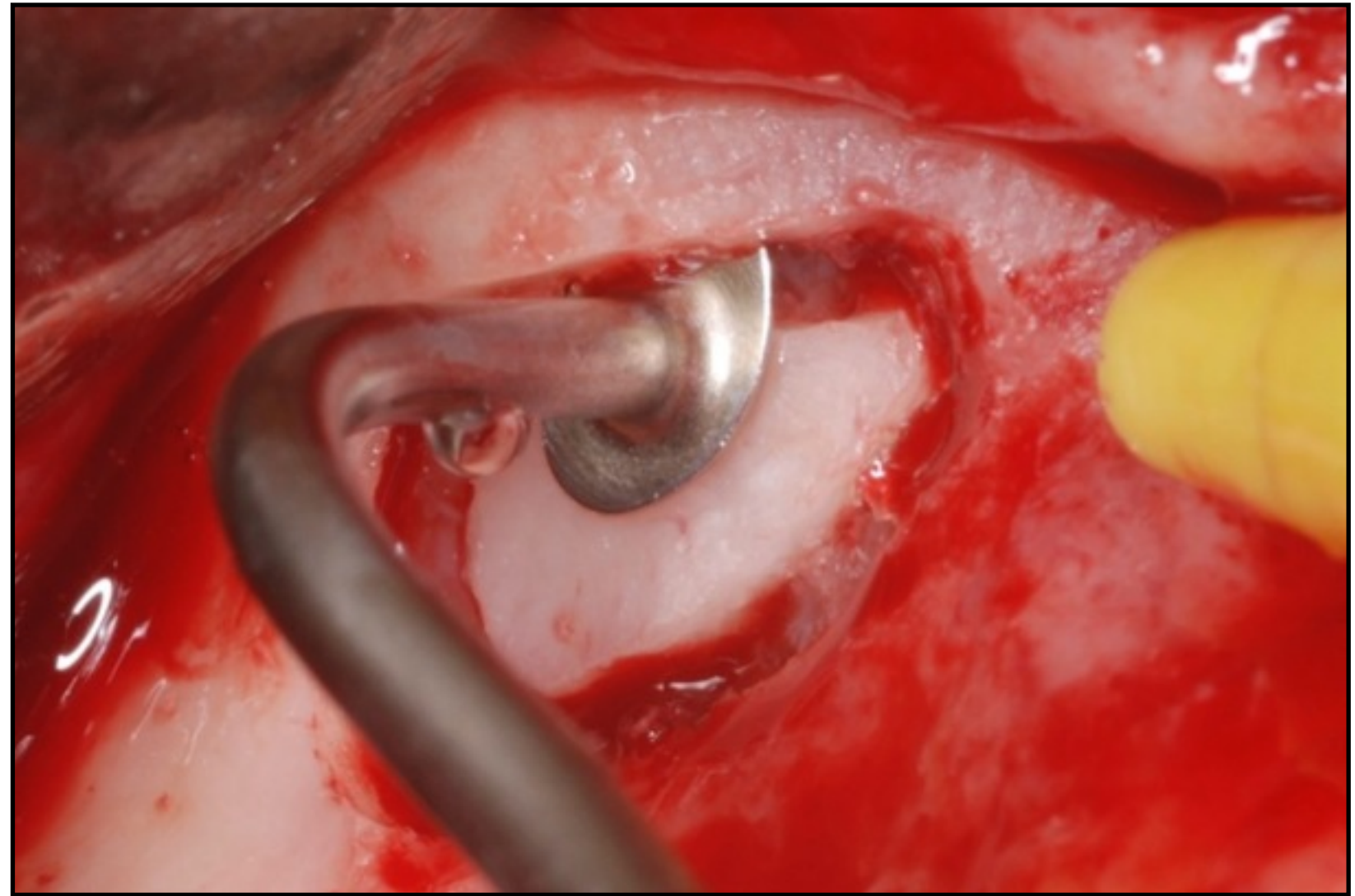
Maxillary Sinus Lift





# Clinical Applications

Maxillary Sinus Lift





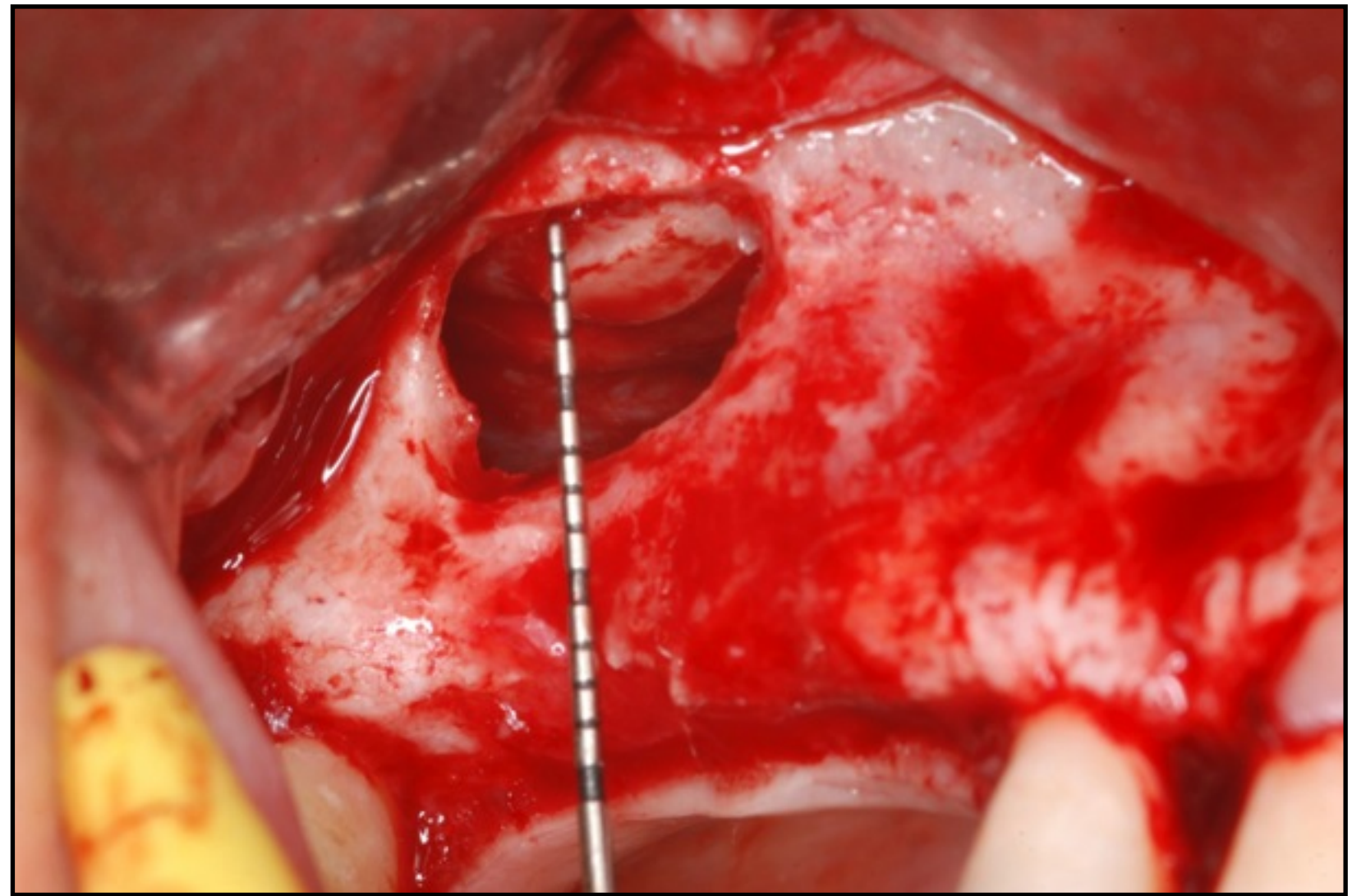
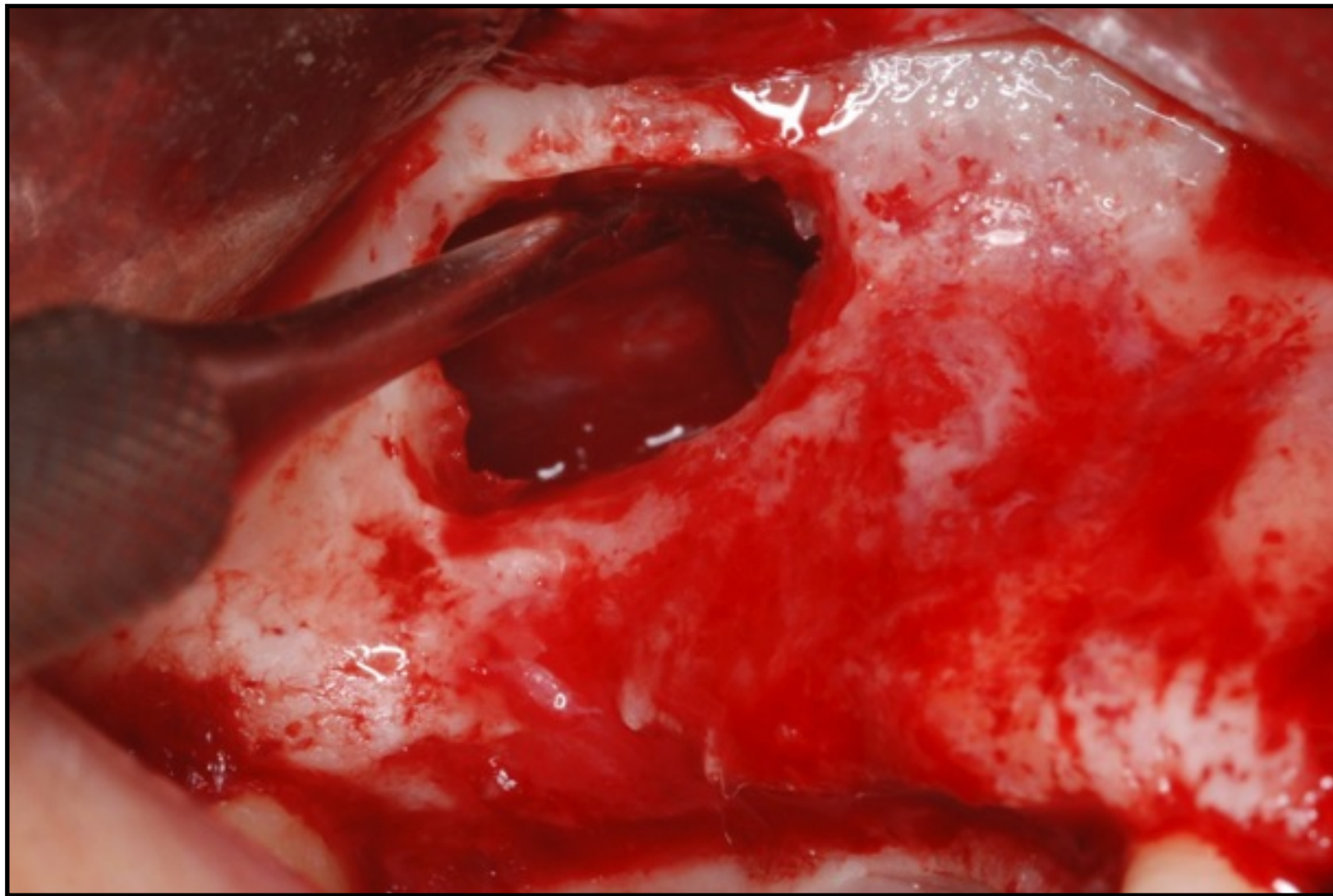
# Clinical Applications

Atraumatic Extraction



# Clinical Applications

Maxillary Sinus Lift





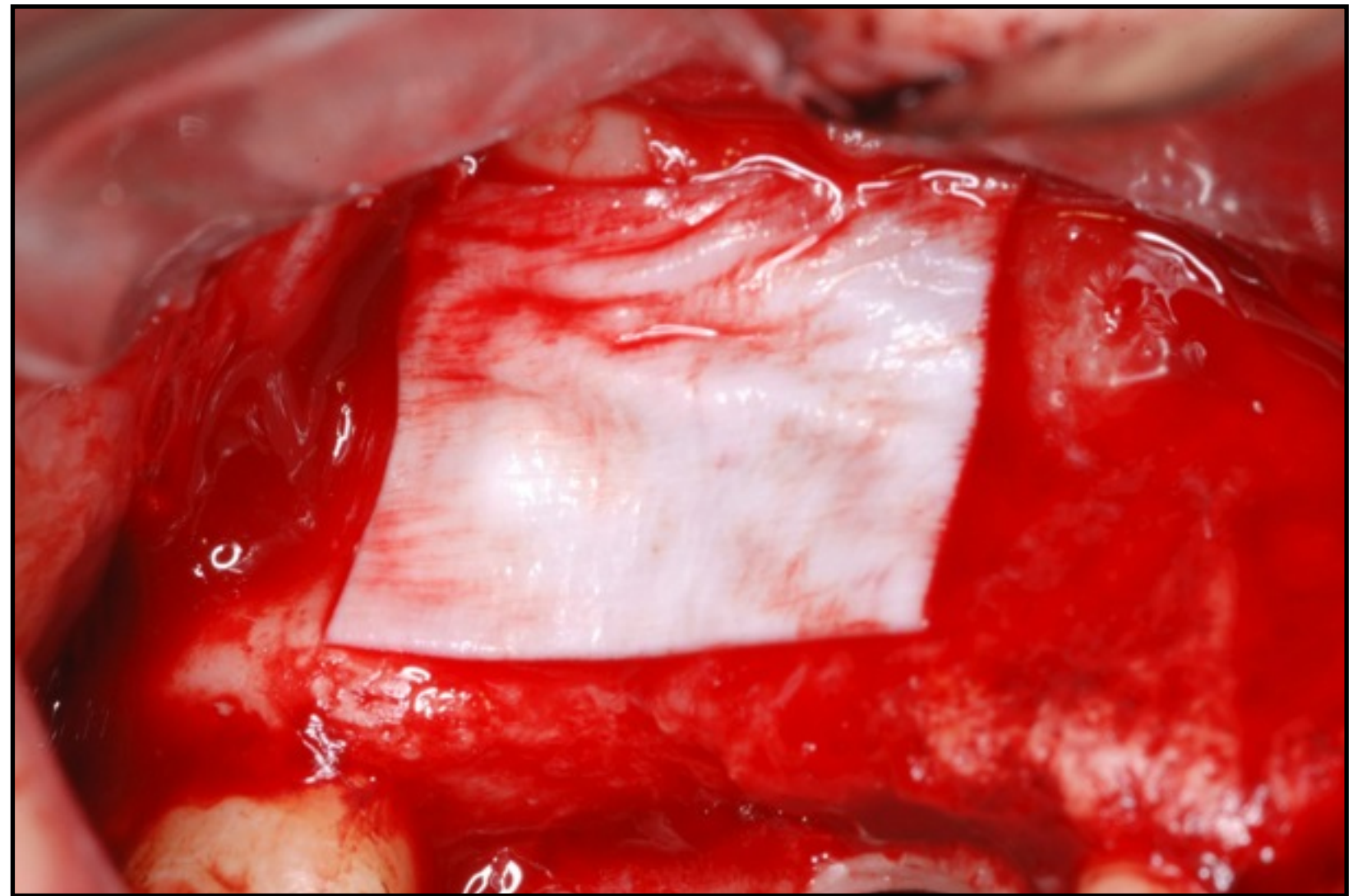
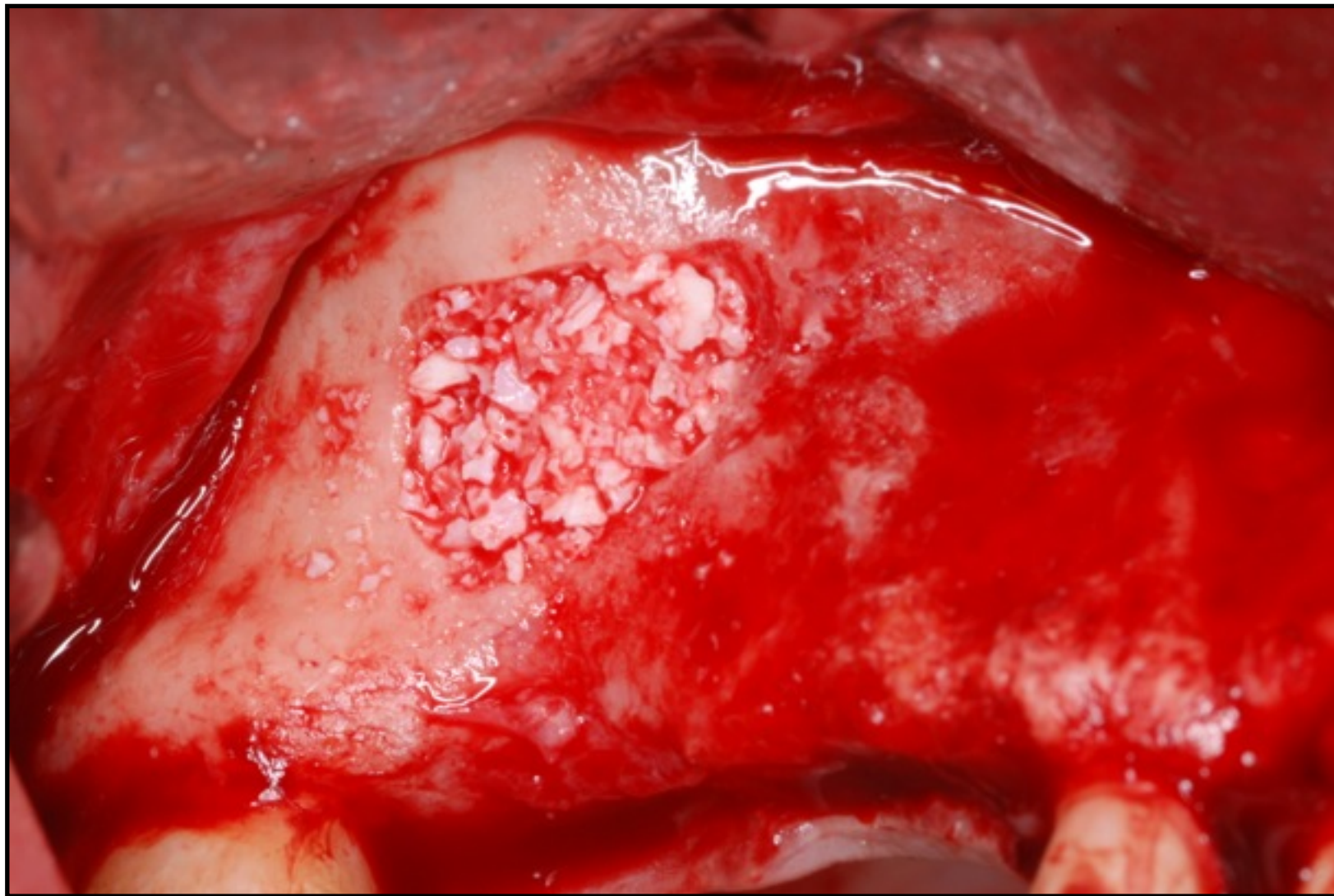
# Clinical Applications

Atraumatic Extraction



# Clinical Applications

Maxillary Sinus Lift





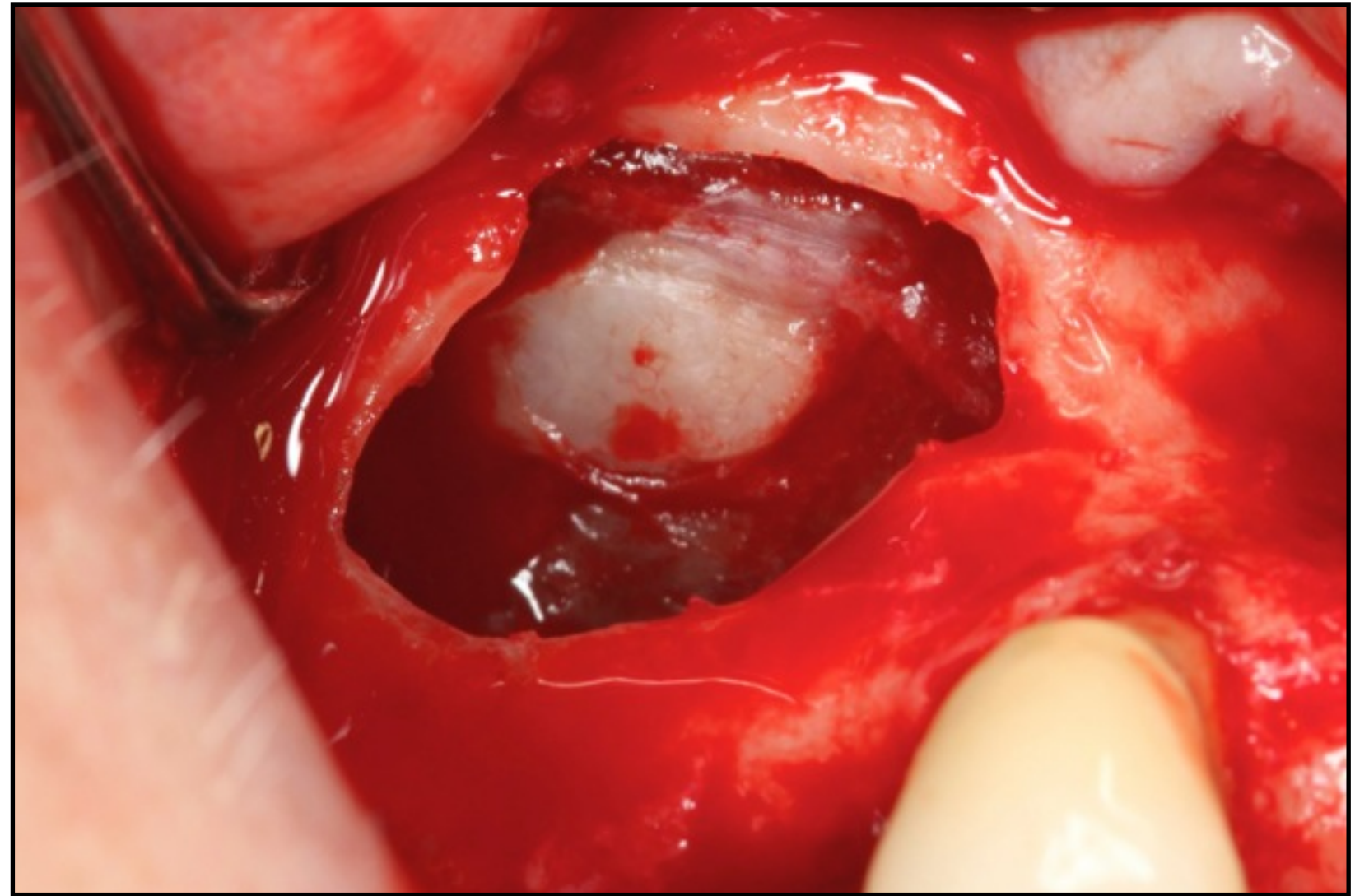
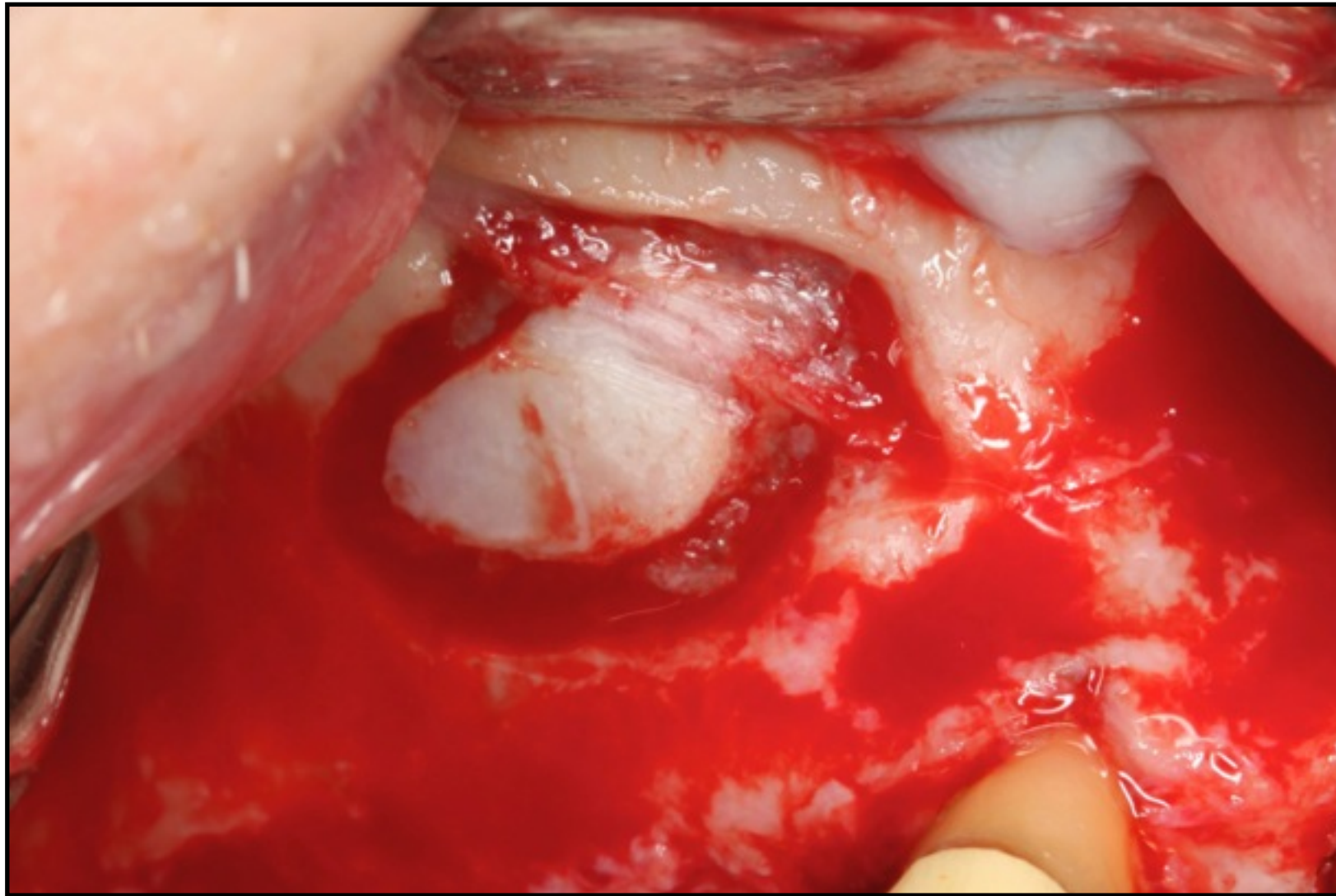
# Clinical Applications

Maxillary Sinus Lift



# Clinical Applications

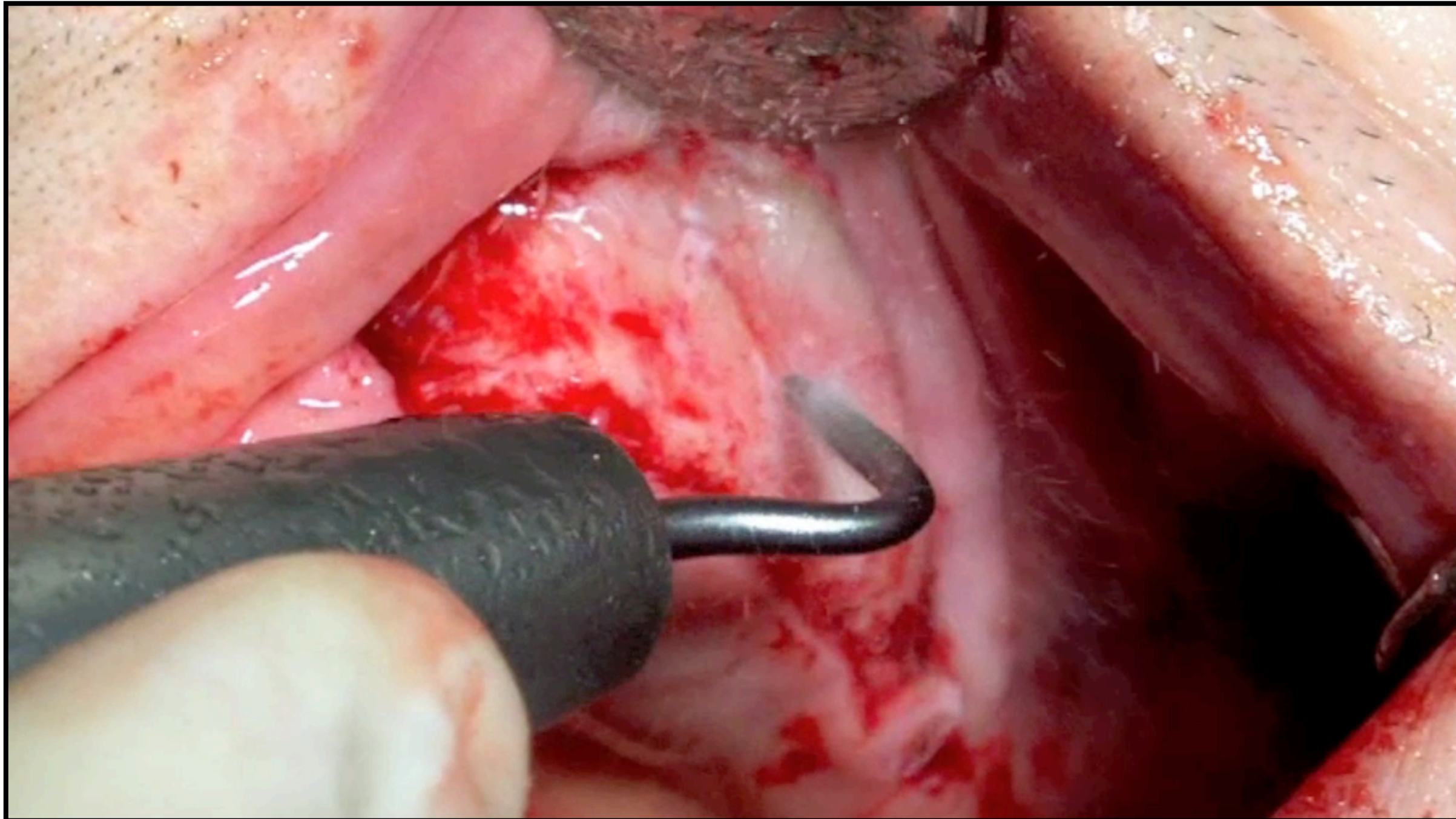
Maxillary Sinus Lift





# Clinical Applications

Maxillary Sinus Lift



# Clinical Applications

## Maxillary Sinus Lift

- Incidence of sinus membrane perforation with conventional surgical technique 14-56%

Wallace et al. 2007

- Incidence of sinus membrane perforation with OIBS 5-20%

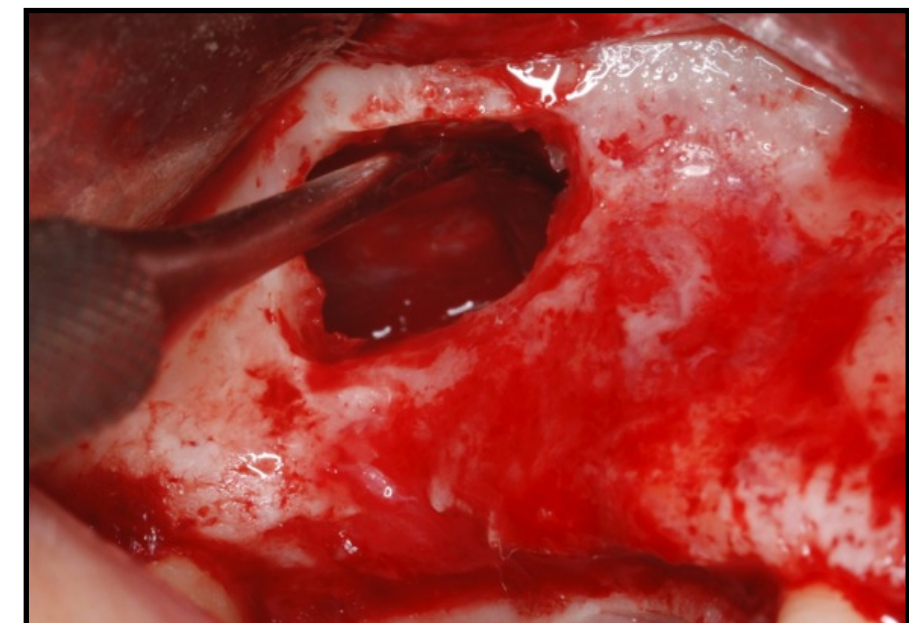
Vercellotti et al. 2001

- Level of scientific evidence:  
randomized clinical trial  
longitudinal studies (case control)  
longitudinal studies (case series)

Barone et al. 2007

Geminiani et al. 2011

Rickert et al. 2011





# Barone et al. 2007 - RCT

- Study could not reject the null hypothesis
- Limited power to show a significant difference

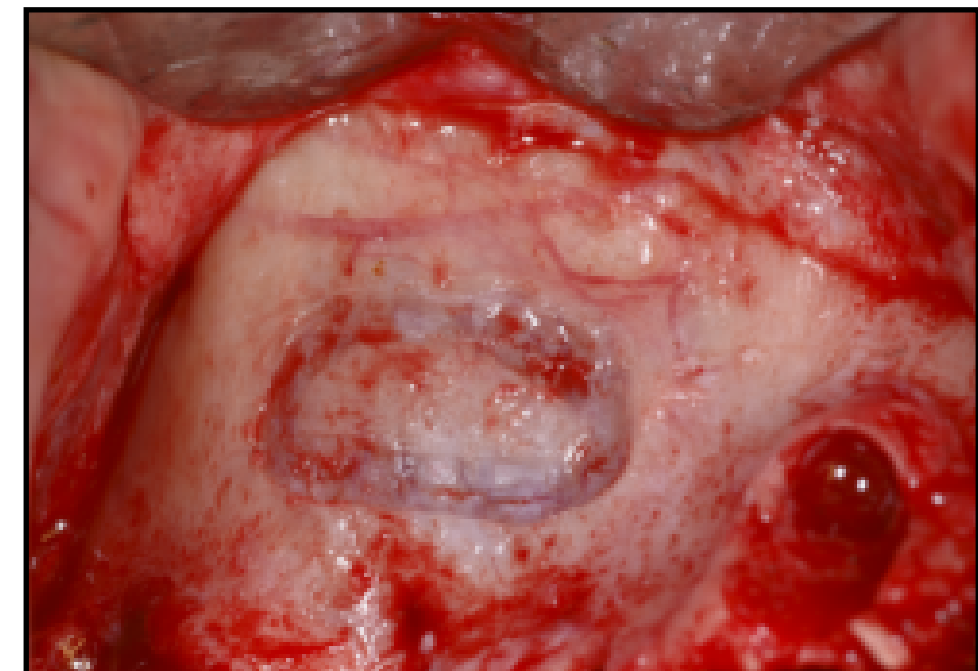
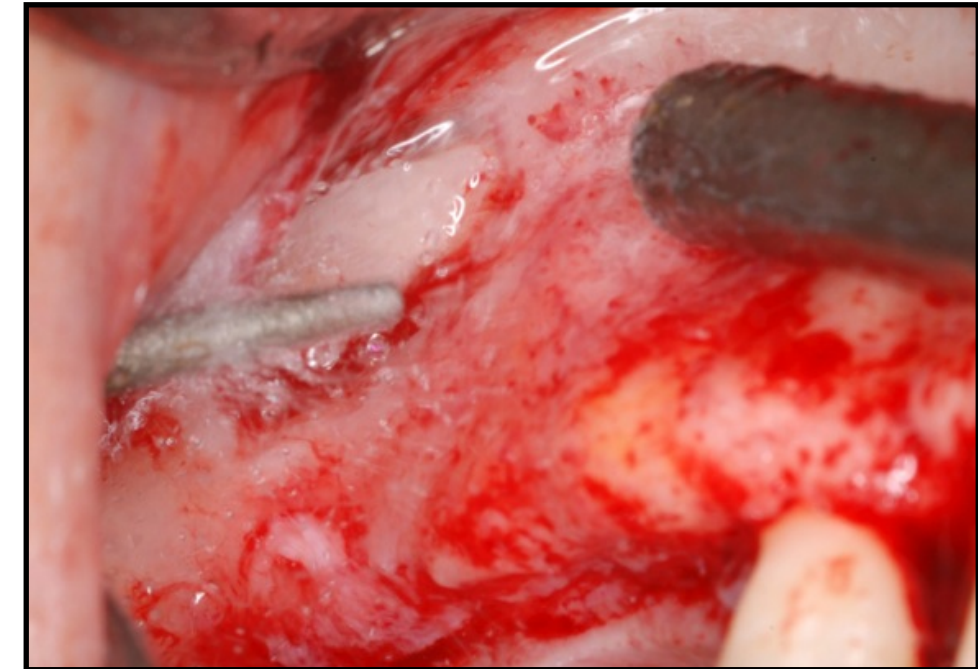
**Table 1. Clinical parameters (mean  $\pm$  standard deviation) during osteotomy and sinus membrane elevation in the piezoelectric group and conventional instruments group**

Parameters	Piezoelectric device (test group)	Conventional instruments (control group)	<i>P</i> value significant for $P < 0.05$
Window height <i>H</i> (mm)	8.9 $\pm$ 1	9.3 $\pm$ 1.1	NS
Window length <i>L</i> (mm)	15.3 $\pm$ 1.5	16.2 $\pm$ 0.7	NS
Window area <i>A</i> (mm <sup>2</sup> )	137 $\pm$ 24.2	151.2 $\pm$ 20.4	NS
Bone thickness <i>T</i> (mm)	0.7 $\pm$ 0.2	0.8 $\pm$ 0.2	NS
Time required (min)	11.5 $\pm$ 3.8	10.2 $\pm$ 2.4	NS
Perforations	4 (30.7%)	3 (23%)	NS

NS, not significant.

# Geminiani et al. 2013

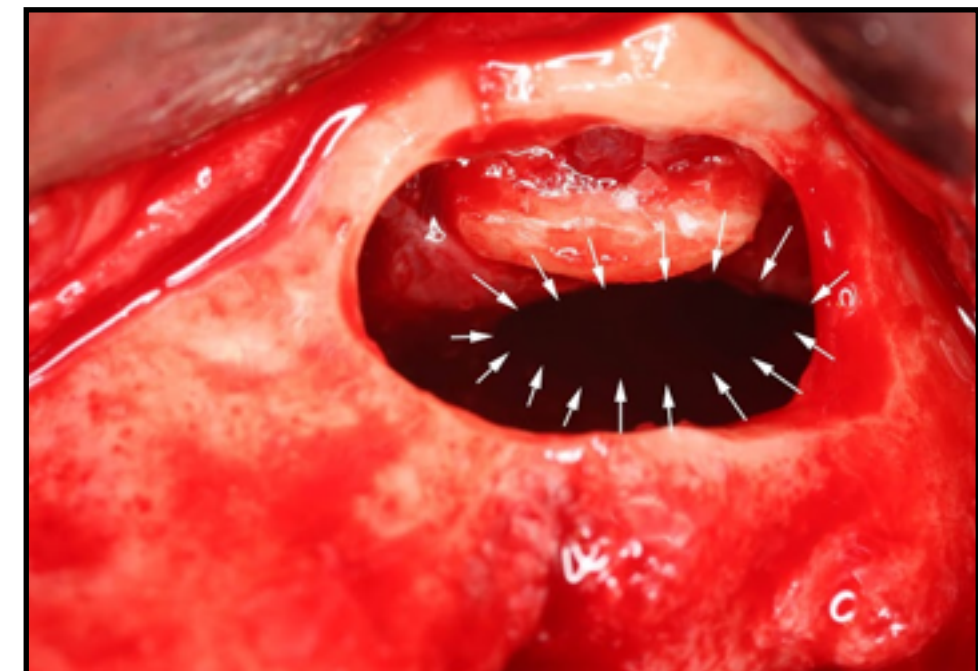
- MM: Retrospective study, chart review, 93 consecutive patients (130 sinus augmentation)
- Group 1 (control): preparation of the window with rotary diamond bur, elevation of the membrane manual instrument
- Group 2 (test): preparation of the window with OIBS (sonic), elevation of the membrane manual instrument





# Geminiani et al. 2013

- Group 1 (control): 51 maxillary sinuses  
27.5% perforation during osteotomy  
43.1% perforation during elevation
- Group 2 (test): 79 maxillary sinuses  
12.7% perforation during osteotomy  
25.3% perforation during elevation
- NS difference in post-operative complications



# Why this difference?

- Possible explanation of difference two study:
  - Sample size
  - Operator experience
  - Bias study design
  - Difference sonic - ultrasonic frequency





# Other Applications



Implants



Endo



Crown & Bridge



Scaling

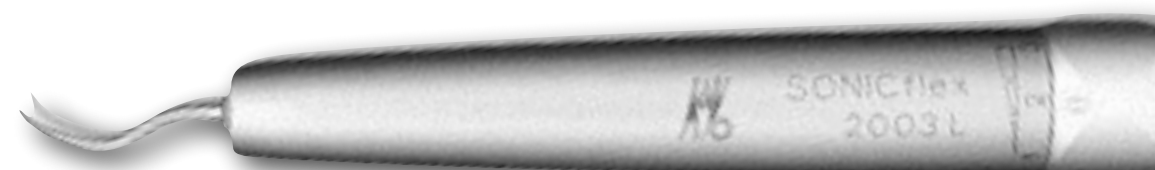
# Other Applications

The tips can also be used in:

W&H Series Synea®

SIROAIR L made by Sirona

SONICflex® made by KaVo.





# Clinical Applications

Crown & Bridge



# Clinical Applications

Crown & Bridge





# Clinical Applications

Crown & Bridge



# Clinical Applications

Crown & Bridge





# Clinical Applications

Crown & Bridge



# Conclusions

1. Sonic handpiece is a versatile tool with numerous applications in restorative dentistry, periodontics, implants & oral surgery
2. The incidence of intra-operative complication might be reduced by using non-rotating surgical tools
3. The learning curve of complicated surgical procedure might be reduced by using “safer” surgical tools (confidence, better visibility and control)

