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Educational Objectives:
This clinical study will offer the dental professional the basic steps needed to place and restore a dental implant in the esthetic zone. After reading this article, the reader should be able to:
1. Understand the methods used in the atraumatic extraction of a tooth
2. Plan and execute bone grafting with guided tissue regeneration
3. Understand the steps used in the surgical placement of a tissue level dental implant
4. Have the ability to restore a dental implant

Author Profiles
Dr. Ian Shuman maintains a full-time general, reconstructive, and aesthetic dental practice in Pasadena, Maryland. Since 1995 Dr. Shuman has lectured and published on advanced, minimally invasive techniques. He has taught these procedures to thousands of dentists and developed many of the methods. Dr. Shuman has published numerous articles on topics including adhesive resin dentistry, minimally invasive restorative, cosmetic and implant dentistry. He is a Master of the Academy of General Dentistry, an Associate Fellow of the American Academy of Implant Dentistry, a Fellow of the Pierre Fauchard Academy. Dr. Shuman was named one of the Top Clinicians in Continuing Education since 2005, by Dentistry Today.

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Abstract
The diagnosis and extraction of a fractured root is a common occurrence in clinical dentistry. The missing tooth can be restored in a variety of ways. This course will demonstrate the evaluation, treatment planning and implementation of surgical extraction, bone grafting with guided tissue regeneration, implant placement and subsequent restoration of an extracted maxillary second premolar.

Introduction
When presented with a tooth requiring extraction with replacement by implant, each stage of the process and future planning for those processes must be carefully considered. The extraction must be performed with maximum bone preservation for the future implant bed, followed by the placement of the implant and finally its restoration.

Case History
In this case, a 32-year-old female presented with the chief complaint of pain during function in the maxillary left second premolar. The tooth had a history of root canal therapy and porcelain fused to metal crown. (Figure 1) The crown had been in function for five years. Following a comprehensive examination with radiographs, the occlusion was evaluated and it was determined that there was idiopathic hyperocclusion. The occlusion was adjusted, however the pain persisted. At a subsequent appointment all occlusal contacts were relieved in all paths of function. This did not relieve the symptoms and soon thereafter a buccal fistula developed.

Figure 1.

Periodontal probing was within normal limits and a tracer film was taken using gutta percha introduced into the fistulous tract. The radiograph revealed the lesion originating from the mesio-radicular aspect, two-thirds up the root surface. The patient was placed on antibiotic therapy and root canal retreatment was considered. After one week of antibiotic therapy, the patient returned to initiate retreatment of the root canal. The possibility of root fracture was discussed and if present, immediate extraction followed by an implant and crown in the future would be necessary. The decision to proceed with implant therapy was made.

At the surgical appointment, the patient was instructed to rinse with a bacteriostatic rinse (Tooth and Gums Tonic, Dental Herb Co.). Typically, antibiotic premedication is given when dealing with sites already infected or requiring aseptic a technique as possible. Either 2 grams of penicillin or 600mg of clindamycin are given orally. Although used for premedicating at risk patients as per the American Heart Association, it is also helpful in all patients to create a spike in blood levels in patients receiving oral surgical care. This patient was already on a course of antibiotic therapy so this was not required. The surgical site was then anesthetized using 1.8cc 4% Citanest Plain (Dentsply Pharmaceutical), followed by 3.6cc 0.5% Marcaine with epinephrine 1:200,000 (Cooke-Waite) on the buccal and palatal aspects. The crown was sectioned and removed and a fracture was discovered upon chamber access running in a mesio-distal direction extending into the floor of the chamber. The buccal aspect of the tooth demonstrated mobility. It was determined that the tooth was hopeless due to a non-restorable fracture and extraction was initiated.

Extraction
When extraction of a tooth is needed in a potential implant site, it is vital to the success of the future implant that the proper amount and density of bone exists. The extraction must be as atraumatic as possible, and any defects in and around the socket must be corrected. To achieve rapid healing for sockets and socket defects, bone grafting and guided tissue regeneration are necessary.

The periodontal ligament was severed circumferentially using a #2 periotome (Karl Schumacher) and several minutes are allowed to elapse. This promotes bleeding in the periodontal ligament space and creates a hydraulic action that pushes the tooth in a coronal direction. Elevating forces were then placed on the mesial and distal aspects of the root using a specialized elevator, The Periotome (Salvin Dental). This instrument has a specialized purchase point and small handle that prevents fracture using lower torqueing forces. A forceps was finally used to remove the tooth with minimal effort. (Figure 2) These surgical tools are used in concert because it is imperative to extract a tooth with minimal damage to the surrounding bone. This bone must be kept whole and undamaged to provide a future implant site.
The socket was then evaluated for any imperfections and a 5mm fenestration was discovered on the buccal aspect, approximately 10mm apical to the crest of bone. This was due to the buccal fistula that had formed as a result of the fractured root. Granulomatous tissue was curetted using a spoon excavator enucleating the infected site. Next, the socket walls on the palatal, mesial and distal were perforated to a depth of 1mm with a #2 surgical length round bur (SS White) to induce blood flow. This new blood flow contains osteoprogenitor cells that will greatly aid in the bone grafting process. A resorbable guided tissue membrane, RCM6 (Ace Surgical) was placed against the buccal wall. The method of Guided Tissue Resorption is vital in assisting complete bone regrowth in socket walls when a defect is present. Without it, the soft tissue, which has a greater rate of growth than bone will invade the socket and prevent future implant placement.

**Bone Grafting**

A small particle (250-1000 mic.) cancellous particulate human bone allograft (alloOss, Ace Surgical) was hydrated in sterile water and placed into the socket. Resorbable collagen tape (Ace Surgical) was placed over the socket and a figure eight suture was placed using 4.0 chromic gut. Prescriptions were written to aid in post-operative healing and pain management, home care instructions were given orally and written and the patient dismissed. The patient was seen at 10 days post-op for evaluation.

**Evaluation of site for implant size**

When considering an implant as a restorative choice, the size of the three-dimensional bony site must be determined. (Figure 2) There are several methods to determine whether the site is ideal, from the simple to the more complex. These include but are not limited to visual inspection, digital palpation, periodontal probing, the use of bone calipers, radiographs, CT scan, and cone beam computerized technology.

This case will focus on basic, cost effective evaluation methods for the single site implant. Perhaps the easiest method for determining the status of the implant site is a combination of radiographs and bone calipers. Because the implant occupies a three-dimensional space, three measurements are needed: horizontal distance between the adjacent roots, vertical height of available bone, and the width or thickness of the available bone.

**Bone Mapping: Horizontal and vertical space**

A radiograph of a single site can be used to measure the two-dimensional distances between the adjacent roots, and the vertical length or height of available bone. The minimum distance between the implant and adjacent root is 1.5 -2.0mm and between adjacent implants; 3.5-4mm. This provides an adequate amount of inter-implant-radicular bone space necessary for an adequate blood supply. This blood supply is required to nourish the periodontal ligament of adjacent tooth roots and bone of adjacent implants and the bone surrounding the new implant with the cells required for creating osseointegration of the titanium-bone interface. Encroaching on this space will compromise the blood supply and potentially damage the periodontal ligaments.

**Bone Mapping: Width**

The bucco-lingual width of available bone can be determined with a bone caliper taking regular measurements in the mouth, from the most coronal aspect of the edentulous surgical site to the desired apical height. In addition, probing the periodontal spaces of adjacent teeth will aid in determining the health of the site. Any periodontal therapy needed for the adjacent teeth can be performed prior to implant surgery and the site reevaluated following healing.

**Implant size selection:**

Based on the above measurements, the size of the implant needed can then be determined. In this case, a conical self-threading screw type implant was selected (Biodenta). Measurements of the implant bed were taken based on the above criteria and the results were as follows:

- **Horizontal:** 10.5mm (between adjacent root/implant)
- **Vertical:** 13.3mm (from crest to below the maxillary sinus)
- **Width:** 7.8mm (from palatal to buccal at the narrowest point)

Implant size selected: 3.5mm wide by 10mm long

The horizontal size of the implant was based on subtracting 2mm from the adjacent root and 4mm from the adjacent implant. Based on these calculations there was 4.5mm of space leaving adequate space for a 3.5mm implant. The vertical length of 10mm of the implant was based on the height of the adjacent root/implant and it simply is not necessary to place an implant with any considerable length beyond this. There must be sufficient bone to house the 3.5mm wide implant. A 7.8mm bone width provides

![Figure 2.]
more than adequate space for this. Because this case was located in the posterior, and there was a sufficient amount of soft tissue, a tissue level implant was selected.

**Implant Type Selection: Tissue Level vs. Bone Level**

While this article is by no means an official guide to implant types and their variations in design, the following should offer a brief review of the basics of these two varieties of implants. (See table 1)

<table>
<thead>
<tr>
<th>Table 1 image a: Tissue Level</th>
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<tbody>
<tr>
<td>1. Short neck area of 1.5 mm</td>
</tr>
<tr>
<td>2. Gentle cortical area for smooth osseointegration</td>
</tr>
<tr>
<td>3. Cylindrical core area for precise positioning</td>
</tr>
<tr>
<td>4. Self-cutting thread</td>
</tr>
<tr>
<td>5. Sharp and conical screw head for easy placement</td>
</tr>
<tr>
<td>6. Safe and reliable connection with abutment done by octagonal connection</td>
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<table>
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<th>Table 1 image b: Bone Level</th>
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<tbody>
<tr>
<td>1. Tight Fit Connection — tight and stable</td>
</tr>
<tr>
<td>2. Cylindrical core area for precise positioning</td>
</tr>
<tr>
<td>3. Internal thread for stable osseointegration</td>
</tr>
<tr>
<td>4. Self-cutting thread</td>
</tr>
<tr>
<td>5. 6° conical hex connection system</td>
</tr>
<tr>
<td>6. Platform switching</td>
</tr>
</tbody>
</table>

**Bone level implant pros and cons:**

1. The bone level implant, as its name suggests, is placed to the crest of the bone or slightly sub-osseous.
2. It is best used in anterior tooth replacement where aesthetics are a concern, but can also be used in any other position in the arch.
3. This type of implant offers a wide range of options when designing an abutment and has great flexibility in correcting a less than desirable implant angulation.
4. Unless a healing cap is placed at the time of surgery, a second stage surgical procedure is required to access the implant.
5. The implant-abutment interface is at the level of crestal bone or slightly sub-osseous.
6. A micro-gap between the implant and the abutment has been identified.

7. This micro-gap has been implicated in the bone loss known as saucerization that occurs in the first two millimeters of the crestal bone.

**Tissue level implant pros and cons**

1. The tissue level implant is placed to the crest of the bone with the polished collar extending coronally, housed in soft tissue.
2. The tissue level implant is ideal in the posterior.
3. The gingival margin and emergence profile of the tissue level implant is already built in to the implant.
4. Since the abutment-implant interface is above the crestal level of bone, the problem of bone loss as with a micro-gap in the bone level implant is eliminated.
5. This type of implant does not require surgical recovery, which is commonly necessary with a bone level implant.

**Surgical Treatment: Preparation**

At the surgical appointment, the patient was instructed to rinse her mouth with a bacteriostatic rinse (Tooth and Gums Tonic, Dental Herb Co.). She was given 600mg clindamycin and 800mg Motrin orally. As previously mentioned it has been found helpful in all patients to create a spike in blood levels with an antibiotic in patients receiving oral surgical care. The surgical site was then anesthetized using 1.8cc 4% Citanest Plain (Dentsply Pharmaceutical), followed by 3.6cc 0.5% Marcaine with epinephrine 1:200,000 (Cooke-Waite) on the buccal and palatal aspects. (Figure 3)

**Flap Selection**

An incision was made along the crest of the ridge from mesial to distal. The incision was made vertically, avoiding the papillae and extending several millimeters into the mucogingiva on the buccal. Because a tissue level implant was used, this type of flap is necessary. Although this case could have been accomplished without an incision, there is no substitute for direct visualization of the surgical site and complete evaluation of the bone. In addition, evaluation of the guided tissue healing could be directly evaluated and further repair made if necessary.
Osteotomy

A full thickness flap was raised using a periodontal elevator. With the flap reflected, the bony crest was evaluated. At this point, the success of the guided tissue and bone graft was observed. A 3mm surgical length round bur was used to create an initial depression or dimple in the crestal bone. This was followed by drilling into the bone to a depth of 4mm using a guide drill followed by a 2mm pilot drill to the same depth. A parallel pin was placed and a radiograph taken to determine the mesio-distal angulation: this is the time to make a course correction, if necessary, allowing some flexibility in the creation of the osteotomy.

Once correct angulation was determined, a depth of 8mm was made using the pilot drill followed again by radiograph with the parallel pin. If the osteotomy is made correctly, the pilot drill is taken to depth, in this case 10mm. The osteotomy was then widened with a 2.8mm drill to the desired predetermined implant length. In general maxillary bone is less dense than mandibular bone and care must be taken not to over-widen the osteotomy. In a newly grafted site the bone is even softer so further widening of the osteotomy was not necessary. A 3.5mm profile drill was used to create a countersink.

Primary stabilization of the implant is achieved through tight contact with the osteotomy. The self-cutting threads of the implant engage this bone, allowing osseointegration to occur during the healing phase. A 3.5mm tissue level implant was selected and screwed into the osteotomy. (Figure 4,5,6) The implant holder was unscrewed (Figure 7) and a radiograph was taken to verify ideal placement and distances from various periodontal anatomic landmarks that will provide a successful outcome. (Figure 8)

The cover screw was seated to place and the flap sutured around the tissue level collar using 4.0 chromic gut. Provisional tooth replacement was not necessary as this area was not visible when the patient smiled. In addition, immediate provisionalization can create movement of the implant, compromising osseointegration. Prescriptions were written to aid in post operative healing and pain management,
home care instructions were given orally and in written form and the patient dismissed. The patient was seen ten days later for post-op evaluation.

**Definitive Prosthetics**

After ninety days the case was ready for a final impression. (Figure 9) Following cover screw removal (Figure 10) a final impression was made of the transfer using polyvinyl siloxane (Honigum, Zenith Dental). There are two impression methods for dental implants: closed tray and open tray techniques.

The closed tray technique uses an implant impression coping that is at the same general occlusal height as the adjacent teeth allowing it to fit comfortably within the housing of a standard impression tray. (Figure 11)

The open tray technique uses an implant impression coping that extends well beyond the occlusal height of adjacent teeth. (Figure 12, 13) A cutout is made in the tray (hence the name open tray) to allow for the elongated impression copings to extend through the tray, providing unencumbered access to the screw hole. (Figure 14, 15) This technique is required most often when multiple implants are being impressed. The open tray technique works as follows: the impression coping is screwed to place and a cotton pellet is placed in the access hole followed by a small ball of beading, orthodontic or similar wax and the impression is made. (Figure 16) Once the impression material is set, the screw hole is accessed by removing the wax and cotton, and the screw is removed. (Figure 17) The impression is then removed essentially acting as a pick up impression for the coping. This prevents movement of the coping, thus maintaining the exact location of the implant.

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**Figure 9.**

![Figure 9 Image](image1)

**Figure 10.**

![Figure 10 Image](image2)

**Figure 11.**

![Figure 11 Image](image3)

**Figure 12.**

![Figure 12 Image](image4)

**Figure 13.**

![Figure 13 Image](image5)

**Figure 14.**

![Figure 14 Image](image6)
Because of the limited posterior inter-occlusal space between opposing arches, a screw retained titanium-to-porcelain crown was prescribed. Upon receipt of the definitive laboratory fabricated crown, it was torqued to 30Ncm as per manufacturer’s specifications. A radiograph was then taken to ensure complete seating and the occlusion evaluated. Occlusal contact was evaluated in maximum intercuspation and all excursive movements were eliminated. The abutment screw hole was filled with a cotton pellet and the access hole closed with direct composite. (Figure 18,19) To ensure a successful outcome the occlusion was evaluated a second time. (Figure 20,21)
Summary
The ability to diagnose and treatment plan the restoration of a fractured tooth is a necessary function in daily clinical dentistry. Presenting the treatment option of extraction with implant replacement to the patient is a must and should always be considered. Practitioners should always present their patients with an entire array of treatment options listing all of their positive and negative attributes.

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1. In this case, the buccal fistula was caused by:
   a. trauma
   b. hyperocclusal forces
   c. root fracture
   d. sinus inflammatory response

2. The open tray technique uses an implant impression coping that...
   a. extends well beyond the occlusal height of adjacent teeth
   b. is housed within the impression tray
   c. requires an intact impression tray
   d. is limited to specific implant cases

3. All of the following instruments were used for an atraumatic extraction except:
   a. periotomes
   b. periotome elevator
   c. forcep
   d. surgical round bur

4. In the bone level implant, bone loss known as saucerization is due to
   __________ .
   a. micro-gap
   b. poorly placed implant
   c. soft maxillary bone
   d. platform switching

5. Saucerization has been seen to occur in the first ______ millimeters of the crestal bone.
   a. 1.5
   b. 2.0
   c. 3.5
   d. 4.0

6. Which of the following is the correct sequence of events when using an open tray impression technique?
   a. A cotton pellet is placed in the access hole followed by a small ball of wax, the impression coping is screwed to place, the screw holes are accessed after the impression is set and unscrewed and the impression is removed.
   b. The impression coping is screwed to place, the screw holes are accessed and lightly unscrewed, a cotton pellet is placed in the access hole followed by a small ball of wax and after the impression is set the impression is removed.
   c. The impression coping is screwed to place, the screw holes are accessed and screwed with double the torque force recommended, a cotton pellet is placed in the access hole followed by a small ball of wax and after the impression is set the impression is removed.
   d. The impression coping is screwed to place, a cotton pellet is placed in the access hole followed by a small ball of wax, the screw holes are accessed after the impression is set and unscrewed and the impression is removed.

7. One of the positive aspects of a bone level implant is:
   a. second stage surgery is required to access the implant
   b. the micro-gap between the implant and abutment
   c. a and b.
   d. none of the above

8. One of the negative aspects of a tissue level implant is
   a. it is ideal in the posterior
   b. The gingival margin and emergence profile of the tissue level implant is already built in to the implant.
   c. Since the abutment-implant interface is above the crestal level of bone, the problem of bone loss as with a micro-gap in the bone level implant is eliminated.
   d. None of the above.

9. To aid in bone grafting, the socket walls are perforated bringing in new blood flow containing what type of cells?
   a. mesenchymal
   b. osteoclasts
   c. osteoprogenitor
   d. a. and c.

10. Which of the following is used to prevent soft tissue in-growth when bone grafting an extraction socket?
    a. bone wax
    b. guided tissue membrane
    c. bone chips
    d. all of the above

11. In this case, what size was the small particle cancellous particulate human bone allograft?
    a. 250-1000 mic.
    b. 500-1000 mic.
    c. 250-500 mic.
    d. 500-1250 mic.

12. Here, the particulate human bone allograft was hydrated in:
    a. sterile water
    b. saline
    c. blood
    d. none of the above

13. The self-threading implant will compress against bone resulting in primary stabilization of the implant. That is why it is important to:
    a. undersize the final width of the osteotomy
    b. oversize the final width of the osteotomy
    c. match the diameter of the osteotomy to the implant
    d. b and/or c

14. Which of the following should not be used to determine whether a site is indeed a good candidate for implant?
    a. a comprehensive examination with radiographs
    b. periodontal charting
    c. bone mapping
    d. none of the above

15. When placing a tissue level implant, what type of flap was used due to its polished tissue collar?
    a. full thickness ridge incision
    b. punch
    c. papillae sparing
    d. z-plasty

16. The minimum distance between the implant and adjacent roots is:
    a. 1.0-2.0mm
    b. 3.0-4.0mm
    c. 1.5-2.5mm
    d. 1.5-2.0mm

17. The minimum distance between the implant and adjacent implants is:
    a. 2.0-2.5mm
    b. 2.5-3.0mm
    c. 3.0-3.5mm
    d. 3.5-4.0mm

18. In this clinical case, which of the following was used to determine the width of available bone?
    a. MRI
    b. CT Scan
    c. bone caliper
    d. periapical radiograph

19. Bone grafting and guided tissue regeneration is necessary for:
    a. rapid healing
    b. encouraging the induction of osteoprogenitor cells
    c. advancing the growth of soft tissue
    d. all of the above

20. When faced with limited posterior interocclusal space between opposing arches, which of the following is used:
    a. bone level implant
    b. separate short abutment and crown
    c. cast crown only
    d. screw retained crown
ANSWER SHEET

Surgical and Prosthetic Implant Treatment of a Maxillary Premolar

Educational Objectives

1. Understand the methods used in the atraumatic extraction of a tooth
2. Plan and execute bone grafting with guided tissue regeneration
3. Understand the steps used in the surgical placement of a tissue level dental implant
4. Have the ability to restore a dental implant

Course Evaluation

1. Were the individual course objectives met?
   Objective #1: Yes No
   Objective #2: Yes No

   Please evaluate this course by responding to the following statements, using a scale of Excellent = 5 to Poor = 0.

   2. To what extent were the course objectives accomplished overall?
      5 4 3 2 1 0
   3. Please rate your personal mastery of the course objectives.
      5 4 3 2 1 0
   4. How would you rate the objectives and educational methods?
      5 4 3 2 1 0
   5. How do you rate the author’s grasp of the topic?
      5 4 3 2 1 0
   6. Please rate the instructor’s effectiveness.
      5 4 3 2 1 0
   7. Was the overall administration of the course effective?
      5 4 3 2 1 0
   8. Please rate the usefulness and clinical applicability of this course.
      5 4 3 2 1 0
   9. Please rate the usefulness of the supplemental webography.
      5 4 3 2 1 0
   10. Do you feel that the references were adequate?
      Yes No
   11. Would you participate in a similar program on a different topic?
      Yes No
   12. If any of the continuing education questions were unclear or ambiguous, please list them.

   13. Was there any subject matter you found confusing? Please describe.

   14. How long did it take you to complete this course?

   15. What additional continuing dental education topics would you like to see?

   Please evaluate this course by responding to the following statements, using a scale of Excellent = 5 to Poor = 0.

   1. A B C D E 11. A B C D E
   5. A B C D E 15. A B C D E
   6. A B C D E
   7. A B C D E
   8. A B C D E
   9. A B C D E
   10. A B C D E

   AGD Code 496, 616

Please photocopy answer sheet for additional participants.