



Implant
Resource
Center

For further information please contact:
Implant Resource Center **(800) 565-3559**
404-1023 Wolfe Ave., Vancouver, BC, V6H1V6 Canada



info@implantresourcecenter.com
www.implantresourcecenter.com

©2004, Revised 2012 by Dr. Harold Bergman. All rights reserved.



Implant
Resource
Center



Dental Implants for Small Animals

www.implantresourcecenter.com

This Manual was a co-ordinated effort by Dr. Anthony, Dr. Mele and Dr. Bergman



Welcome to Dental Implants and Small Animals

Dental implants have been successfully placed and restored and bone grafting procedures performed in humans for over 25 years and are now considered the Standard of Practice for replacement of missing teeth and bone maintenance in humans. Implant dentistry and bone grafting have had limited use in the small animal field with this service being provided by only a few veterinarians. Many veterinarians and other health professionals now believe these protocols can be used successfully for the benefit of small animals.

Approximately **50% or more of small animals have periodontal** disease resulting in tooth extraction. It is estimated that over **2,000,000 teeth are removed annually in small animals in the USA alone**. Generally these teeth are not replaced with implants or grafting procedures resulting in tooth migration and malocclusions, loss of supporting bone, inability to eat properly and poor esthetic's. One of the main reasons the teeth are not replaced is the perceived high cost of replacement with implants and crowns but more importantly, the animal must undergo several general anesthetics before the final crown is placed. Our goal is to eventually develop a protocol to accomplish this in one procedure and one anesthetic rather than the current two and three stage protocols.

There are over 500 dental implant systems being offered worldwide for human use. The vast majority are `me too` copies of other systems. They all can work and they all can fail. As a general rule, implants are not successful due to better designs or better features. They work because clinicians are operating in an environment that is incredibly user friendly. We are fortunate that the oral cavity is a most forgiving environment when performing surgery there. Implants mainly fail for two reasons, inaccurate evaluation of the patient's medical condition and incomplete treatment planning. The intent of this manual is to teach you how to place and restore dental implants successfully based upon the experiences, failures and more importantly the successes of many "pioneers" in human dentistry, veterinary dentistry and bone grafting. This will be an ongoing learning experience for you. This may be the first time in history that humans have been the *guinea pigs* for animals rather than the other way around.

There is currently no formal training program for Veterinary Dentists in implant dentistry. This training manual was developed as part of the clinical training program for Dental Implants in Small Animals. The manual, protocols and training program are in the process of gaining acceptance by the specialty College for Continuing education RACE credits.

Good Luck

About the Authors



Dr James Anthony

James Anthony, BSc(Agr.), DVM, MRCVS, FAVD. DipAVDC, DipEVDC, PAg. Since graduating in 1983 he has been in private practice and served as a referral dental specialist in veterinary dentistry for several referral practices. He has been active in many local, national and international veterinary and dental organizations. He has authored numerous articles for journals and been on staff of a number of teaching universities. Dr Anthony has placed over 200 dental implants into dogs and cats with 4 to 10 year follow ups and only experienced 6 failures mainly due to periodontal disease.



Dr Rocco E. Mele

Rocco E. Mele DVM is originally from Youngstown Ohio and has been practicing veterinary medicine and surgery for over 40 years throughout the USA with the past 14 years in Tucson, AZ. He attended Youngstown State University, Ohio State before an early acceptance to The Ohio State School of Veterinary Medicine graduating in 1973. His decision to practice at some of the most progressive and respected veterinary hospitals across the country led to a more complete understanding and training in medicine and surgery. With the help of Veterinary Dental Specialists, Human Dentists and Oral Maxillofacial Surgeons in the US, Canada and Australia, he has been placing implants and using the most advanced augmentation techniques and bio-materials for the last 4 years. Currently he is a member of the Advisory Panel of K9 Implants.



Dr. Harold Bergman

Harold Bergman, DDS, DipIOS&A, MScD(Path) is a retired Oral & Maxillofacial Surgeon. He has been involved in dentistry for 48 years as a specialist and has over 40 years clinical experience in the placement and restoration of dental implants. An internationally recognized lecturer, Dr. Bergman has been active in training dentists in the placement and restoration of implants for 25 years. During that time, he has authored over 100 scientific and technical publications and articles to both the profession and the public. For 15 years prior to his retirement, he limited his practice to the placement and restoration of all forms of dental implants and bone augmentation procedures. He is the President of K9 Implant Solutions Inc. and Simpler Implant Solutions Inc., a company which has been successfully manufacturing and selling implants for over 25 years.

Acknowledgements

This manual was co-authored by Dr. James Anthony, Dr. Harold Bergman and Dr. Rocco Mele. We especially want to thank Dr. Helen Newman (Veterinary Dental Transplants) for her input into Chapters 5 and 6 and Dr. Mele for most of the clinical photos of the various cases appearing in this manual. We all would also like to acknowledge the support and input from many other persons including Karen Bergman and Ms. Sandra Malone for their patience with me when things were not going well, their editing and constructive criticism and their ongoing support and effort, Dr. Marcus Carius for his creativity and technical expertise in manufacturing and prototyping of most of the dental implant related products shown here, Ms. Carrie Kuehn of CK2Design for her imaginative support literature, Ms. Laurel Bergman for her beautiful photos of the animal skulls and other photos and Cathy Mele, whose practiced eye took most of the clinical photos of Dr. Mele's clinical expertise.



Dental Implants for Small Animals

Table of Contents

Chapter 1: Introduction to Implants	05
Chapter 2: Small Animal Evaluation	27
Chapter 3: Dental Implants and Anatomy.	51
Chapter 4: Treatment Planning for Small Animals	61
Chapter 5: Bone and Bone Grafting Materials	79
Chapter 6: Bone Grafting Procedures	109
Chapter 7: Dental Implant Surgery	125
Chapter 8: Implant Uncovering and Impression Taking	155
Chapter 9: Restoration of Dental Implants	169
Chapter 10: Complication of Dental Implants	185



Implant
Resource
Center

Dental Implants for Small Animals education about Implant Dentistry. All rights reserved. No copy, reproduction or use of this document is permitted without prior written approval of either Dr. Harold Bergman or the Implant Resource Center, Vet Division, veterinarian division



Chapter One - Introduction to Implants

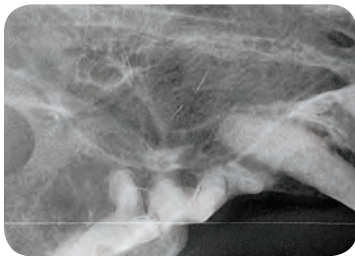
Objective . . . . .	.05
What You Will Learn . . . . .	.05
Terminology . . . . .	.06
What are Dental Implants . . . . .	.07
Conventional vs Narrow Diameter Implants . . . . .	.09
Sterility and Degree of Contamination . . . . .	.12
Evolution of Materials . . . . .	.14
Evolution of Design: Endosteal, Transosseous, Subperiosteal. . . . .	.15
Evolution of Technique . . . . .	.18
Branemark Protocol . . . . .	.20
Moving Forward . . . . .	.20
Indications for the Use of Dental Implants . . . . .	.22
Frequently Asked Questions . . . . .	.24
Suggested Reading . . . . .	.25



Objective

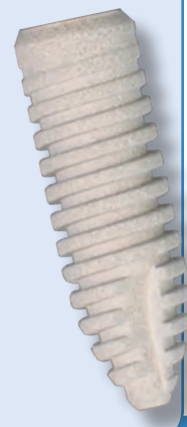
The objective of Chapter 1: Introduction to Implants is to give you a better understanding of what implants are, how they have reached their present acceptance, the materials, designs, techniques used, why they are successful and why they fail and when dental implants should be used. As well, you will be introduced to the **TERMINOLOGY** used and we will answer several of the most commonly asked questions by veterinarians and animal owners.

On successful completion of this chapter, you will be in a better position to intelligently discuss implant dentistry with your clients, and to better evaluate the many diverse claims by implant manufacturers.



What You Will Learn

- Terminology
- What are implants
- Implant Surfaces: machined, grit blasted, acid etched, porous, sintered, hydroxylapatite
- Implant Interfaces: osseointegration, bone/Ti, bone/HA, CT interfaces,
- Implant Materials: Calcium carbonate, Precious metals, Stainless steel, Vitallium, Titanium & alloys, HA
- Implant Designs: Endosteal, Transosseous, Subperiosteal, One & Two Stage, Unloaded and Loaded, Grafts, Other
- Background and history
- Successful Implant Practice versus a Successful Implant
- Indications for Implants
- Frequently Asked Questions
- Suggested Reading



Abutment: That part of the implant system that joins the implant body with the tooth portion (prosthesis).

Alveolar: Pertaining to the bone associated with the teeth.

Asepsis: The absence of pathological micro organisms.

Aseptic technique: Although sepsis cannot be eliminated when operating in the mouth, every attempt should be made to eliminate anything foreign. It appears that implants placed in the mouth are capable of healing if aseptic procedures are followed.

Blade Implant: An endosteal implant that is long, thin and flat in shape.

Cancellous: The inner, marrow part of the bone. The marrow can range from very dense in the symphysis area to very open in the posterior part of the maxilla.

Connector, Attachment: That part of the implant system that joins the removable prosthesis to the fixed portion of the implant system, usually a metal bar.

Cortical Bone: The outside layer, usually much denser than the inner or marrow space.

Endosseous: An implant that fits into the bone.

Hydroxylapatite (HA): A non-resorbable, mineral compound made mainly of Calcium (Ca) and Phosphate (PO₄). $Ca_{10}(PO_4)_6 OH_2$. HA is the main mineral content of bones (60%) and teeth (90%). It is sometimes referred to as synthetic bone. Many implants have a very thin (65 micron) (less than 1/10 mm) coating of HA on their surfaces. Studies seem to indicate that HA gives a quicker and stronger bond to bone than uncoated implants.

Immediate Load: When an implant has the abutment and prosthesis attached and the implant system is brought into immediate function.

Implant Body (Fixture): A metal device that is compatible with the bone and soft tissue, which is surgically imbedded into the bone and provides support for an artificial tooth or teeth.

Implant System: Consists of the implant body, abutment, attachments and the teeth or prosthetics portion.

Inferior Dental Nerve: A nerve running in a tunnel in the bone in the posterior or back part of the mandible. It supplies sensation to the teeth and gums of the lower jaw as well as the lower lip. Damage to this nerve will result in a numb feeling, (lack of sensation) in the lower lip.

Maxillary Antrum (Sinus): A hollow space lying on each side of the posterior part of the maxilla. It opens into the nose and the other sinuses.

One Stage System: When the top of the implant and healing collar/tissue former is brought into the mouth lying flush with the mucosa.

Osseointegration: The process where bone attaches directly to the implant without an intervening connective tissue (scar tissue) layer. The process results in having a bony interface with an implant. An osseointegrated implant will not move. Mobility of the implant means the implant has lost its osseointegration (failed).

Osteoconductivity: The feature of a material inducing bone to form on its surface. i.e. bone, hydroxylapatite.

Mucosa: The soft tissue in the mouth lying over the bone.

Osteotomy: The preparation of a hole into the bone to accept an implant.

Panograph, Panorex: A large radiograph which shows both upper and lower jaws, the teeth, the sinuses, the joints and the floor of the nose.

Percussion: The process of tapping on the implant with an instrument. An osseointegrated implant will elicit a sharp ringing sound. A non-integrated implant will elicit a dull thud.

Radiographic Template: A plastic overlay with drawings of implants. The template is laid over a radiograph to show whether an implant will fit into the available bone.

Resorption: The normal shrinkage of the bone after the teeth have been removed. The resorptive process can be hastened if the patient lost their teeth due to periodontal or gum disease.

Root Form: An endosteal implant conical or cylindrical in shape.

Sterile: The absolute absence of microorganisms.

Study Model: A plaster replica of the jaw.

Subperiosteal Implant: An implant that fits under the periosteal layer on top of the bone rather than into the bone. It is usually coated with HA.

Surgical Template: A plastic guide that fits over the teeth and gums and acts as a guide to the surgeon when placing or locating implants and has only been used in humans. It would be difficult in animals as it would mean using CAT CAM scanning procedures or the taking of pre-operative study models.

Tri Calcium Phosphate: A resorbable, mineral compound made mainly of Calcium (Ca) and Phosphate (PO₄). $Ca_3 (PO_4)_2 OH_2$. Used to fill defects in bone around implants.

Titanium: An elemental metal from which most modern implants are made. It is the metal along with its alloy (6/4 Titanium) most compatible with bone and soft tissue of all the metals used in implant dentistry.

Titanium Alloy: A mixture of metals, 6% Aluminum, 4% Vanadium and 90% Titanium.

Two Stage System: When the top of the implant and healing screw is lying under the mucosa and out of function.

Vitallium: An alloy made from cobalt-chromium-molybdenum. This material was used years ago in the fabrication of subperiosteal implants.

What are Dental Implants

Dental implants or implant fixtures are artificial roots placed in the bone to provide a solid base for tooth replacement. Most implants today are of the endosseous type where the implant system consists of several parts, the implant body or fixture, the abutment portion and the prosthetic portion. **(Fig 1)**

All these components are precisely machined to fit together and attach the prosthesis to the implant

The fixture portion is the part that is surgically inserted into the bone and allowed to integrate with the bone. The original implant protocol was called a "Two Stage". The coronal top of the implant fixture was designed to be flush with the crest of the bone or slightly below the bone and allowed to heal for 3 to 6 months. This protocol and design necessitated a second surgery to expose the implant to attach the transmucosal abutment portion.

It was later realized that the implant fixture could be placed flush with the mucosa. The design of the implant changed having a 2 to 3 mm shiny, transmucosal collar as part of the top of the implant. After the 3 to 6 month healing period, the second surgery was not required to attach the abutment portion. This design was named "One Stage". As both designs required a second stage, a better description would have been "One Surgery" and "Two Surgery". As dentists gained more experience, it was found that implants could be loaded immediately under certain circumstances and be successful. The success rates with "One Stage" surgery appear to be equal to that of the "Two Stage" surgery. The success rates with "Immediate Load" implants are not as successful as either the "One Stage" or the "Two Stage" surgery. I would recommend the "One Stage" for small animals as it is less traumatic and much easier to perform by eliminating the second surgery. **(Fig2)**

The abutment portion is either threaded or cemented into the implant body bringing the abutment portion into the oral cavity. The abutment effectively joins the fixed implant body to the prosthetic portion, as either a crown or a bridge.

The abutment and implant portion of the implant system can be individually separate **(Fig2)** or the implant and abutment portion may be one piece. **(Fig 2 right)** In humans, the prosthetic portion can consist of an individual crown, a bridge to replace several or all teeth fixed to the implants and/or teeth, or a removable prosthesis to replace several or all the teeth. In small animals, the choice of prosthesis is limited to a crown attached to an individual implant or a short bridge supported by a few implants by cement or screws. Removable prostheses are not practical in animals for obvious reasons and long span bridges are impractical due to the heavy bite forces (up to 2,500 PSI) exerted by larger dogs.

There are over 150 different manufacturers of endosseous dental implants although there are only two basic shapes used today; Press fit (push in) or threaded. The press fit has parallel walls with a rounded end whereas the threaded is shaped like a wood screw. **(Fig 3)** The threaded shape is probably better for small animals due to the increased initial support offered by the threads. **(Fig 4).**

Continue on next page



Fig 1: Implant fixture portion - left. Crown post abutment - middle. Crown and abutment - right.



Fig2: Red band represents the mucosa. Two Stage implant on left, One Stage in middle and Immediate Load on right.



Fig3: Threaded and Press Fit.

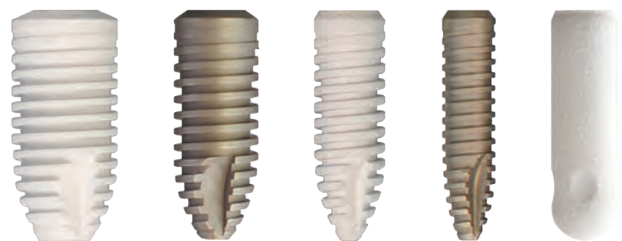


Fig4 : White implants are HA coated and grey ones are grit blasted/acid etched.



Fig 5: Implant supporting a crown in a dog.



Fig 6: Two implants supporting two bridges in a dog.



Fig 7: Six implants supporting a bridge in a human.

Implants initially were made from Commercially Pure (C.P.) Titanium. Almost all implants today are made from 6/4 Titanium Alloy (6% Aluminum and 4% Vanadium). In reality, C.P.Titanium is quite soft and relatively weak, whereas 6/4 Titanium Alloy is 60% stronger and better able to withstand greater loads. Some implants are coated with Hydroxylapatite (HA). The reason for HA coating is explained later under the subject of implant surfaces. Zirconium as an implant fixture is being tested but as yet is still unproven in regards to osseointegration as an alternative to titanium. It has been used for abutments but has been found to fracture. Implants can be used to secure a crown for one missing tooth (Fig 5) as a bridge abutment for several missing teeth (Fig 6) or to help retain a prosthesis for totally edentulous patients in humans. (Fig 7)

Implants are manufactured in a number of different lengths from 6 mm to 24 mm and in diameters from 1.2 mm to 7 mm in diameter. The implant length and diameter is determined by the amount of available bone. Implants less than 3 mm in diameter are considered Mini, Narrow Diameter or Small Diameter. Three 3.0 to 4.0 mm implants are considered Conventional Diameter and wider diameters known as Wide Diameter. The Mini implants are usually one piece and Immediate load. The problem with Mini implants is they are made in One Piece necessitating immediate loading. immediate loading may prove impractical due the inability of the owner to control the animals eating and biting habits after implant placement.

Veterinary dentists placing implants into small animals will be interested in Mini implants due to the lack of bone availability in small animals especially in the incisor area. However, 3.0 and 4.0 mm implants should be placed if bone is available. Occasionally there may be situations where 5.0 and even 6.0 mm implants can be placed.

Conventional vs Narrow Diameter Implants

Conventional implants are those larger than 3.0 mm in diameter. Wide diameter are considered larger than 4 mm in diameter and Minis are 3.0 mm or less in diameter (Fig 4). The greater the diameter, the more support the implant will give but will require more available bone in which to place the implant. A new implant will be available later in 2012 that will offer greater surface area, in diameters ranging from 3.0 through 6.0 mm.

The table below lists the differences between Conventional and Mini implants

	MINI	CONVENTIONAL
Diameter	2.2 to 3.0 mm	3.25, 4.0, 5.0, 6.0
Lengths	10, 13, 15, 18	6, 8, 10, 13, 15
Construction	One Piece	Two Piece +
Load	Immediate	Minimal
Minimal Bone Height	10 mm	8 mm
Minimal Bone B/L Width	3.5 mm	8.0 mm
Minimal Bone M/D Width	4.5 mm	8.0 mm
Use	Incisors or orthodontic use.	All
Main Area of Use	Symphysis	Everywhere
Minimum # Implants	1	1 to 8
Cost to the Owner	Minimal	Moderate to Expensive
Start up Costs	Minimal	Moderate to Expensive
Cost of Implants	Minimal	Moderate to Expensive
Experience of User	Minimal	Moderate to Advanced
Trauma to Animal	Minimal	Atraumatic to Extensive



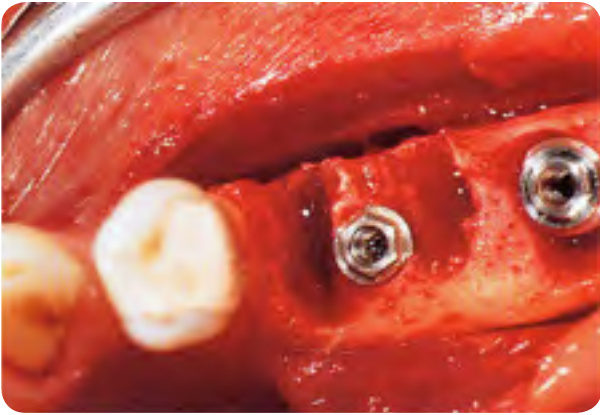


Fig 28 Implants placed at same time as extraction in human on Top with graft and membrane covering on Bottom.

For over 20 years, dentists have been successfully placing implants in humans at the same time as the tooth is removed. **(Fig 28)** Placing an implant in humans at the same time as tooth removal is now considered the Standard of Care. It is well documented in humans that an implant will help maintain bone similar to what was previously proven with vital tooth roots left in situ. There is no reason why an implant cannot be placed at the same time as tooth removal in small animals to help maintain bone.

As described earlier the abutment portion is either threaded into or cemented into the implant body and joins the fixed implant body portion into the oral cavity. Following this, the prosthesis is then attached to the abutment by cement, a screw or some form of clip or rubber O ring. For obvious reasons In animals, the prosthesis must be fixed and not removable.

The two shapes most commonly used for implants are the push in or press fit, and threaded screw like implants. Over the past 10 years, Press Fit implants have fallen “out of vogue” and threaded have become more popular. The perception is that a threaded implant has more surface area to retain the implant initially in the bone. There are over 150 different manufacturers of endosseous dental implants today.

Nearly all implants today are made from 6/4 Titanium Alloy. Some companies coat their implants with hydroxylapatite (HA) and others use a form of sintering, grit blasting and/or acid etching. **(Fig 29)**

Evolution of Technique

Initially endosseous implants were made from stainless steel, blade shaped having many shapes and forms but mostly being narrow in width (1mm), shallow in depth (3 to 10mm) and long in length (6 to 40mm). The implant body and the abutment were one piece and the implant put into function immediately. A connective tissue bone/implant interface resulted.

With the advent of the use of titanium for dental implants, endosseous implants became root form in shape, screw or cylindrical in design, having parallel walls with rounded or blunted ends. One school of thought (Sweden) previously insisted that the implant body and the abutment be separate and that the implant be buried under the mucosa and not allowed into function immediately.

Another school of thought (Switzerland) insisted that similar to the stainless steel blades, the implant be one piece and not buried under the mucosa but allowed into function immediately. A direct bone to implant interface resulted with no intervening connective tissue. Popular opinion at that time rejected the immediate load theory and it subsequently fell into disfavor.

However, during the 1990’s a compromise was suggested where the implants were placed with the top of the implant flush with the mucosa instead of flush with the bone and the implant allowed minimal immediate function. A direct bone to implant interface resulted with no intervening connective tissue.





Today, the evolution of technique has come full circle with many advocates supporting the use of one piece, titanium dental implants being put into function immediately. **(Fig 29)** A direct bone to implant interface generally results with no intervening connective tissue.

All implants can be loaded immediately. The two main factors in successful osseointegration of a dental implant is first to increase the degree of support provided by the implants and secondly to reduce the amount of load on the implants. There is a balancing act between support and loading to attain osseointegration.

The clinician can increase support as much as possible by increasing the number and size of implants, by splinting the implants together, by incorporating other teeth into the splinting and by the use of quicker bonding surfaces such as HA.

The clinician can decrease loading as much as possible by decreasing the area of the occlusal table, by ensuring the implants are out of function, by placing the patient on a soft diet.



Fig 29: HA in white and grit blasted dark.



Chapter Two - Small Animal Evaluation

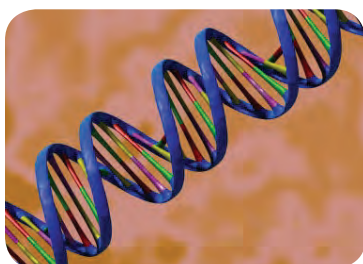
Objective	27
What You Will Learn	27
Introduction	28
Medical Evaluation	29
Laboratory Tests	30
Dental Evaluation	31
Evaluation of Available Bone	32
Radiographic Screening	34
Medical Problems	36
Dental History and Clinical Examination	43
Medical Lab Tests	46
Radiographic Considerations	47
Financial Considerations	48
Suggested Reading	49



Objective

The objective of Chapter 2: Small Animal Selection for Implants, is to teach you to better understand the medical, physiological, dental, financial and consent factors that need to be assessed and considered to ensure success in placing and restoring dental implants in small animals. As well, we would like you to be aware of the advantages of proper record keeping in the event of possible medico-legal problems.

On successful completion of this chapter, you will be in a better position to intelligently discuss implant dentistry with your clients, and to better evaluate the many diverse claims by implant manufacturers.



What You Will Learn

- Documentation
- Medical Evaluation
- Dental Evaluation
- Evaluation of Available Bone
- Initial Radiographic Screening
- Initial Implant Evaluation
- Medical Considerations
- Medical Lab Tests
- Dental Considerations
- Radiographic Considerations
- Financial Considerations
- Sample Forms
- Small animal Educational Literature



Medical Problems as they Relate to Implant Dentistry in Small Animals

Age is not important on its own and not a contra indicator to the placement of implants. The oldest patient in humans this author has treated was 92 years of age, the youngest 16. In small animals implants can be placed in mature bone at 1 yrs of age. Implant placement in older dogs can certainly be performed at any age if there is no degenerative process taking place that would slow or impede bone development. The important factors are the health of the bone and the bodies healing abilities, the medications the animal is taking and the amount of bone they have left. The older an animal gets, the greater the chance that any or all of these are diminished.

The average life span of the North American or European dog is 12.8 years but ranging from 10 to 18 years depending upon the breed. In general, larger dogs live shorter lives than smaller dogs due to the fact that the bodies of larger dogs must work harder (are more stressed) than the bodies of smaller dogs. The average age of cats is 12-19 years. Given proper care, nutrition, and regular veterinary visits, a cat kept indoors can live as long as 21 years or more. Another factor in placing implants into very young small animals is that the animal care giver expects the implant to last the rest of the animals life. It is probably realistic to expect life long usage and success with implants in small pets.



Allergies: Allergy to commonly used metals in implant dentistry should not pose a problem. Titanium allergy has been detected in humans, even though its estimated prevalence is low (0.6%). It is estimated that the percentage is similar in small animals. There are no known recorded cases of allergy to hydroxylapatite.

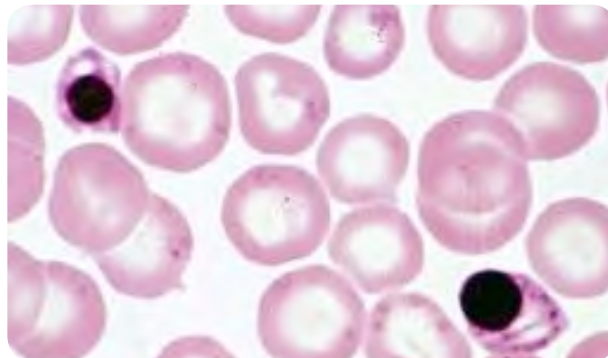
However, some of the alloys used in casting substructure procedures do contain metals which will provoke an allergic reaction, i.e. nickel, molybdenum. Up to 13% of humans are sensitive to nickel, cobalt, or chromium.

Frequently, humans will have a history of allergy to local anaesthetics. While true allergy does exist, what the human usually describes is a syncope or "fainting" (a vasovagal response). It is not known if small animals have "syncopies". True allergies to the drugs found in local anaesthetic however, must be known and their use avoided.



Arthritis: The placement of implants in small animals with either osteoarthritis or rheumatoid arthritis is not contra-indicated. The degree of incapacitation, the animal care giver's ability to maintain oral hygiene and the limitation of opening the mouth by the disease are the main considerations. However, certain medications might interfere with the healing process, and should be discussed with the animal care giver prior to having dental implants placed.

Blood Dyscrasia: The formed elements of the blood, as well as its liquid portion, play extraordinary roles in many physiologic mechanisms and processes in the human body. When a disturbance of one of these constituents occur, severe problems may result. Abnormalities in clotting, bone and soft tissue healing, the body's ability to fight infection, and general long range prognosis of the implant are some of the concerns with implant treatment in small animals with blood dyscrasias. In the worst form, a dyscrasia can be life threatening and contra-indicate the placement of implants.



Blood Thinners: Blood thinners, also known as anticoagulants, are not generally used in small animals.

Cardiovascular Disease: Peripheral Vascular Disease, High Blood Pressure, Heart Murmur: Although heart disease does not have a direct bearing on the success or failure of implants, it must be considered to the degree that the small animal can tolerate the surgery and anaesthetic method involved with the placement of implants. Ideally, to determine the current cardiovascular disease status of small animal, every small animal undergoing a general should have a cardiac workup such as EKG, ultra sound, etc. taken prior to surgery. However in the real world, this is impractical and an ECG should be considered if the veterinarian suspects a cardiovascular problem or the animal has a history of heart disease.



Chemotherapy: Small animals undergoing chemotherapy in the treatment of malignancies pose several potential problems depending upon the type, location and prognosis of the malignancy, the effect of the chemotherapy on healing and the interaction of the drugs with the proposed treatment. The degree to which dental implants will improve the quality of life for the small animal as opposed to the degree of further insult to the small animal must be evaluated.

Diabetes is a biochemical disease caused by the reduction in the production of insulin by the pancreas. There are two forms of diabetes in dogs and cats: 1) uncomplicated diabetes and 2) diabetes with ketoacidosis. Pets with uncomplicated diabetes may have the signs of bladder, kidney and skin infections and cataracts but are usually not extremely ill. Pets with ketoacidosis are very ill and may be vomiting and depressed.

Diabetes results in lowered tissue resistance to infection, delayed healing, and demineralization of the alveolar process. The placement of implants in human patients with uncontrolled diabetes is **definitely contra-indicated**. Borderline and well controlled diabetics can be considered for implant placement but the prognosis must be guarded, estimated at 9-10% failure rate.





Epilepsy: Epilepsy is characterized by uncontrolled, excessive activity of part or all the central nervous system. Epileptic episodes are quite common in dogs and actually show up more often in certain breeds of dogs than in others. For unknown reasons, epilepsy in cats is rather rare. When seen in a cat, epileptic episodes may have more serious underlying mechanisms than when present in dogs.

Its consideration in the treatment of small animals by dental implants is not significant except for small animals with epilepsy that are frequently treated with phenobarbiturates. This drug will occasionally cause a fibromatosis or enlargement of the gums about the teeth and implants. This enlargement is generally the result of lowered hygiene about the teeth or implants. Small animals on this drug must be given greater oral hygienic care than usual.

Gastrointestinal Disease: Symptoms and areas affected by GI ulcerative type diseases can include the oral cavity and significantly interfere with implant placement. Otherwise, diseases of the gastrointestinal tract are significant to implants only to the degree that they interfere with the small animal's ability to take intra-oral medications normally associated with the treatment of implants.

General Anaesthetics: General anaesthetics do not pose a risk to the success of implants. They will have a bearing on the organization of the treatment in that proper facilities and a qualified person will be required to deliver the anaesthetic.



Hepatitis: The metabolic functions of the liver are numerous and intricate. The liver is involved with the metabolism of carbohydrates, fats, and proteins. As well, it plays an important role in the storage of vitamins, especially A, D and B12. Except for that found in the haemoglobin in the blood, by far the greatest proportion of iron in the body is usually stored in the liver in the form of ferritin. The liver makes a large portion of the blood substances utilized in the coagulation process including fibrinogen, prothrombin, accelerator globulin, proconvertin and several other less important coagulation factors.

A good way to diagnose liver disease is with a Biochemistry Panel (BCP). There are several tests on the BCP which aid in the diagnosis of liver disease.



Dogs can get Infectious Canine Hepatitis caused by the CAV-1 adenovirus which can attack the liver, eye, blood vessels, spinal cord, brain and kidneys. The liver is responsible for the synthesis of amino acids and carbohydrates produces albumin, the breakdown of glycogen, the metabolism of lipid, coagulation factors, red blood cell production in infants, produces and excretes bile, insulin-like growth factor 1 (IGF-1), the breakdown of insulin and other hormones, breaks down or modifies toxic substances and most medicinal products in a process called drug metabolism. It also stores a multitude of substances, including glucose, vitamin A, vitamin B12, iron, and copper. It also produces albumin, the major osmolar component of blood serum.

The liver supports almost every organ in the body and is vital for survival. Because of its strategic location and multidimensional functions, the liver is also prone to many diseases.

Drugs are the real dilemma as liver is responsible for the breakage and excretion of many toxic chemical materials including many drugs.

Also, there are some drugs that are considered toxic to the liver and can severely harm the liver in compromised small animals. Many drugs should be used with caution or avoided completely in severe liver disease. Paracetamol, NSAIDs, sedatives that usually prescribed after extraction or surgery are the most common. As some drugs, even with normal dosage, can be toxic to the liver in small animal because it fails to break and excrete the drug and accumulate in the body. It is difficult to estimate the impairment of drug metabolism even with liver function tests so adjusting the doses of drugs can be very difficult even for the experienced.

If liver damage is suspected, it must be evaluated by ordering liver function tests as well as coagulation and prothrombin studies to assess the degree of interference with the blood clotting mechanisms.

Diseases that interfere with liver function will lead to derangement of these processes. However, the liver has a great capacity to regenerate and has a large reserve capacity. In most cases, the liver only produces symptoms after extensive damage.

HIV: The Human Immunodeficiency Virus that effects humans and some primates and eventually causes AIDS cannot be transmitted to dogs. Cats have an analogous virus, FIV, but that cannot be passed to dogs either. The only major immunodeficiency we know of that dogs can end up with is Severe Combined Immunodeficiency or SCID, and that's genetic. Parvo causes an immunodeficiency, just by a different mechanism, and that's a self limiting virus. It's not in the same classification as any of the other immunodeficiency viruses though.

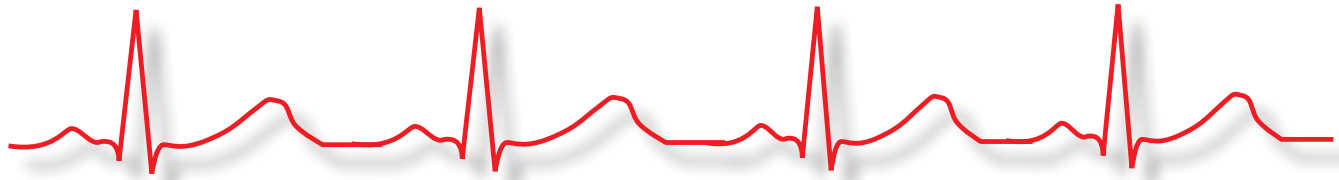
HIV positive humans generally have a reduced immune system and their ability to fend off illnesses is compromised. The better the immune system, the better the chances for osseointegration and long term survival of their implants.

Osseointegrated dental implants appear to be well tolerated with long-term predictability in well controlled HIV-positive individuals. However, significant alveolar bone loss may occur with severe immunosuppression. It is expected that small animals with a reduced immune system to respond similar to that of humans.

Hypertension: The average canine BP is 133/75, average feline BP is 124/84. Small animals with hypertension may proceed with elective dental treatments, but blood pressure should be monitored during the procedure. Those with severe hypertension should undergo only emergency or non-invasive elective treatments.

Small animals with high blood pressure are generally treated with diuretics. These drugs increase the amount of water eliminated through the kidneys. Along with water elimination, there is an increase in the loss of potassium ions resulting in a possible chemical imbalance. Small animals on diuretic medication should have routine sodium and potassium serum chemistry performed prior to implant placement.





Unusual Experience with General Anaesthetic: The animal care giver of the small animal should be questioned as to the animal's previous experience with general anaesthesia. These may include post-operative nausea, or histories of prolonged recovery periods. In humans, a prolonged recovery period especially with a similar history with other family members can be indicative of pseudocholinesterase deficiencies which pose grave problems for the anaesthetist.

Vital Signs: Vital signs of small animals are breed specific. However they usually are lower for larger animals and higher for small animals.

Vital Signs: Blood Pressure: is necessary to establish a Base Line of the small animal's physiological status. These should be taken at the initial non-invasive examination. Average canine BP is 133/75, average feline BP is 124/84. The base line allows the veterinarian to compare the small animal's reactions to various invasive stimuli allowing the operator to consider pain and anxiety control regimens, premedication, etc. for the small animal. It also gives the operator a base line to note and compare any deviations from normal which might indicate an impending crisis. If high, the veterinarian should determine and treat the cause prior to treatment, and treat only emergency or non-invasive elective treatments.

Vital Signs: Pulse Rate: In a healthy dog, it can range from 60 to 100 beats per minute for large dogs, 100 to 140 for small dogs. In cats, it will range from 120 to 140. Generally lower (bradycardias) is better, but can be dangerous. Symptoms of a dangerously slow heartbeat include weakness, loss of energy and fainting. [Tachycardia typically refers to a heart rate that exceeds the normal range for a resting heart rate (heart rate in an inactive or sleeping individual)]. It can be dangerous depending on the speed and type of rhythm. It is necessary to establish a Base Line of the small animal's physiological status. These should be taken at the initial non-invasive examination. This base line allows the dentist to compare the small animal's reactions to various invasive stimuli allowing the operator to consider pain and anxiety control regimens, premedication, etc. for the small animal. It also gives the operator a base line to note and compare any deviations from normal which might indicate an impending crisis.



Vital Signs: Respiratory Rate is an indicator of a number of disease states. It is necessary to establish a Base Line of the small animal's physiological status. These should be taken at the initial non-invasive examination. Cats normal respiratory rate is 16 to 40 breaths per minute and dogs 10 to 34. This base line allows the dentist to compare the small animal's reactions to various invasive stimuli allowing the operator to consider pain and anxiety control regimens, premedication, etc. for the small animal. It also gives the operator a base line to note and compare any deviations from normal which might indicate an impending crisis.

Guide to Evaluation of the Dental History and Clinical Examination as it Relates to Implant Dentistry

Bone Quality: The quality of the bone refers to the bone density. One can get an indication of bone quality from the degree of radiopacity/radiolucency of digital X-rays but analogue radiographs can make the method of evaluation up to 35% inaccurate. Digital bone densitometry can give a much more accurate measurement of bone density with an approximate 2-3% margin of error. Large marrow spaces are indicative of decreased density.

Various conditions adversely affect bone density. In humans, post-menopausal females, post-Hysterectomy females, tall, thin profiles, low calcium intake and kidney disease can all decrease bone density.

Bone , Buccal Lingual Width and Contour: Much information can be gathered by running the index finger along the buccal sulcus, the lingual of the mandible and the alveolar ridges. Muscles and circumoral muscle attachments on the lateral surface of the anterior portion of the mandible can mimic bone and give an impression of greater bone width than is actually present.

Clinical Assessment of Available Bone: There are five factors to assess when evaluating available bone: **Height, Buccal Lingual Width and Contour, Mesio Distal Width, Angulation, Quality.** Although the assessment is accomplished by using information from the diagnostic aids and techniques such as Periapical X-Ray, and Palpation, only palpation can be used and evaluated during the clinical examination stage. Clinicians must use extreme care to prevent being bitten by the animal.

Extraoral: Prior to entering the oral cavity, assess the small animal's face, muscles, neck, and TMJ for any signs of gross pathology or disharmonies.

Gingiva, Unattached vs. Attached: In the cat the mucosa can be very thin, not even 1 mm and the surgeon must be careful when raising a flap. In the dog, the mucosa can vary from 1 to 3 mm depending on size of the animal. After surgery with bone grafting and tissue bio material, the mucosa can become very thick keratinized tissue, 3 to 5 mm thick.

As the mandibular ridge resorbs, the width of the band of attached gingiva becomes narrower until in some cases, the band is only one to two mm wide. It is better that the implant emerge through the mucosa in an area of attached gingiva rather than unattached. Surgery performed in unattached gingiva can result in a greater degree of post-operative swelling and edema than found in areas of attached gingiva.





Chapter Three - Dental Implants and Anatomy

Objective . . . . .	.51
What You Will Learn . . . . .	.51
Differences Small Animals and Humans . . . . .	.52
Vital Structures . . . . .	.54
Specific Problem Areas in the mouth . . . . .	.56
Suggested Reading . . . . .	.59



Objective

The objective of Chapter 3: Small Animal Anatomy & Implants is to give you a better understanding of the maxilla and the mandible of small animals and how it relates to the placement and restoration of dental implants. It is not intended to provide an in-depth knowledge of the anatomy of the head of small animals but only to how the anatomy relates to the placement of implants into animals.

On successful completion of this chapter, you will be in a better position to intelligently treatment plan and place dental implants into small animals to attain maximal support for the implant without jeopardizing vital structures of the animal.



What You Will Learn

- Differences Between Small Animals and Human Anatomy
- What are vital structures
- Specific Potential Problems in Various Areas of the Mouth
- Maxillary Incisors
- Maxillary Canines
- Maxillary Premolars
- Maxillary Molars
- Mandibular Incisors
- Mandibular Canines
- Mandibular Premolars
- Mandibular Molars
- Suggested Reading



Fig. 1 Human skull and teeth showing consistency in size and shape of teeth.

Differences of Small Animals from Humans

Although there are some studies involving dental implants performed on animals over the past 25 years, the vast majority of information available about dental implants today results from the placement and restoration of implants in humans, not animals. Since there are numerous scientific articles using animals, we can reasonably assume equivalent responses to implant placement in animals will be similar as found with humans. However, there are some differences which require acknowledgment including:

- Age
- Size of the Jaws and Teeth
- Healing Time
- Life Span
- Loading
- Support

Age: Implants are generally placed in adult humans only over 20 years of age whereas implants could be placed in animals after the permanent teeth have erupted. On average, permanent teeth are in position in dogs and cats by the age of one year. Periodontal problems can start to develop by as early as age two.

Size of the Jaws and Teeth: Since implants are generally placed only in adult humans over the age of 20 years, the average size of the teeth and jaws in humans is reasonably consistent. Human teeth roots range in diameter from 3.0 mm in lower incisors to 7.0 mm in molar teeth. Human teeth roots range in length from 10.0 mm to 20.0 mm and are consistently conical in shape. This narrow range of diameters, lengths and shape in turn allows the manufacturers to limit the sizes and shapes offered. (Fig 1)

The range in actual size of small animals ranges from quite small as found with cats and some lap dogs such as Yorkies and Chihuahuas through to quite large as found with Mastiffs and other large breeds (Fig 2). Although the shape of the roots found with incisor teeth and premolars and molar teeth are conical in shape in small animals, the canines are more elliptical in shape and greatly curved (Fig 3). Although conventional implants designed for humans can be used with most medium to large animals, the canines due to their shape and much larger size and incisors in small animals require a special design and modification to be used effectively.

Size of Implants: This consistency in humans in diameters, lengths and shape in turn allows the manufacturers to limit the sizes and shapes offered. Most conventional delayed loading implants for humans are designed and manufactured within diameters ranging from 3.0 to 7.0 mm and 6 to 18 mm in length (Fig 4). Although Mini implants are made less than 3 mm in diameter and have the potential to be used in small animals especially the incisor areas, there may or may not be problems depending upon occlusion and immediate loading.



Fig 2. Dog skull showing variations in size and shape between Collie and Chihuahua.

Canine tooth replacement in small animals, dogs and cats can use the conventional sized implants for humans, larger sized animals generally will require either larger diameter implants or specially designed canine implants. (Fig 5)

Mandibular Symphysis: Unlike humans, the symphysis in small animals does not fuse and the two halves of the mandible remain separated by a connective tissue interface. This can cause problems especially in cats and is a common area of fractures in small animals. (Fig 6)

Healing Time: It is estimated that the healing time for dogs is 1/3 faster than that with humans and ¼ times quicker in cats. This means that the time required for osseointegration in small animals is faster and should be reflected in higher success rates. This is especially important with immediate loading of implants. Clinically however, healing time (osseointegration) in dogs and cats should be considered the same as humans (4 to 6 months after grafting or extractions).

Life Span: While humans life expectancy is 80 years, a dog’s average life is 12.8 years depending on its size while cats live from 18 to 20 years This shorter life expectancy should be reflected in higher long term survival rates for implants in animals. One of the authors, Dr James Anthony, BSc(Agr.), DVM, MRCVS, FAVD. DipAVDC, DipEVDC, PAg has reported the loss of only 3% of the implants placed over the life time of animals in which he placed implants. Other veterinary dentists have experienced similar results.



Fig 3. Dog teeth showing variations in size and shape of teeth.



Fig 4. Conventional threaded and press fit implants on left and Mini implants on right.



Fig 5. Proposed new implant design for canines.

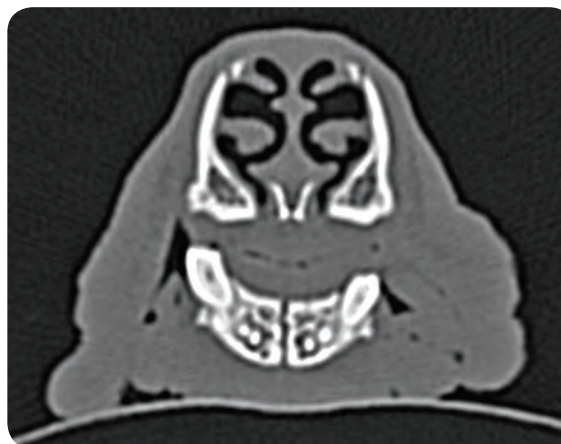


Fig 6. Cat scan of dog mandible through the symphysis showing separation.



Chapter Four - Treatment Planning

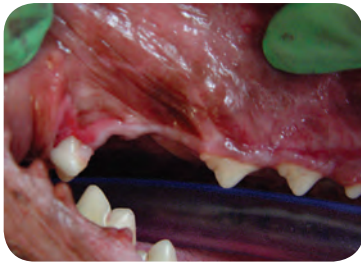
Objective . . . . .	.61
What You Will Learn . . . . .	.61
Treatment Planning. . . . .	.62
Basic Rules – Placement and Restoration. . . . .	.64
Mechanical Principles . . . . .	.66
Load Versus Support . . . . .	.67
Replacement Dentition. . . . .	.72
Location tips. . . . .	.75
Suggested Reading . . . . .	.77



Objective

The objective of Chapter 4: Treatment Planning for Small Animals is to teach you the background and thought process or steps a veterinary dentist might follow to arrive at a scientifically and clinically based plan of treatment for a small animal involving dental implants.

On successful completion of this Chapter, you should be able to determine which prosthesis should be used, how many implants are required, where they can be placed, their angulation, depth and diameter, mechanical principles associated with implants and implant prostheses.



What You Will Learn

- What is Treatment Planning for Small Animals?
- Basic Rules of Implant Placement & Restoration
- Mechanical Principles
- Load & Support
- Determination of Replacement Dentition
- LADDI™
- Suggested Reading



Chapter Five - Bone and Bone Grafting Materials

Objective	79
What You Will Learn	79
Introduction.	80
Cells associated with Bone.	81
Bone	82
Methods of Embryonic Bone Formation	85
Repair, Resorption of Bone.	87
Bone Morphogenic Protein (BMP)	88
Bone Grafting	89
Bone Grafting Materials	92
Tissue Guidance	102
Principles of Guided Bone Regeneration	103
Various Bone Grafting and Guidance products.	104
Suggested Reading	106



Objective

The objective of Chapter 5: Bone Graft Material and Tissue Guidance, is to teach you to better understand how bone functions, its formation, its repair, why bone grafting works and why it doesn't and what grafting materials are available. Once finished, you will be in a better position to understand how to place grafts successfully.

Periosteum



What You Will Learn

- Bone as a Tissue
- Structure of Bone
- Methods of Embryonic Bone Formation
- Methods of Bone Growth and Repair
- Resorption of Bone
- Repair of Bone
- Remodelling
- Requirements for Successful Bone Grafts
- Ideal Bone Grafting Material
- Types of Bone Graft Materials
- Processing and Sterilization of Donor Bone
- Resorbability of Calcium Phosphate Materials
- Various Bioceramic Products
- Polymers
- Principles of Guided Bone Regeneration
- Re-hydration/Reconstitution of Freeze Dried Material
- Tissue Guidance
- Tissue Guidance Materials

Chapter Six - Bone Grafting Procedures

Objective	109
What You Will Learn	109
Clinical Problems	110
Graft Materials	110
Extraction Site and Bone Maintenance	111
Procedures: Extraction, Placement to Grafting.	113
Suggested Reading	122

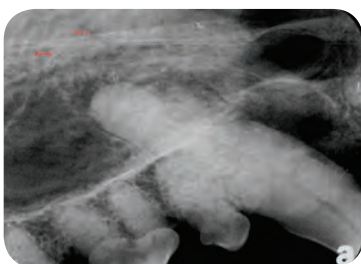
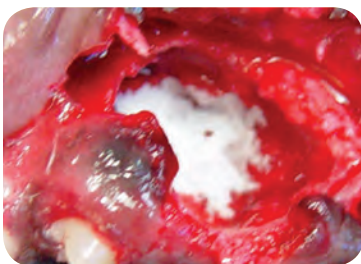
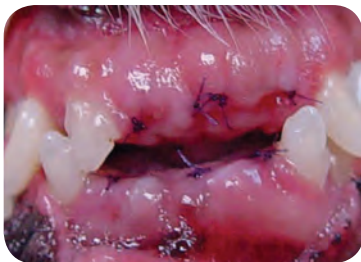




Objective

Although the clinician has many choices of materials to choose from when augmenting bone in the mouth, each material has different advantages and disadvantages. These features were addressed in Chapter 5: Bone Grafting Materials. Which material or combination of materials used in the graft will determine what the final graft consists of; either bone, collagen, fibrous tissue or a combination of the above. The result the clinician desires (bone maintenance, bone repair or implant placement) will dictate which procedure and what materials are used.

This chapter will endeavour to show the clinician the procedures and materials required for the successful grafting of replacement tissue to maintain bone in the jaw. We will address the rationale used for the materials needed in the treatment of various clinical problems as well as the procedures to place the various materials.



What You Will Learn

- Overview of Graft Materials
- Clinical Considerations with Extraction Sites
- Clinical Considerations with Bone Maintenance
- Clinical Considerations with Bone Grafting After Extractions
- Clinical Considerations with Implant Placement at Same Time as Extractions
- Clinical Considerations with Periodontal Defects Around Teeth
- Clinical Considerations with Bone Loss Around Existing Implants



Chapter Seven - Dental Implant Surgery

Objective	125
What You Will Learn	125
Introduction	126
Indications, Contra-indications	127
Preoperative planning	127
Surgical Considerations	129
Sterility and Asepsis	131
Equipment and Instrumentation	132
Implant Placement and Techniques	133
Surgical Placement of a Threaded Implant	144
Preparing the Osteotomy Site	145
Cases pictorials	148
Suggested Reading	153



Objective

The objective of Chapter 7: Surgical Placement of Implants is to give you a better understanding of the indications, contra-indications, pre-operative planning, surgical techniques involved, post-operative care and the problems the clinician is liable to encounter during the surgical placement of implants. We will introduce you to the concept of **Flapless Surgery** which emphasizes the limitation of soft tissue manipulation. Limitation of soft tissue manipulation results in less swelling and soreness for the patient which should be the goal of all surgeries.

On successful completion of this chapter, you will understand how to properly place dental implants into small animals. It is not intended to take the place of clinical experience in implant dentistry but act as an adjunct to the already qualified surgeon.



What You Will Learn

- Warnings
- Indications
- Contra-indications
- Pre-operative Planning
- Pre-operative Care
- Pre Operative Medications
- Surgical Considerations
- Sterility & Asepsis
- Equipment & instruments
- Full Periosteal Flap Technique
- Limited Flap Technique
- Extraction Site Technique
- Cookie Cutter Flap Technique
- Soft tissue considerations
- Slit Technique
- Attached Gingiva
- Unattached Gingiva
- Post-operative Care
- Side effects and Sequelae
- Suggested Reading



Chapter Eight - Implants, Uncovering and Impression Taking

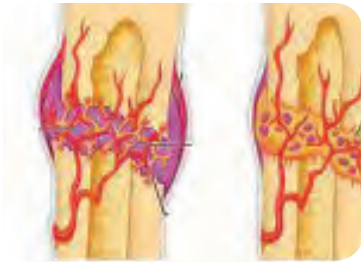
Objective	155
What You Will Learn	155
Introduction	156
History of Types of Implants	157
Repair of Bone	158
Remodeling	159
Locating the Submerged Implant	160
Uncovering the Implant	161
Testing for Osseointegration	162
Soft Tissue Considerations	164
Cover Screw Removal	164
Abutment Selection	165
Suggested Reading	166



Objective

The objective of Chapter 8: Uncovering of Implants & Impression Taking is to give you a better understanding of what to expect at the second stage uncovering, how to test for osseointegration, how to find the implants and the procedures and impression techniques needed to continue treatment toward the restoration of the final prosthesis.

On successful completion of this Chapter, you will understand how to properly uncover and assess the dental implants for integration. You will know how to select the proper healing abutments and how to take proper impressions.



What You Will Learn

- One, Two Stage and Immediate Load Implants
- Bone Repair
- Bone Remodeling
- Locating the Implant
- Uncovering the Implant
- Testing for Integration
- Soft Tissue Considerations
- Cover Screw Removal
- Transmucosal Abutment Placement
- Impression Taking
- Open Top Tray Impressions
- Direct Impressions
- Suggested Reading



Chapter Nine - Restoration of Dental Implants

Objective	169
What You Will Learn	169
Introduction.	170
Factors to Consider for Crowns and Bridges	172
Type of Abutments	174
Remodeling	159
Impression Taking.	176
Placement of Crowns and Bridges.	179
Bridges in Small Animals	181
Suggested Reading	182



Objective

The objective of Chapter #9: Restoration of Implants for Small Animals is to provide you the background, rules and techniques a clinician might follow to produce an accurate, properly fitting crown or bridge over implants in small animals.

On successful completion of this Chapter, you should be able to take proper impressions, choose the best crown abutment for the desired result, direct the laboratory to fabricate the prosthesis and secure the prosthesis properly onto the implant.



What You Will Learn

- Basic Rules
- Factors in Planning
- Types of Abutments
- Impression Taking
- Considerations
- Restoration Procedures: Crowns
- Restoration Procedures: Bridges
- Suggested Reading



Fig 1: PFM crown placed over an implant replacing the 4th premolar (Top), Zirconium crown over lower canine (Middle) Crown at Carnassial (Bottom).

Introduction

At this stage the implant has been allowed to heal undisturbed for at least 2 to 3 months, the implant has integrated and the animal owner expects to have a fixed crown or bridge attached to their animal's implant which can be treated similar to a natural tooth. **(Fig 1)**

Although in Chapter 4: Treatment Planning, numerous basic rules regarding implants were indicated, there are also several basic rules which apply specifically to the restoration of crowns and bridges over implants. Some of those rules are as follows.

1. **Excessive occlusal and lateral forces will cause most implants to fail.**
2. Natural teeth in small animals in the opposing arch can exert a force of 250-2,500 PSI.
3. **Loading** on the prosthesis can be reduced by:
 - Reducing and eliminating cantilevers
 - Reducing the occlusal surface
 - Using softer, more impact resistant materials in the prosthesis such as composite
4. **Support** can be increased by:
 - Increasing the number of implants
 - Increasing the lengths of the implants
 - Using larger diameter implants where possible
5. **Implants do not handle lateral loads well;** the occlusion must be free of interferences in lateral excursion.
6. **Do not exceed crown/root ratio of 1:1.** The greater the crown/root ratio, the more the lateral forces are magnified.
7. **Assess torque loads:** the angulation of the forces onto the long axis of the implant must be considered. It is unrealistic to expect implants to tolerate torque loads **in excess of 30 degrees** from the long axis.
8. The animal should have an **intact dentition in the rest of the mouth.** Missing, periodontally involved, over erupted, some maloccluded teeth, etc. should all be assessed and corrected before implants are placed and restored.
9. Once initial osseointegration is attained, the bone formed around the implant is a weak, immature woven type. During the next **12 - 18 months** this immature bone converts to stronger more mature lamellar bone. **Excessive occlusal loading** during this transition period **can result in crestal bone loss and/or the loss of osseointegration** and replacement by a connective tissue interface. Mature bone can withstand greater loads.

10. **Flexure of the mandible:** In small animals, unlike humans, the midline of the symphysis does not ossify but remains a connective tissue interface. In cats and dogs, this fibrous interface can widen with age and/or from trauma, extractions or periodontal disease. This can result in the two halves of the mandible being more flexible with each other. A bridge across this space can result in stresses in the bridge and cause fracture of the bridge especially in cats.

Therefore, any fixed prosthesis that crosses this space can result in a splinting of the flexure zone which can lead to the patient experiencing pain and/or the bridge undergoing metal fatigue and a broken prostheses. A more prudent method is to incorporate a **stress breaking feature** into the design of the prosthesis in the flexure area or have two separate prostheses. **(Fig 2)**

11. Allow **adequate clearance** around and under the prosthesis for hygiene.
12. Although **cantilevering** is possible with osseointegrated implants, **avoid it**.

Porcelain teeth have very **little stress absorbing capacity** and should be used with caution in crown & bridge cases, especially when opposed by natural teeth as they tend to chip and fracture. Zirconium has become popular but has a high incidence of fracture. Composite materials are recommended where possible but have the disadvantage of shearing off the metal substructures if the composite material is too thin or too thick. If esthetics is not a problem, stainless steel or all metal crowns can be made which are much stronger and less likely to shear than porcelains, zirconium and composite materials. **(Fig 3)**

Always use **metal analogues** in the lab working models. Metal analogues offer greater accuracy than ones poured in dental stone. As well, many of the prostheses incorporate screws into their design and threads cannot be duplicated accurately with dental stone. **(Fig 4)**

13. The **accuracy of the metal framework fit** that seats onto implants is more critical with implants than with natural teeth. With teeth, there is a certain degree of adaptability by the periodontal ligament to accommodate minor discrepancies found with metal framework construction. The ligament is not present with implants eliminating the “adapting factor” necessitating the need for greater accuracy in the casting.



Fig 2: Two separate bridges placed using two implants with a space between bridges in the midline.



Fig 3: Metal crown placed over a tooth.



Fig 4: Metal implant analogue.



Chapter Ten - Complications With Dental Implants

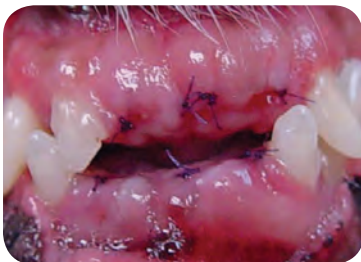
Objective	185
What You Will Learn	185
Introduction.	186
Problem Areas	187
Treatment Planning.	189
Surgical Placement	190
Immediate Postoperative Problems	193
Delayed Post Operative Problems.	195
Four Month Uncovering Stage.	197
Restoration	198
After Restoration	201
Patient Post Operative Home Care	203
Other Complications	204
Suggested Reading	206



Objective

The objective of Chapter #10: Complications with Dental Implants is to give the reader a better understanding of the problems encountered when placing and restoring dental implants in small animals, how to recognize problems, their course of treatment and most importantly how to prevent them.

On successful completion of this Chapter, the reader will be in a better position to better evaluate small animal patients having dental implants and avoid potential problems as well as those who already have implants but are experiencing problems.



What You Will Learn

- Complications during Animal Selection
- Complications during Treatment Planning
- Complications during Surgical Placement
- Complications during Restoration
- Complications during Home Care
- Complications during Other



Fig 1: Healthy young cat and dog



Fig 2: Healthy young veterinary dentist.



Fig 3: Dental lab.

Introduction

In spite of the continued success with dental implants, if you place and restore enough of them you will inevitably encounter problems. In the experience of the authors, most problems encountered with implants are due to the failure to recognize the potential pitfalls with the patient, with the treatment plan, or with the implementation of the suggested treatment plan. As a veterinary dentist, it is important to recognize the factors that make up the ideal small animal patient and to understand the potential problems that can arise with a less than ideal one.

The **ideal small animal implant patient** should be younger and healthy with no medical problems, no medication allergies, a good healer with sufficient bone to place implants and have no periodontal problems. As well the **owner** should be able to provide good oral hygiene to the animal, be financially sound and be dentally appreciative. **(Fig 1)**

In the ideal situation, **the veterinary dentist** is surgically knowledgeable and experienced in implant dentistry with extensive clinical experience in dentistry and the prosthetic considerations and limitations in the restoration of dental implants. As well, the veterinary dentist should have a working relationship involving mutual respect with an ideal dental laboratory. **(Fig 2)**

The ideal dental laboratory should be a competent dental lab with extensive laboratory experience in dental laboratory procedures and especially small animal implant dentistry. Ideally the lab should be aware of the surgical and restorative limitations imposed on the veterinary dentists. The laboratory must also have enough confidence in their role and responsibilities to insist on proper impressions and adequate information from the veterinary dentists. **(Fig 3)**

Usually, the reality is that the small animal may have some minor medical problems but is still able to have surgery, may have some minor periodontal problems, and/or often is older and has marginal available bone for the placement of implants. As a consequence, there is often some factor with the patient, albeit minor, that will jeopardize the success of even the best of treatment plans.

The combination of all four ideal criteria, the patient, the owner, the veterinary dentist and the dental lab rarely exists.

Problem Areas

While **prevention is the key** to decrease the problems encountered with dental implants, problems can often develop with patients due to the less than ideal patient, owner, veterinary dentist and/or dental lab. We will now introduce you to the most common problems normally encountered with dental implants.

Most problems that patients experience with dental implants are **preventable** and fall into one of the following categories:

1. **Animal Assessment**
2. **Treatment Planning**
3. **Surgical Placement**
4. **Restoration**
5. **Patient Post Operative Home Care**
6. **Other**

The first four of these categories fall within the responsibility of the veterinary dentist providing the service. The responsibility of small animal **home care** lies both with the pet owner and in the veterinary dentist's instructions to the owner. Without the ideal veterinary dentist, who has the ultimate responsibility for each area, the home care aspect becomes clouded and the pet frequently **"falls between the cracks"** resulting in what could have been a preventable patient problem. Therefore, it is important that **the veterinary dentist take overall responsibility for the entire treatment of the patient and ensure that all potential problem areas are addressed.**

Animal Assessment

The objective of **Animal Assessment** is to understand the medical, dental, financial, concensual and medico-legal factors that need to be assessed and considered to ensure success in placing and restoring dental implants in patients. This entire subject is addressed fully in **Chapter #2: Animal Assessment. (Fig 4)**

As mentioned earlier, it is unusual to have the ideal patient. It now becomes a question of to what degree the patient's problem will affect treatment. It is the prudent veterinary dentist who realizes this and ensures the patient's owner is aware of the limitations.

When assessing a patient for consideration for the placement and restoration of implants, a number of factors need to be evaluated to ensure that the needs of both the patient and the veterinary dentist are met. Not only must the implants successfully integrate and be restored but the patient's owner must accept and understand the treatment, the follow up care as well as meet their financial obligations. Subsequently the owner needs to be satisfied in the decision of the treatment plan and its implementation.



Fig 4: Veterinarian assessing dog.

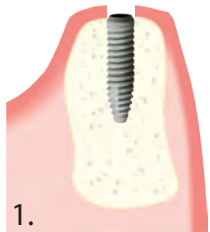


Suggested Reading:

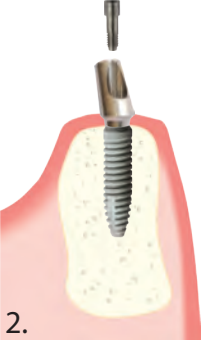
1. Prevention and treatment of postoperative infections after sinus elevation surgery: clinical consensus and recommendations., Testori T, Drago L, Wallace SS, Capelli M, Galli F, Zuffetti F, Parenti A, Deflorian M, Fumagalli L, Weinstein RL, Maiorana C, Di Stefano D, Valentini P, Gianni AB, Chiapasco M, Vinci R, Pignataro L, Mantovani M, Torretta S, Pipolo C, Felisati G, Padoan G, Castelnuovo P, Mattina R, Del Fabbro M., *Int J Dent.* 2012;2012:365809.
2. Factors associated with early and late failure of dental implants., Sakka S, Baroudi K, Nassani MZ., *J Investig Clin Dent.* 2012 Aug 27. doi: 10.1111/j.2041-1626.2012.
3. Surgical repositioning of osseointegrated malposed dental implant with segmental osteotomy., Netto HD, Olate S, Mazzonetto R., *J Craniofac Surg.* 2012 Sep;23(5):1540-2.
4. R root resection in the era of dental implants, Horwitz J, Gabay E., *Refuat Hapeh Vehashinayim.* 2012 Jan;29(1):7-14, 62.
5. Risk of postoperative bleeding after dental procedures in patients on warfarin: a retrospective study., Hong C, Napenas JJ, Brennan M, Furney S, Lockhart P., *Oral Surg Oral Med Oral Pathol Oral Radiol.* 2012 Oct;114(4):464-8.
6. Immediate loading of four (all-on-4) post-extractive implants supporting mandibular cross-arch fixed prostheses: 18-month follow-up from a multicentre prospective cohort study., Grandi T, Guazzi P, Samarani R, Grandi G., *Eur J Oral*
7. Short (5 and 7mm long) porous implants in the posterior atrophic maxilla: a 5-year report of a prospective single-cohort study., Perelli M, Abundo R, Corrente G, Saccone C., *Eur J Oral Implantol.* 2012 Autumn;5(3):265-72.
8. Soft tissue management for dental implants: what are the most effective techniques? A Cochrane systematic review., Esposito M, Maghaireh H, Grusovin MG, Ziounas I, Worthington HV., *Eur J Oral Implantol.* 2012 Autumn;5(3):221-38.
9. Managing esthetic implant complications., Butler B, Kinzer GA., *Compend Contin Educ Dent.* 2012 Jul-Aug;33(7):514-8, 520-2.
10. A retrospective analysis of replacing dental implants in previously failed sites.,m Mardinger O, Ben Zvi Y, Chaushu G, Nissan J, Manor Y., *Oral Surg Oral Med Oral Pathol Oral Radiol.* 2012 Sep;114(3):290-3. Epub 2012 Feb 10.
11. Clinical outcomes of single dental implants with external connections: results after 2 to 13 years., Camargos Gde V, do Prado CJ, das Neves FD, Sartori IA., *Int J Oral Maxillofac Implants.* 2012 Jul;27(4):935-44.
12. Biomechanical implant treatment complications: a systematic review of clinical studies of implants with at least 1 year of functional loading., Hsu YT, Fu JH, Al-Hezaimi K, Wang HL., *Int J Oral Maxillofac Implants.* 2012 Jul;27(4):894-904.
13. Clinical management of implant prostheses in patients with bruxism., Komiyama O, Lobbezoo F, De Laat A, Iida T, Kitagawa T, Murakami H, Kato T, Kawara M., *Int J Biomater.* 2012;2012:369063. Epub 2012 Jun 4.
14. Post-implant neuropathy of the trigeminal nerve. A case series., Renton T, Dawood A, Shah A, Searson L, Yilmaz Z., *Br Dent J.* 2012 Jun 8;212(11):E17.
15. Survival of ceramic veneers made of different materials after a minimum follow-up period of five years: a systematic review and meta-analysis., Petridis HP, Zekeridou A, Malliari M, Tortopidis D, Koidis P., *Eur J Esthet Dent.* 2012 Summer;7(2):138-52..
16. Exotic encounters with dental implants: managing complications with unidentified systems., Mattheos N, Janda MS., *Aust Dent J.* 2012 Jun;57(2):236-42. doi: 10.1111/j.1834-7819.2012.01676.x. Epub 2012 Mar 16.



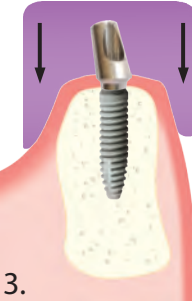
IMMEDIATE LOAD



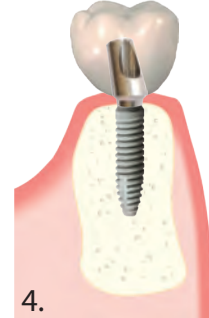
1.
Place implant 1-2 mm below bone.



2.
Attach crown posts at time of surgery.

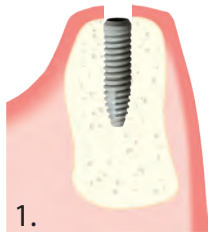


3.
Take impression.

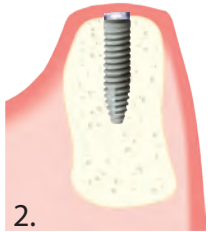


4.
Add prosthesis within 48 hours.

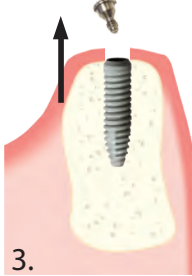
TWO STAGE



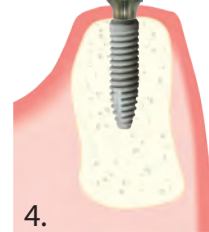
1.
Place implant 1-2 mm below bone.



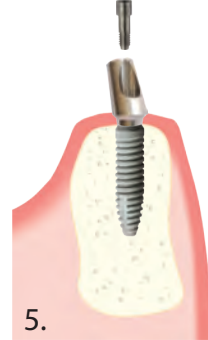
2.
Attach cover screw flush with bone



3.
Uncover by removing cover screw in 3-6 months.

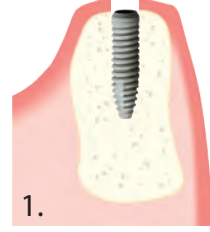


4.
Place Tissue Former (or continue with step 5)

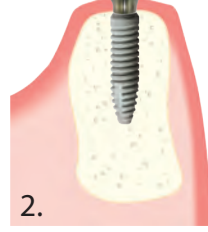


5.
Place abutment

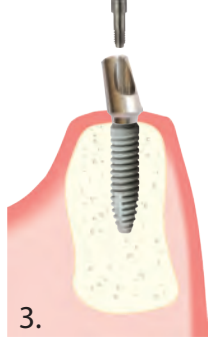
ONE STAGE



1.
Place implant 1-2 mm below bone.



2.
Place Tissue Former



3.
Remove Tissue Former in 6 - 8 weeks, take impression and place abutment.