Introduction

The advantage of using implants to replace missing dentition has been advocated since its introduction in the late 1960s by the Swedish orthopedic surgeon Prof. Branemark. The original protocol was to provide anchorage in the lower jaw of the edentulous patients who had difficulties with their conventional complete dentures. Dental implants were surgically installed in the jawbone to provide support and retention for the dental prostheses. A process called osseointegration occurred when bone is allowed to integrate on the titanium implant surface under optimal condition. In this article, the various aspects of dental implant treatment will be discussed.

Applications of dental implant

In general, patients who have acquired or congenital missing teeth can be benefited from implant treatment. Conditions such as the loss of teeth due to caries or periodontal disease, genetic conditions such as ectodermal dysplasia, trauma from accident or gun-shot, tumour resection or reconstructed defects can be rehabilitated.

Implant crown

Implants are installed to support individual missing teeth in the oral cavity. The feasibility of this treatment modality depends on the amount of alveolar bone available. Apart from clinical and radiographic assessment, advanced imaging technology such as CT scanning provides additional information of the quality and quantity of the bone. Implants of suitable diameters and lengths can be selected for installation. Recently, implants with rough surface morphology are becoming more popular than smooth surface implants due to the fact that a reduced osseointegration time can be achieved (Fig. 1 & 2).

Implant Bridge

In the situation where multiple teeth are missing, a number of implants can be installed to rehabilitate the dentition. Consensus for the number of implants required is not available scientifically and the decision is usually dependent on the experience and preference of the practitioners. However, to reduce the degree of complexity and cost of the prosthetic reconstruction, the trend is to use the minimal number of implants to support the prosthesis (Fig. 3 & 4).

Full arch implant

In the rehabilitation of a full edentulous arch complicated with bone resorption, the options of 3 to 6 implants will be commonly selected to support a long-span fixed prosthesis. Promising long-term results can be achieved if the treatment is adequately performed and the post-treatment oral hygiene of the patients are maintained (Fig. 5 & 6).

Implant supported over-denture

The technology in using implants to assist stability and retention of partial or complete dentures is available. Patients with compromised alveolar bones which are not suitable for fixed prosthesis reconstruction can be benefited from the implant supported over-denture alternative. As the dentures are both mucosal and implant bearing, the reliance of anchorage on implants is less and fewer implants are therefore required. This is a relatively inexpensive oral rehabilitation for both the maxillary and mandibular jaws. For the maxilla, evidence on patient satisfaction has proven that implant supported over-dentures are as good as the implant fixed option. If the mandibles are reconstructed with the implant supported over-dentures, and especially for jaws with increased bone resorption, significantly higher bite force and better control of the prostheses are demonstrated in the patients (Fig. 7 & 8).

Craniofacial prosthesis

Implants are used widely in the craniofacial region with promising results. Examples are implant-retained ocular and auricular prostheses (Fig. 9 & 10).
Success criteria

The most commonly referred guideline was proposed by Albrektsson and colleagues in 1986.

1. The implant must be clinically immobile.
2. There should be no peri-implant radiolucency around the implant.
3. Annual marginal bone loss around the implant should be less than 0.2mm after 1st year.
4. There should be absence of persistent pain, discomfort or infection related to the prosthesis.
5. The implant has to be 85% success after 5 years, and 80% success after 10 years.

Implants are considered to be 'survived', instead of 'success', if they do not meet all the criteria even though they are still functioning.

Patient factors affecting implant treatment

Some conditions have been cited as potentially critical, but studies comparing patients with and without the specific conditions in a controlled setting are sparse.

Diabetes

In the oral cavity, xerostomia, caries and periodontitis have been linked to diabetes mellitus. It is associated with various systemic complications including retinopathy, nephropathy, neuropathy, vascular disturbances and impaired wound healing. The osseointegration process, will logically be affected as it depends on bone healing. In retrospective studies, uncontrolled diabetes has been reported to have lower implant success rate (85%)4,5. The tendency for subjects with diabetes to have higher failure rates is equivocal6. Special contingency planning is important in installing implants in those patients. The usual approach is to include additional implants in the restorative plan.

Osteoporotic patients

The evidence for an association of osteoporosis and implant failure was not scientifically established although osteoporosis has been mentioned as a possible risk factor for osseointegration failure due to the decrease in bone mass and density6. The prevalence of osteoporosis increases among the elderly and after menopause. It appears that osteoporosis, as diagnosed at one particular site of the skeleton, is not necessarily affecting the maxillary and mandibular bones7. It is important for practitioners to be aware of the potential risk for treating patients who are under bisphosphonate therapy, either orally or by intravenous (IV) infusion. Bisphosphonates suppress osteoclast activity and their IV application has been reported to be associated with osteonecrosis of the jaw8,9. Implant surgery, if to be performed in those patients, will be considered at risk. A case report described 63 cases of osteonecrosis of the jaw in cancer or osteoporotic patients10. The effect of patients having long-term oral bisphosphonates is still not fully understood and implant treatment on those patients must also be performed with caution.

Smoking

Similar to the negative effects in periodontal disease, the adverse effect of smoking on implants has also been well documented11,12. Significantly more failures were reported in smokers than in non-smokers and having a hazard ratio is 4.3 times13. In the long-term, smoking is associated with significantly higher levels of implant marginal bone loss and poor peri-implant gingival health14,15. Heavy smokers, those who take more than 12 cigarettes per day, will be affected more severely16. A smoking cessation protocol was suggested that complete cessation for 1 week pre-surgery and 8 weeks post-surgery has shown short-term benefits of having similar failures to non-smokers. However, the compliance of the patients who follow this protocol is being questioned.

Age

There is no upper age limit. Although theoretically patients with increased age will have more systemic health problems, there is no evidence correlating old age with implant failure17. On the other hand, the minimum age of a patient for implant has been questioned. Because of their osseointegrated character, installed implants behave as an ankylosed element and do not follow the further growth of the jaw and alveolar bones18. Therefore the clinical outcome, in terms of appearance and occlusion, of the implant prosthesis will be compromised as the patient’s facial growth continues. The installed implant will be retained in a submerged position after some years.

Irradiated bone

Dental implants are commonly used to provide anchorage for craniofacial prostheses. Irradiation therapy in combination with surgical excision is the treatment protocol generally employed for malignant tumours in the craniofacial region. Although irradiation is not an absolute contraindication to implant installation due to the risk of osteoradionecrosis, reported success rate is only about 70%19. Adjunctive hyperbaric oxygen (HBO) therapy has been proposed for previously irradiated patients prior to implant treatment. A case-controlled study has shown increased implant success rate with HBO therapy in irradiated patients20.

Complications

Although the success rate is high, failures do occur. Failure is classified as early, when osseointegration fails to occur, or as late, when the achieved osseointegration is lost after a period of function. It can also be biological or mechanical in nature. Biological failures include those implants which are unable to osseointegrate due to surgical problems, or loss of established osseointegration due to infection. Heating of the bone to 47°C for 1 minute during drilling will cause failure in osseointegration21,22. Mechanical failures refer to complications of the connecting parts such as screw loosening or fracture, deterioration of the prosthetic components. There are other complications such as the poor angulations and positioning of the implants in the jawbone giving rise to problems in the reconstruction, poor esthetic outcome of the prostheses, and, inadequately contouring of the prostheses causing daily oral hygiene maintenance difficulties or impossibilities.
Patient satisfaction

Patients are more interested in enjoying suitable levels of comfort, aesthetics and function. These are the factors difficult for the practitioners to measure. To satisfy the patients, we have to administer the implant treatment that is clinically achievable, while at the same time acceptable by the patients. Dental implants do improve the quality of a patient's life. In a longitudinal clinical trial to compare the impact of the dental implant on the psychosocial well-being of subjects with problems related to their conventional dentures, it was found that patients who had received implant supported prostheses had a profound improvement in health-related quality of life. Moreover, subjects who wore implant supported mandibular over-dentures had significantly increased ease of chewing, denture stability, and comfort than patients with conventional dentures[23,24,25]. Although implant prostheses enhance patient satisfaction, it is still controversial to determine whether the fixed or the removable option has a better impact on the quality of life and satisfaction for the patients. Factors such as age, gender, occupational status, and socioeconomic class might influence the outcome. The literature lacks valid data of the relationship between satisfaction and personality profiles and their impact on the success of this treatment modality.

New development

Computer CAD-CAM technology has been utilised in assisting implant reconstruction treatments. Custom-made CT scan templates are worn by the patients during the scanning. Systematic planning of the number of implants, diameter and length, positioning and angulations can be performed using user-friendly 3D computer software based on the DICOM CT scan data of the patient's jaws. Vital structures such as nerves and vessels are identified and the implants are planned in the most optimal areas. High precision surgical guides (Fig.11), according to the planning, will be delivered to the practitioners by courier after internet transmission of the digital data to specific manufacturers. The second advantage is that it is possible to pre-fabricate the implant prostheses, temporary or definitive ones, prior to the implant surgery. Therefore, immediate restoration of function and aesthetics of the patients are possible. This concept is not new but long-term study is lacking. The final results of the reconstruction using this protocol can be varied and it is highly experience and technique sensitive. Errors such as the accuracy of the CT scanning with respect to the relationship of the CT scan template and the jaw bone, repositioning of the surgical guide to the jaws during surgery, and the complex prosthetic procedures are the main sources of the failure.

Is implant for life?

It can be quite sure to say that the implant fixtures have a good prognosis of 95% success rate based on recent longevity studies[26,27,28]. But the clinical outcome of the prostheses/restorations supported by the implant varies. Technical complications are not infrequent. The longevity of implant supported fixed prostheses was systematically reviewed in studies and the reported success rates were 95% after 5 years and 87% after 10 years respectively. It was also concluded that the most common failure of the prostheses supported by the implant was prosthetic teeth portion fracture (14%) and connection screw loosening or fracture (7.3%) 29,30. Other critical reviews showed that at 10 years conventional bridges were 71% problem-free whilst implant supported fixed prostheses were 61% instead[31,32]. However, some of the mechanical complications can be managed if the prostheses are designed with screw-retained protocol as retrievability of the prostheses is maintained.

Summary

Implant is a reliable oral rehabilitation treatment nowadays. Information from research has provided the base for the clinical practice of dental implant. Not only knowledge and skill are required, the use of advanced imaging technology as well as the experience is of paramount importance in the success of implant dentistry.

A case example

Advanced implant rehabilitation was demonstrated in a 77-year-old Chinese male smoker who had mobile and hopeless teeth due to severe periodontal disease. Teeth removal and implants installation were performed in the same surgery. A set of temporary prostheses, pre-fabricated prior to surgery, was inserted to restore function and aesthetics immediately after the procedure. CAD/CAM computer software based on CT images was utilised in planning of implants in the jawbones and for the manufacturing of the surgical guide. The final prostheses were constructed following conventional prosthetic procedures after the stabilisation of the dentition with the temporary ones. (Fig. 12, 13 Pre-op radiograph and frontal view showing teeth with poor condition; Fig. 14 Implant planning for lower jaw using CAD/CAM software; Fig. 15 Installation of implant using the software-generated surgical guide after complete removal of lower teeth; Fig. 16 Temporary fixed prostheses inserted to lower jaw immediately after surgery. Upper temporary partial denture also inserted after multiple teeth removal; Fig. 17 Immediate aesthetic result; Fig. 18, 19 Six-month Post-op radiograph and frontal view showing the final prostheses in situ.)
References


