Endosseous Dental Implants

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The most ancient speciemen of a endosseous dental implant ever recorded seems to date as far back as the pre-Columbian era. According to Andrews (1893), at the Peabody Museum of Harward University there was a skull from such a period discovered in Honduras in which the lower left lateral incisor was replaced by a black stone. The calculus on it would seem to indicate that it had been worn for some time during life. According to Johns (1974) that skull can no longer be traced at the Peabody Museum.

If there are doubts with regard to Andrews' report due to lack of photographic evidence, another early documented record on dental implants is that of Maggilo in 1809 (Maggilo 1809). Maggilo designed an implant made of gold (Fig. 1). It consisted of a tube, four claw-like wings and a flat plane. It was inserted into a recent extraction socket. The wings aided retention, the tube provided a pathway for «humours» to escape and acted as a support for a pivot tooth.

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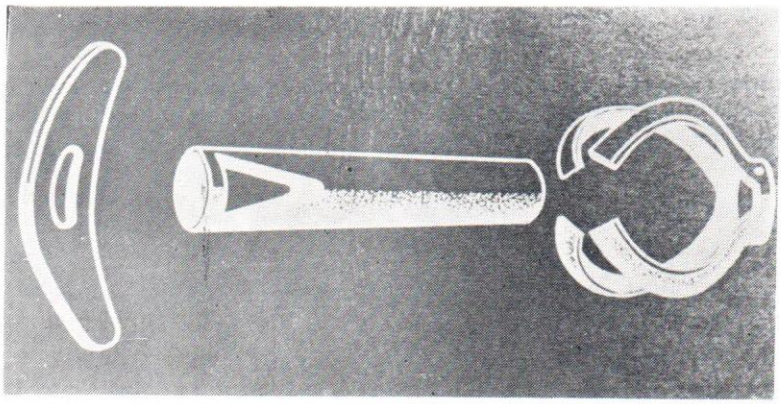


Fig. 1 : Gold implant of Magilo (From Sandhous, S. : Nouveaux Aspects de l'Implantologie, Lausanne 1969).

Harris (1887) described a single case of a tooth replacement for a Chinese male. He used a tooth made of a porcelain crown into which a lead-coated platinum post was fitted.

In 1888, Berry reported a similar case (Berry 1888). He said that he felt roots could just as well be made of wood, tin or silver with an equal of success.

Edwards (1889), suggested the use of a root shaped platinum plug for dental implants and he reported a successful implant case.

Smith (1889), addressed the American Dental Association on the dental implants. He gave a list of practitioners, who having tried different dental implants, felt that implants held no chance of long term success as all implants eventually beiame loose. He also drew attention to Ottolengui's study of anatomical problems of the dental implants, and the risk which might be involved in the preparation of sockets.

Znameisky (1891) reported on his work in Russia in 1889.He tried out a variety of methods and materials on dogs and human beings. He described the shape of his implants as that of a flattened skittle in which holes of varying depth were cut to allow tissue ingrowth. He also suggested that use of transversal and longitudinal grooves in order to provide resistance to rotation. The firing of the porcelain was incomplete to obtain a rough surface.

Payne (1900) reported on a patient in whom an implant using a

seamless gold cartridge, filled with gutta-percha, was inserted. But there was no subsequent report.

Greenfield (1913) designed an endosseous implant which an iridioplatinum latticed cage whose transverse ribs were soldered to upright bars (Fig. 2). At the top of this cage was a slotted disk into which a cap bearing an artifical tooth appropriate to the site could be cemented. He had hoped that the bone would grow around, and through the frame. He reported limited success.

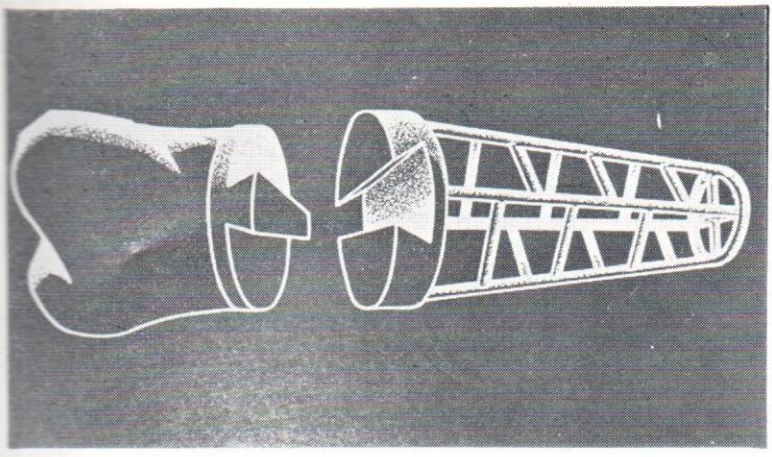


Fig. 2 : Greenfield's cage implant (From Sandhous, S. : Nouveaux Aspects de l'Implantologie, Lausanne, 1969)

Casto (1914) reported on three cases using the Greenfield type of implant. His longest surviving implant was only twelve weeks.

Sandhaus (1969) in his review of dental implants, described the «expanding gold root» of Léger Dorez in 1920 (Fig. 3). It consisted of a split tube 3 mm in diameter and 9 mm in length, which expanded on tightening a threaded conical nut within the tube, thereby giving immediate retention.

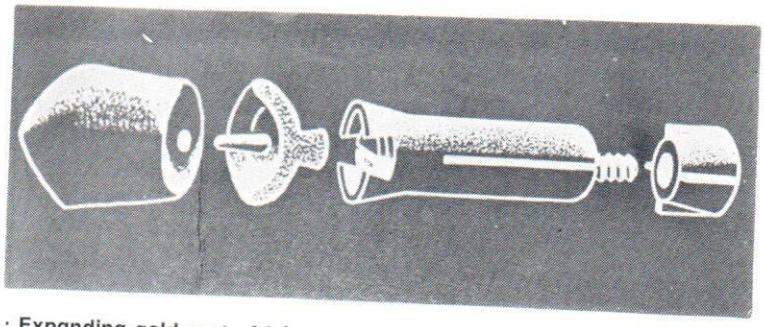


Fig. 3 : Expanding gold root of Léger Dorez (From Sandhous, S. : Nouveaux Aspects de l'Implantologie, Lausanne 1969)

Ehricke (1920) screwed into an artificial socket an ivory root which a Richmond crown was placed.

Weigele (1928) inserted into the jaw bone an ivory 'aseptic implant' from the exterior and also used golden nuts.

Abel (1934) experimented with wipla screws and glass.

Brill (1936) utilized rubber pins inserted into artificial sockets as abutments for movable lower bridges, later he replaced the rubber with porcelain.

These early endosseous dental implants were made of gold, silver platinum, ivory etc. The choice of these metals was probably based on the belief that these metals would be well tolerated.

In 1936 Venable, Stuck and Beach (Venable et al. 1936) presented an extensive research on bone of the presence of metals based upon electrolysis. They concluded that Vitallium was the only alloy which produced no electrolytic reaction when buried in the tissues. Today it is known that Titanium is also welt tolerated by the tissues.

It seems that this report spured some workers to use only Vitallium implants and research for different alloys and designs.

CLASSIFICATION OF DENTAL IMPLANTS

Various classifications have been suggested for dental implants.

Gershkoff and Goldberg (1957) based their classification on the relationship an implant has with the bone : —

1. Endosseous implant: an implant which enter the bone thorough natural or surgically prepared sockets.

2. Intra-osseous implant: indicating transfixation of the bone.

3. Sub-periosteal implant: an implant which is fitted below the periosteum but above the bone.

Taylor (1970) suggested four headings under which implants might be considered: —

1. Sub-perosteal: as defined by Gershkof.

2. Submucous: to indicate the mucosal insert of Lew and Kesselbaum (1953).

3. Endosseous: to cover all the remaining implants with the exception endodontic implants.

4. Endodontic stabilizer: to signify an implant which is inserted into the root canal to stabilize a crown or pontic, the term was used in this context by Orlay (1965).

Linkow and Cherchève (1970) initially classified the dental implants into two groups and they also pointed out that it was difficult to put all types of implants into one or other groups.

Johns (1971) classified dental implants primarily by their function:

1. Retentive implants, indicating that while a retentive influence is exerted on a denture, functional loads are still transmitted through the mucosa.

2. Supportive implants, on the other hand, relieve the soft tissues of some or all of the masticatory load transmitting it directly to the bone.

Zembilci (1972) initialy classified the implants according to the materials used, then he subclassified into different groups.

Natiella et al! (1972) have reviewed the evolution of dental implants during the present century and classified present day implants into sub-pericsteal and endosseous. The endosseous implants include the spiral, blade types, screws, pins and artificial tooth roots in various materials.

Since this article is devoted to endosseous implants, it was felt that it would be better to use Natiella's classification.

THE SPIRAL IMPLANTS

The spiral implants was devised in 1938 by the Italian Marilio S. Formigini (Taylor 1970) who is today acknowledged to be the father of modern endosseous implantology (Fig. 4). He had originated his implant from the treatment of one patient in 1938. He extracted an upper canine and placed iodoform gauze mesh into the socket. He asked the patient to come back the following day for the removal of the iodoform pack. But the patient did not come back for another two months and when examined it was found that the pack was still inplace and set hard. The gingiva around the pack seemed to be healthy and closely connected to the pack, which was difficult to extract. From this, he designed the spiral implant which was usually fabricated from stainless steel or tantalium wire 2 mm in diameter and 20 mm in length, bent by hard at right angles to form a series of spirals. The upper most spires were wider toward the surface of the

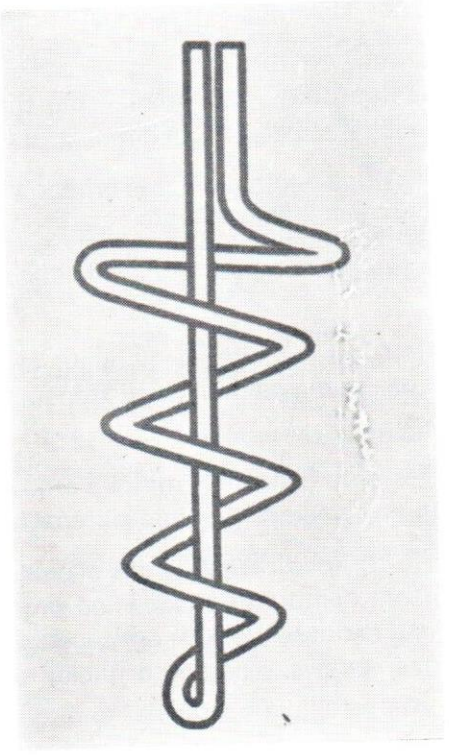


Fig. 4 : Formingini's hand-fashioned spiral implant

alveolar crest than at the apex. The two ends of the wire were soldered to form a post on which the prosthesis was attached. By this design, Formiggini hoped that bone would grow into and around the implant. The design of implant in fact allowed the bone ingrowth.

However, this hand-fashioned spiral implant had certain disadvantages. One major drawback was that the operator himself constructed the implant during the operation, and as a result no two implants were ever alike and suitability of the implant to the socket depended on the operator's skill and judgement. It is also known that the bending the wire to fit certain area creates weak points, and it was always possible to fracture the implant either during insertion or because of stress on the implant during use.

It was assumed that by placing the wider portion of the implant close to the surface, bone would grow on to it and therefore would avoid tissue invagination. This did not occur in practice and there was invagination of fbromucosal tissues and subsequent loosening of the implant when implanted.

When it was necessary to remove the implant, extensive surgery was needed and a block of bone had to be cut out around the basal spires of the implant.

Zepponi (1955) modified Formiggini's spiral implant. In fact he was the first to cast a spiral implant in Vitallium, and this was a major advance. The spirals and the abutment post were one unit and the implant itself was stronger than that of Formiggini. By casting the implant it was also possible to perform a more exact operation, since the operator used spiral implant uniform in size and shape.

In spite of the considerable improvement over Formiggini's handmade implant, Zepponi's design still retained some of the disadvantages.

In 1953 Perron also modified Formiggini's original spiral implant. (Perron 1961) by coating the post with a polyvinyl (Ivalon) sponge. He hoped that polyvinyl sponge would stimulate soft tissue ingrowth but this approach had to be abandoned due to infection spreading from he sponge to the soft tissues (Fig. 5).

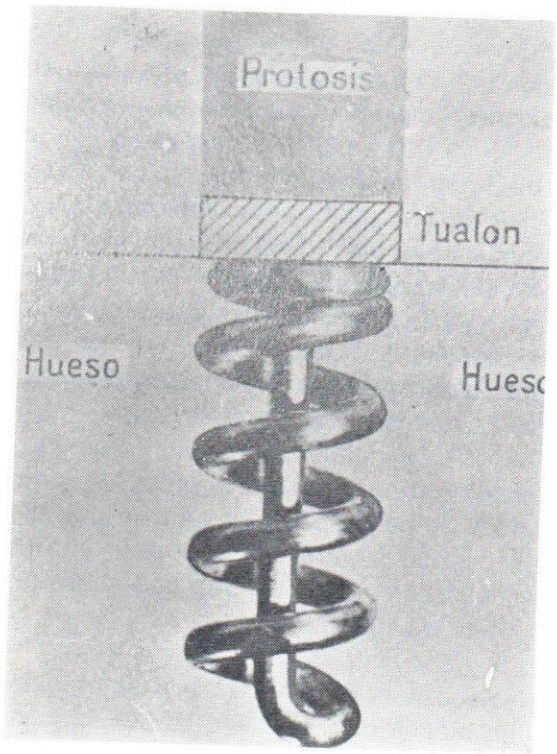


Fig. 5 : Peron and Andres's Ivalon coated spiral implant (From Linkow, L. I., and Chercheve, R. : Theories and techniques of Oral Implantology, Mosby, St. Louis. 1970.

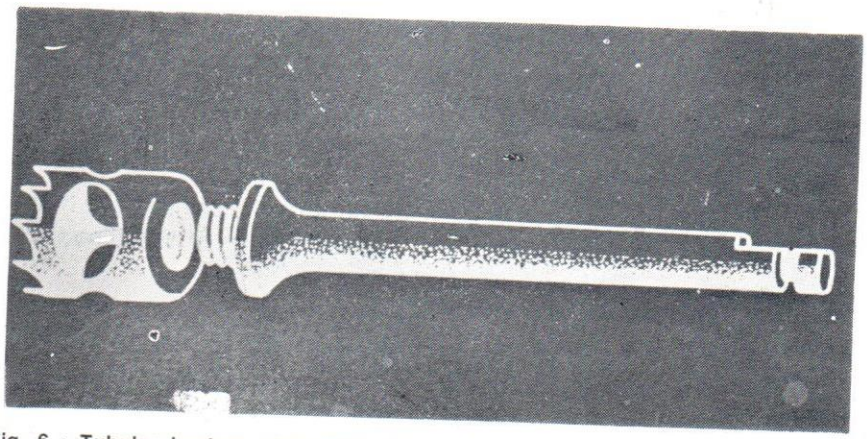


Fig. 6 : Tubular implant of Benaim (From Sandhous, S. : Nouveaux Aspects de l'Implantologie ,Lausanne 1969.

Another approach to modify the spiral implant, was made by Benoim (1959), (Fig. 6). His implant was called a «tubular implant» which consisted of hollow, perforated cylinder of stellite, open at the lower end closed at the upper end by an internally threaded screw.

This implant was too large in diameter and had no variable lengths. Insertion of the implant was a two stage operation. In fact, in the dental literature, there was not enough evidence, illustrating the extent of its use.

The French surgeon R. Cherchève (1962) also modified Formiggini's design, by using Chrome-cobalt and Vitallium (Fig. 7). His initial implant design was called «the buried spring implant». This implant consisted of a hollow spring which was inserted first. A few months later, when the healing of the bone has taken place the soft tissues were re-opened and a prosthesis-bearing shaft inserted.

Obviously this implant did give a great deal of unnecessary damage.

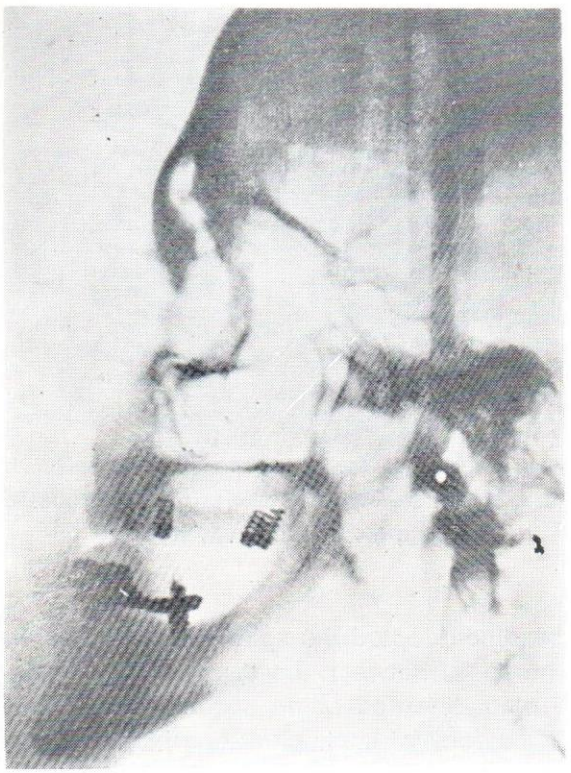


Fig. 7 : The buried spring implant (From Chercheve, R. : Les implants endo-osseox, Librairie Maloine. Paris, 1962 .

Later, he discarded the buried spiral implant and purposed a solid, one piece spring implant (Fig. 8). This implant had fewer spirals than Formiggini's and longer neck, to ensure that spirals were buried well away from the crest.

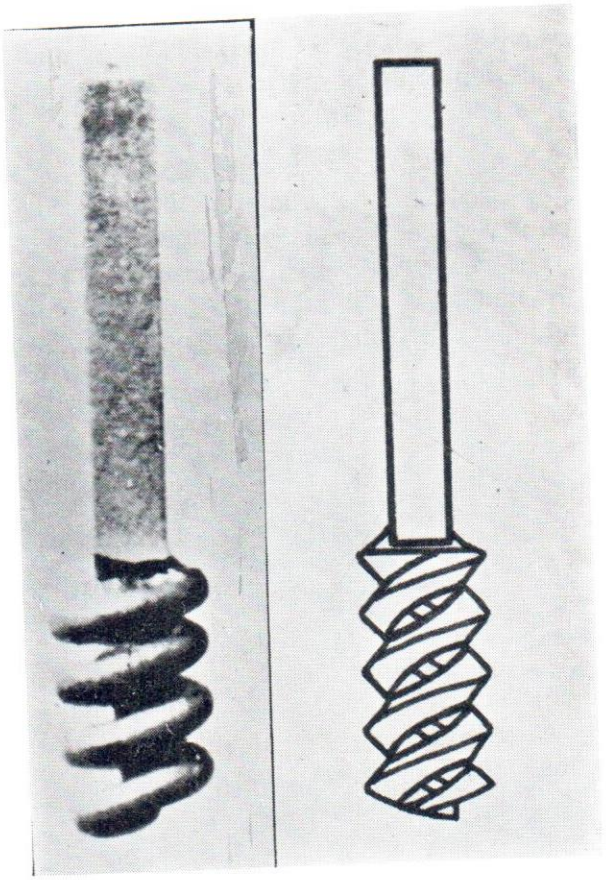


Fig. 8 : Chercheve's one piece spring implant a) Early design, b) Later design (From Linkow, L. I. and Cherchève, R., Theories and techniques of oral implantology-Mosby, St. Louis, 1970).

Furthermore he adopted the spirals intoa helical shape in order to increase the space between the spirals and to easily modify their numbers. He also designed some specific equipment and instrumentation for insertion of his implant and his technique. This helical design allowed the implant to act as a shock absorber or as a pressure breaker.

However, this implant had the disadvantages of having a long shaft which placed a great deal of lever arm action.

In 1962 a further modification of the spiral implant was made by Jeanneret (1962) (Fig. 9). He designed a three-part spiral implant which had a thick shaft to permit the separate pieces to be screwed together. This design was too bulky, which limited its use in narrow ridges and invited the soft tissue invagination.

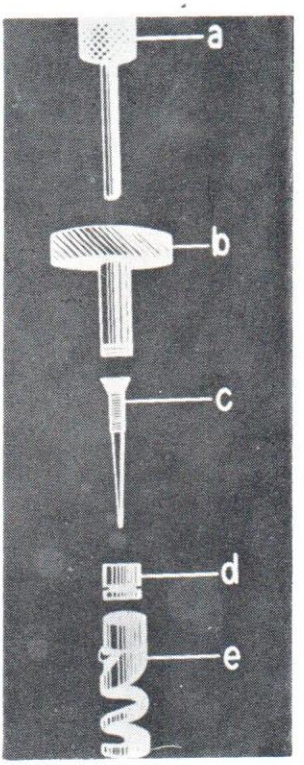


Fig. 9 : Jeanneret's spiral implant (From Sandhous, S. : Nouveaux Aspects de l'Implantologie Lausanne, 1969)

Muratori (1964) also designed a spiral implant which consisted of a spiral encircling two narrow vertical uprights and surmounted by an internally threaded shaft (Fig. 10). Again, this design had a bulky shaft which invited tissue break-down. He later had to re-design his implant by modifying the shaft which was much narrower and rounded.

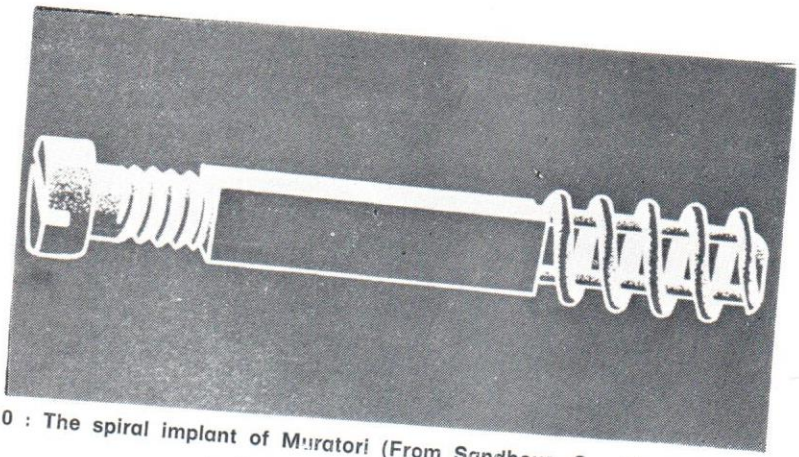


Fig. 10 : The spiral implant of Muratori (From Sandhous, S. : Nouveaux Aspects de l'Impiantologie Lausanne, 1969)

Trattner (1966) presented a two-piece Heli-Coil implant (Fig. 11). He separated the spirals into a separate coil or spring, which was to set into the bone and immediately screw into this shaft portion that would bear the prosthesis.

This design had very little space through which bone could grow between coils.

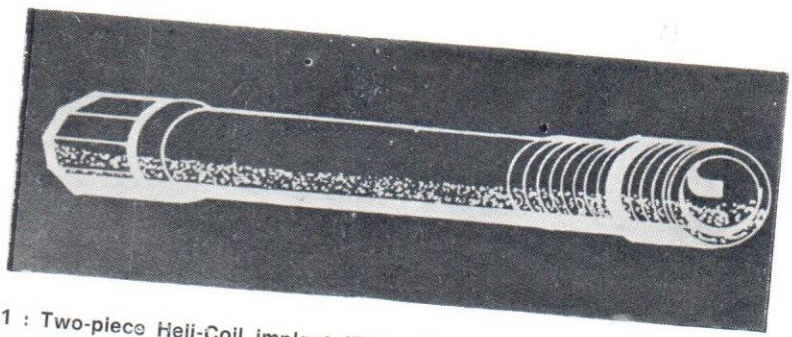


Fig. 11 : Two-piece Heli-Coil implant (From Sandhous S. : Nouveaux Aspects de l'implantologie Lausanne, 1969).

Dumont (Sandhous 1969) purpcsed another spiral implant which was similar to that of Cherchève's double-helical spiraled implant (Fig. 12).

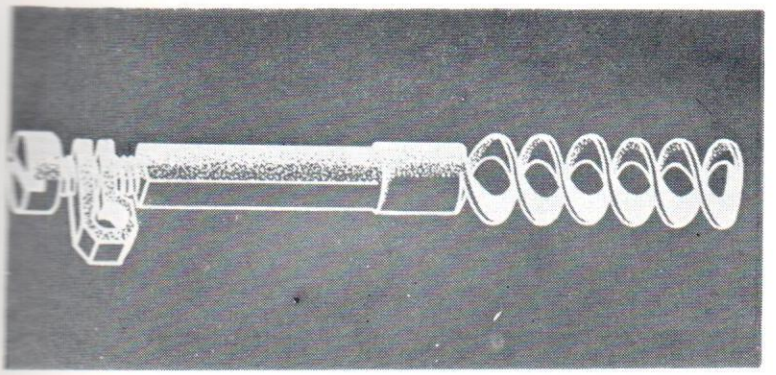


Fig. 12 : **The spiral implant of Dumont (From Sandhous, S. : Nouveaux Aspects de l'Impalnologie Lausanne, 1969).**

Because spiral implants were made of rigid materials Taylor (1970) felt that a precision attachment, preferably of a resilient should be incorporated into the implant. He designed a spring implant which included a built-in spring in the head which could be unscrewed and replaced (Fig. 13).

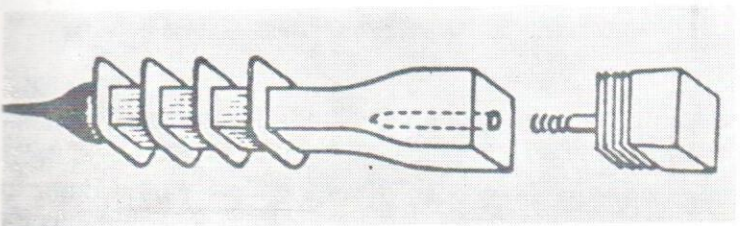


Fig. 13 : **Taylor's precision attachment incorporated implant (From Taylor, A. R. Endosseous dental implants Butterworth, London 1970)**

THE BLADE IMPLANTS

The tantalum arch implant of Lehmans (1959) might be considered the first blade implant, since it was designed for narrow ridges and placed in the mesio-distal direction (Fig. 14).

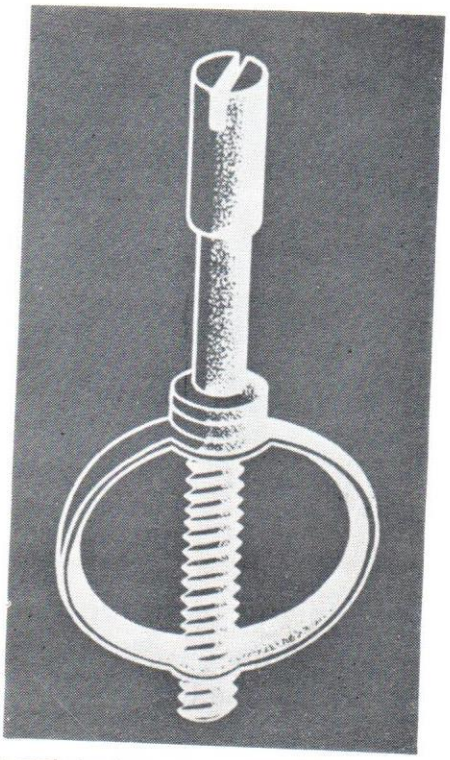


Fig. 14 : The tantalum arch implant of Lehmans (From Sandhous, S. : Nouveaux Aspects de l'Implantologie Lausanne 1969)

The tantalum arch implant consisted of a narrow post bearing a band 1mm wide and held in place by rings. The band could be shaped to an ellipse of any degree by screwing either or both rings toward, or away, from the center of the post. The implant was specifically indicated to replace recently extracted teeth or for one abutment post for bridges of average range. In spite of its careful design, the implant had two disadvantages. Basicially, the operative procedure was rather complex and because the band would leave a large «empty» area within it after insertion, there was considerable risk of soft tissue invagination.

Roberts and Roberts (1970) wrote that the first blade implant which was similar to Linkow's was inserted on 10th November 1967. The implant was made from wrought surgical metal and they did not name the designer of the implant. However Linkow (1968) in the following year was the first to describe today's blade implant in detail (Fig. 15).

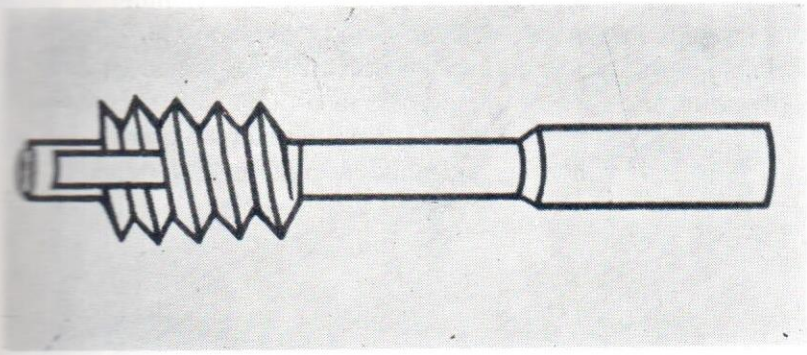
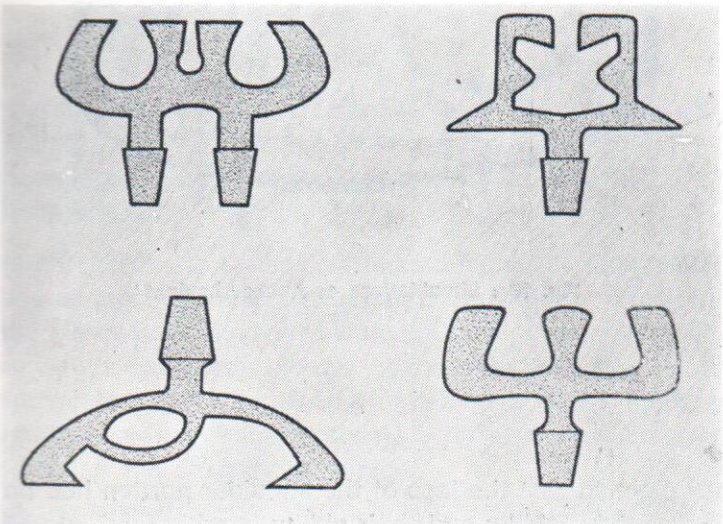


Fig. 15 :
a) Vent-plant's of Linkow (Early design)



b) Different blade implants of Linkow

He termed his implant a «blade vent» implant and he claimed that his implant had the advantage of large contact area with the bone for a minimum of tissue disturbance. The implant was narrow bucco-lingually and quite broad anterio-posteriorly. The spaces within it were intended to allow rapid bone ingrowth. Designs of the blade implant were so numerous that any clinical situation could be satisfied.

Since Linkow proposed the blade implants, a number of modifications have been suggested. Cranin and Dennison (1970) felt that a blade implant would fail due to the soft tissue breakdown over the shoulder area and loss of alveolar bone around the shoulders. To overcome this problem they designed an implant which they called a «shoulderless» or «anchor» endosseous implant (Fig. 16).

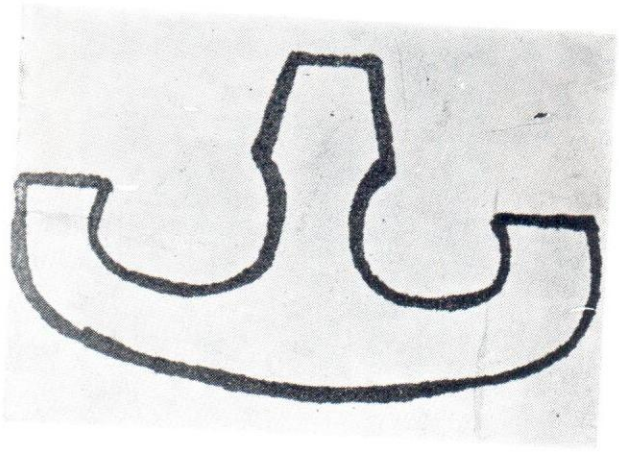


Fig. 16 : Shoulderless or Anchor implant

They claimed that the loss of the shoulder portion had no effect on the implants' stability and their ability to withstand lateral occlusal stresses and permit bone ingrouth.

Roberts and Roberts (1970) designed a different type of implant which was called the «ramus» endosseous implant (Fig. 17). It was designed in such fashion that it could be readily placed in the third molar region of the mandible to provide a distal abutment for a free end saddle, without impinging upon vascular or nerve tissue.

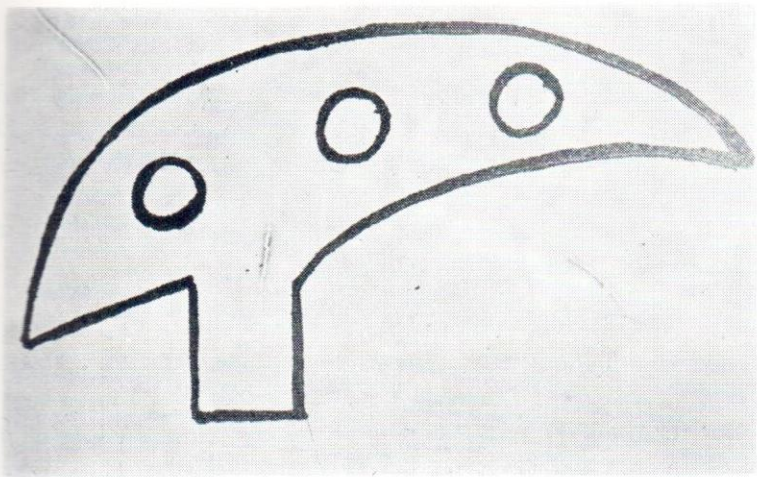


Fig. 17 : Ramus implant

The ramus implant made from ASTM F. 56 surgical stainless steel, having the dimensions 2mm thick, 5mm wide and 31mm long and it was shaped as a biconcave blade with only the distal end being shaped.

Cranin (1970) discussed the inadequacies of stock blade implants and suggested the construction of individual Vitallium blade implants. He cast his implants with the use of periapical films, panoramic X-rays and study models of the operative site. He added a small transversal extension to the upper edge of the implant which he called «whiskers». These not only avoided a deep insertion, but also increased the stability of implant.

Linkow (1971) proposed another blade implant with substantially the same outline as that of his original designs but wit a serrated profile when viewed longitudcnally. He claimed that this design gave a % 22 increase in surface area and improved retentive form. He suggested that the blade implants had the following advantages :-

1. The insertion of the implant was simple.
2. The implant was immediately stable.
3. The implant was usable in virtually every clinical situation.
4. There was little tissue damage and regeneration was rapid.

PIN IMPLANTS

Pin implants, in the broad sense, are today used for two basic purposes : to stabilize loose teeth (Endodontic Implants) and to create an abutment for fixed or removable prostheses.

Abel (1934) reported that he was investigating the use of endodontic pin implants. (Fig. 18).

Storck and Storck (1943) reported a method of reinforcing anterior teeth whose roots were abnormally short as a result of incomplete formation or amputation necessitated by disease. Their mehod consisted of removing the pulp tissue in the canal, amputaing part of the root apex and removing all the granulation tissue. A tantalum or Vitalium wire rod was then inserted through the root canal with a filling material. This implant extended into the area where the original root existed. It was found that normal reorganization and regeneration of the bone into the cavity and around the apical end of the rod took place, resulting in increased stability of the tooth.

This concept has been utilized and varied by a number of operators, Orlay (1960), Held et all (1962), and Shaykins (1962) (Fig. 19-20).

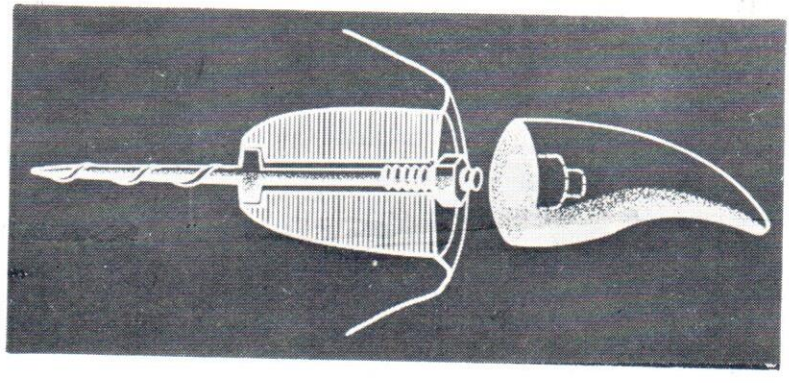


Fig. 18 : Endodontic pin implant of Abel (From. Sandhouses. : Nouveaux Aspects de l'Implantologie. Lausanne 1969.

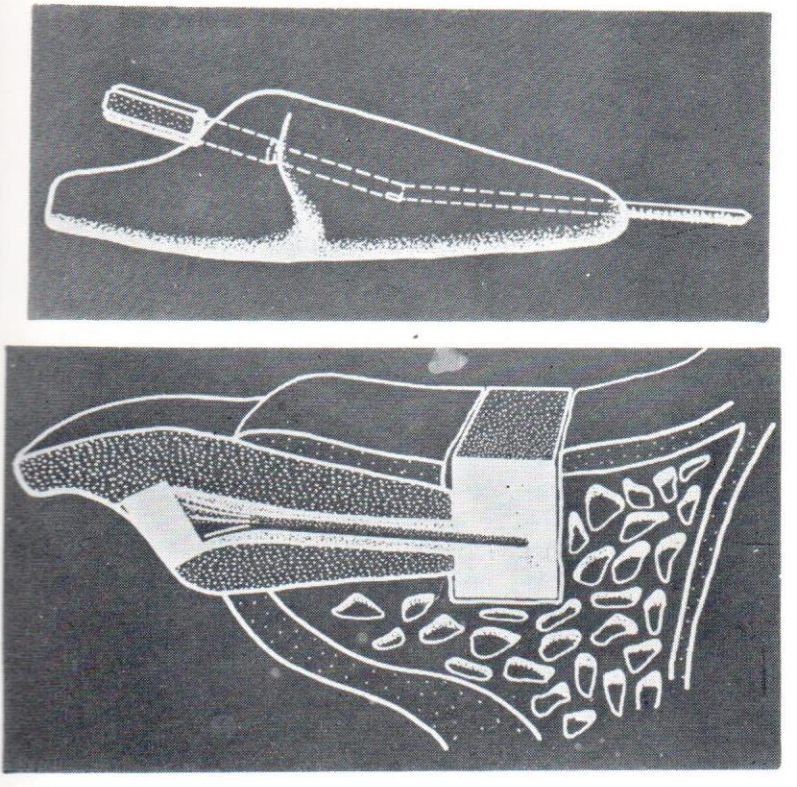


Fig. 19-20 : Orlay and Held's pin implants. (From Sandhous S. : Nouveaux Aspects de l'implantologie. Lausanne 1969)

Scialom (1962) introduced the use of pin implant in the edentulous area to create an abutment. He called this devices «Aiguilles» or «needle» implants. The implants were made of tantalum having a long narrow shape with a drill tip at the insertion end.

Few years later Scialom (1965) described «tripod» or «triplant» implants. He used three pins to from a tripod. The individual pins were not self-retentive, because of their narrow with and smooth surface, but after the pins were driven into bone and spinted together with cold cure acrylic, the total implant was claimed to be practically impossible to remove. This implant was particularly recommended in circumscribing the maxillary sinus or in cases where a mandibulary canal was laying close to the alveolar crest. (Fig. 21).

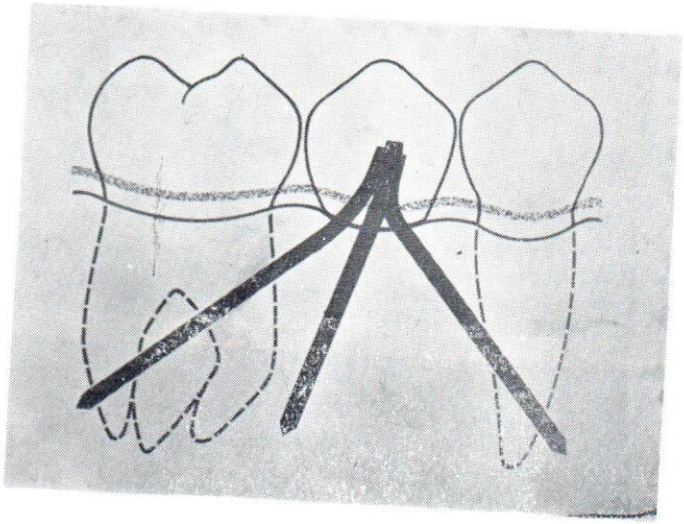


Fig. 21 : Tripod implant of Scialom

Scialom claimed that to be effective and successful, the tripod implant must be long, at least 17 mm in bone and extremely divergent, having a minimum 60 degrees angle between each leg and they should never decussate in bone. He wrote that the advantages of using tripod implants were the minimal bone loss on insertion and the resistance of the tripod to the lateral sresses.

This tripod implant, however, had its disadvantages. The major problem was the loosening of the tripod as a result of vertical pressure. Another disadvantage was that, since the sucess of the implant depended on the placement of the pins which should be as far apart as possible, the implant was dificult to use in sites where the alveolar bone was not broad as in the anterior regions of the jaws.

Variation of the pin implants have been suggested by a number of operators since Scialom. Bordon and Azoulay (1965) designed a «bifid» implant which consisted of two short, narrow vertical pins, extending from a horizontal bar (Fig. 22).

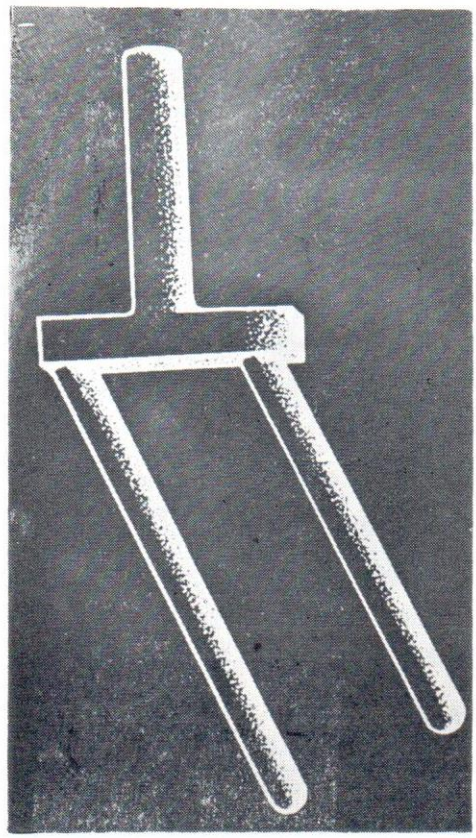


Fig. 22 : Bifid implant (From Sandhous, S. : Nouveaux Aspects de l'Implantologie. Lausanne 1969)

The horizontal bar was seated directly into a groove made in the bone, making the implant a combination of the endosseous and subperiosteal design.

These implants were inserted in pairs and joined together for retention.

The bifid implant had very little resistance to bucco - lingual stress since the vertical pins had such narrow diameters and minimum of two of these implants were necessary to get full benefit of the implant roots going in opposite directions.

Fourteau (1966) described a different design (Fig. 23). He used a pivot 2.3 mm in diameter and 25 or 45 mm in length which was supported by four divergent pins to avoid lateral movement of the pivot. The pivot and pins were splinted together over the mucosa using cold cure acrylic onto which removable prosthesis was seated

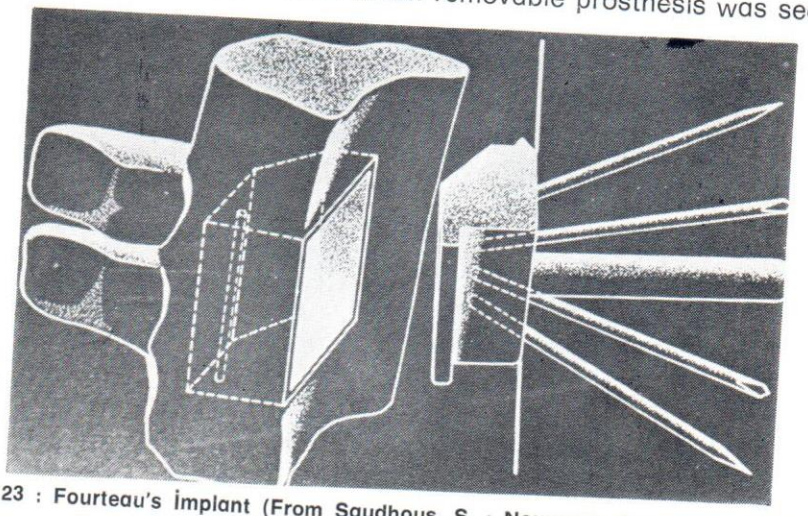


Fig. 23 : Fourteau's İmplant (From Saudhous. S. : Nouveaux Aspects de l'Implantologie Lausanne 1969)

Komari (1966) reported on a pin implant design which was very similar to that of Scialom, but the central pin had an encircling pin on it to improve the retention (Fig. 24).

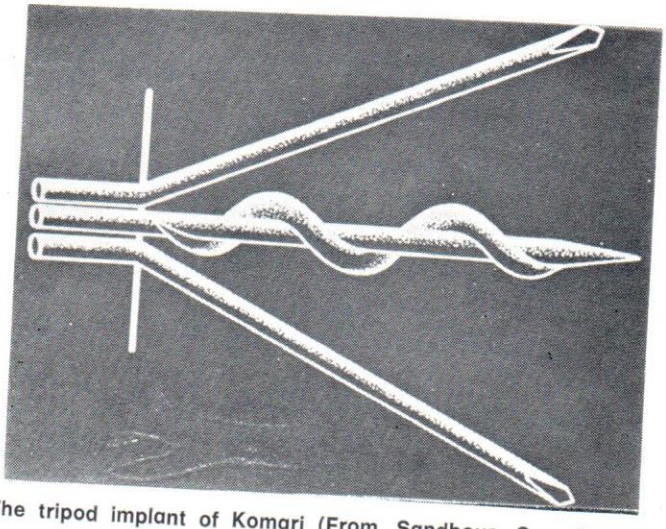


Fig. 24 : The tripod implant of Komari (From. Sandhous. S : Nouşeaux Aspects de l'Implantologie Lausanne 1969

Hodosh et all (1968) suggested the use of Vitallium pins, coated with acrylic resin, the resin being processed in such a way as to be porous. In 1971 (Hodosh et all 1971) these workers reported the result of their studies and claimed that this type of implant was the most effective and safe type of implant which could be used for long term fixed prosthesis support.

THE SCREW IMPLANTS

In orthopedic surgery, to fix fractures, different types of screws are being used for many years. It could be said that screw types of endosseous dental implants were originated from orthopedic surgery.

In 1933 Dag (Sandhous 1969) inserted, an orthopedic type screw which was attached to a body of bridge to replace the missing tooth. In fact he was the first to employ an orthopedic type screw as a dental implant. His implant made of gold (Fig. 25).

However, this orthopedic type screw dental implant had the disadvantages of having too large impact area and its threads were close together.

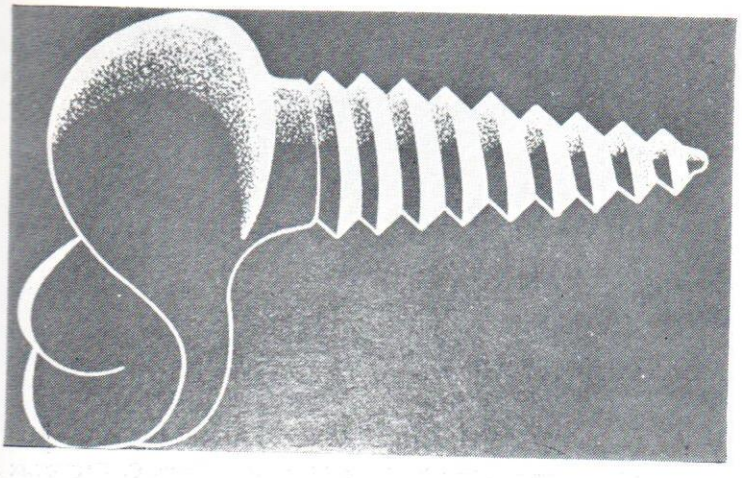


Fig. 25 : The Orthopedic type screw implant of Dag. (From Sandhous. S. : Nouveaux Aspects de l'Implantologie Lausanne 1969)

In 1938 Storck (Linkow and Cherchève 1970) was experimenting on dogs and human beings by using Vitallium screws. In 1955 he reported 17 years successes on a single screw implant (Linkow and Cherchève 1970).

Skinner and Robinson (1946) introduced the use of screw implants for the lower denture stabilization. Their first experiment took place in 1938. In their method the stress was too great which developed hypermobility and the retention was not pleasing.

Lubit and Rappaport (1949) used individualy waxed up and cast, Vitallium screws and the implants were made to fit the alveolar socket. The insertion took place immediatly after the extraction of tooth or a period of week.

Solier and Cherchève (1955) described the vertical transfixation implants for resorbed mandible. In their method three screws were inserted from the crest of the ridge through the lower border of the mandible, approximately 3 mm apart from one another. The extending portion of the screws into the oral cavity splinted together and used for denture retention. (Fig. 26).

In this technique, one could easily disagree on the usefullness of the method.

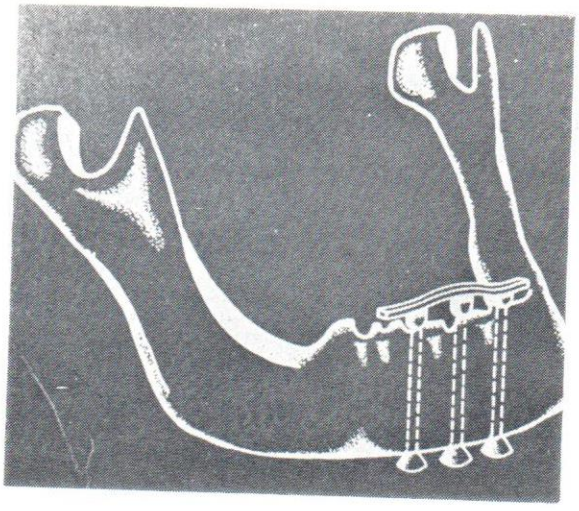


Fig. 26 : The vertical transfixation implants (From Sandhaus, S. Nouveaux Aspects de l'Implantologie Lausanne 1969)

Cherchève (1960) purposed the screw type implant which was a hollow screw with internal threading (Fig. 27). Linkow (1970) named this implant as a «sleep-away» implant. The insertion was made at two stage. In the first operation hollow screw was inserted. When the healing took place the implant fitted into the hollow screw. Cherchève himself discarded this implant due to limited success.

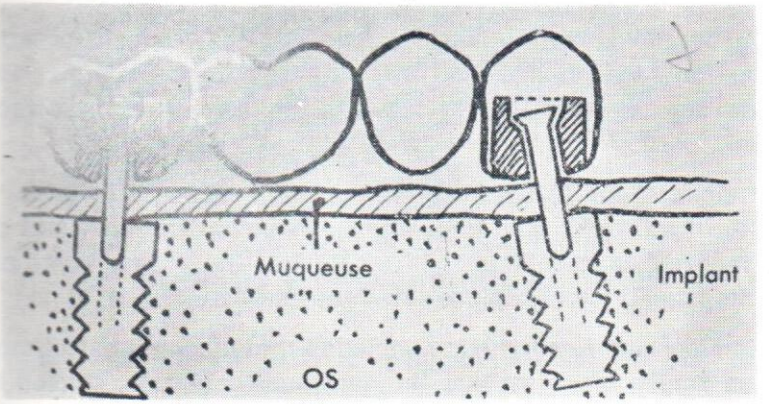


Fig. 27 : The Sleep - away implant (From cherchève, R. : Les implants endoosseaux Librairie Maloine Paris 1962.

Cranin and Dennison (1970) and Christensen (1970) presented the vertical transfixation implant similar to that of Solier and Chèrcheve.

Michèl Cherchève the brother of Rafel Chercheve (Linkow and Cherchève 1970) specifically designed a screw implant made of Titanium for harrow ridges (Fig. 28).

It seems that this implant suffered from lack of bony support.

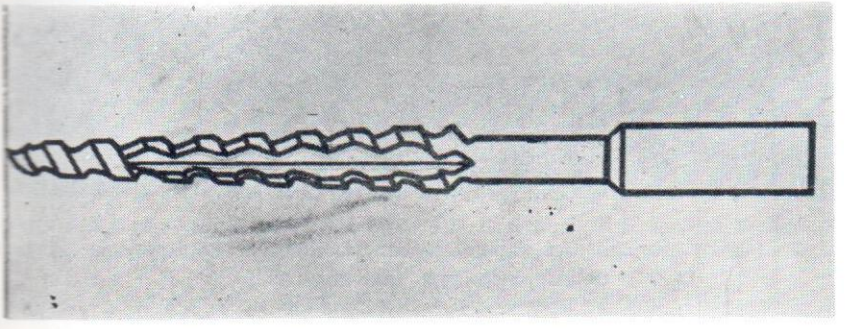


Fig. 28 : The screw implant of M. Cherchève

ARTIFICIAL TOOTH ROOTS

Since all the endosseous dental implants had a number of mechanical disadvantages, many workers have attempted to design anatomically shaped artifical root implants to overcome these mechanical problems. (Flohr, 1953, Hodosh 1960, Seidenberg 1963, Lee 1966 Gremble 1973). (Fig. 29-30).

These implants were inserted mainly into the socket of immediately extracted teeth, and they are made from inert materials : Titanium, Vitallium, certain acrylic materials, ceramics and more recenty carbon.

Hodosh et all. (1965). inserted methyl methacrylate teeth into sockets of extraced natural teeth of monkeys, baboons, and dogs. They reported favourably on the reaction of the tissues-some of the implants having been in place for three years.

Hammer and Reed (1970) concluded that leaching out of unpolymerized acrylic monomer into the surrounding tissues, caused failure of plastic tooth implants.

Among those inert materials, vitreous Carbon seems to be most promising material. (Fraunhofer and et al 1971).

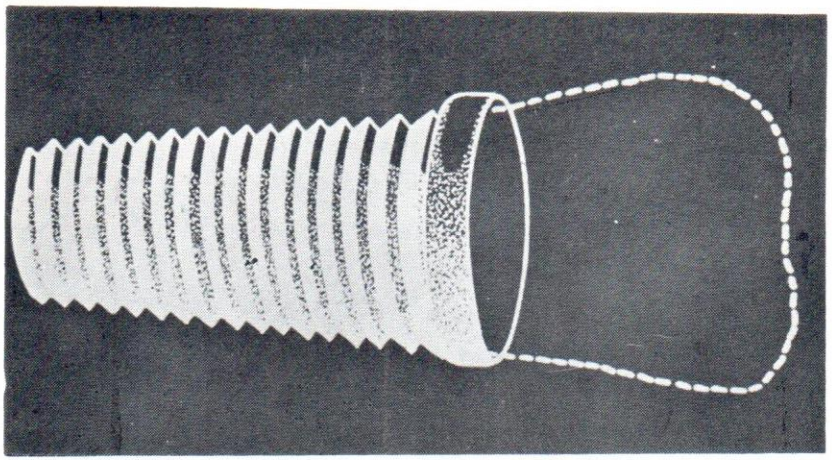


Fig. 29 : Flohr's artificial root implant (From Sandhous S. : Nouveaux Aspects de l'Implantologie. Lausanne 1969)

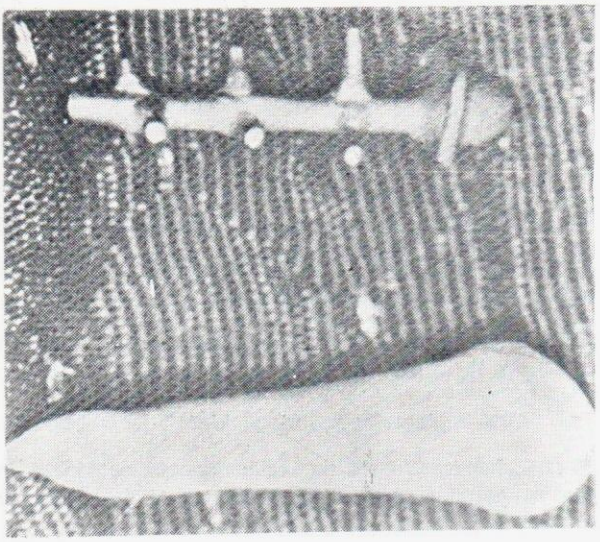


Fig. 30 : **Lee's Implant (From Lee T.C. : Intraosseous imglants J. Oral Implant Transplant Surg. 12.22.1966**

ÖZET

Bu yazıda kemik içi implantların tanımlaması ve tartışması yapılmıştır.

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