in collaboration with Silvano Tramonte

STEFANO TRAMONTE'S DRIVE SCREW

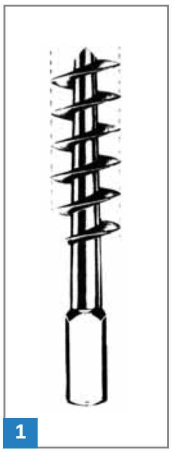
Part II

Just one look at the implant presented by Stefano Tramonte in 1964 (1) and it is immediately clear that it differs enormously from all the previous screws (Fig. 1), for with that screw titanium began to be employed in implantology.[1] This is another merit of Stefano Tramonte, who paved the way for all subsequent implants by introducing this new material. This authorship must be acknowledged, given that thirty years later others would attribute it to the Swedish school (2)!

In 1959 Tramonte initially used screws made of chromium-cobalt (3, 4) (Fig. 2), designed with a streamlined profile and sharper threads than the ones that had been tested by the Strock brothers two decades earlier (5), and that Gola proposed again, also in 1959 (6).

In this regard Tramonte wrote:

> Considering that casting techniques were not as sophisticated as they are today, my chromium-cobalt screws were very unrefined and had to be finished by hand: sprue pin cutting, bubble removal, polishing and sharpening of the threads. Since chromium-cobalt is an extremely hard alloy, it took about two hours to finish each screw! Therefore, I decided not to use that material, even though it showed great biocompatibility, and switched to surgical steel, which could be machined. . . . Towards the end of 1964 I began to manufacture my screws in titanium and proposed the use of this material in implantology for the first time in the world (7) (Figs. 3, 4).



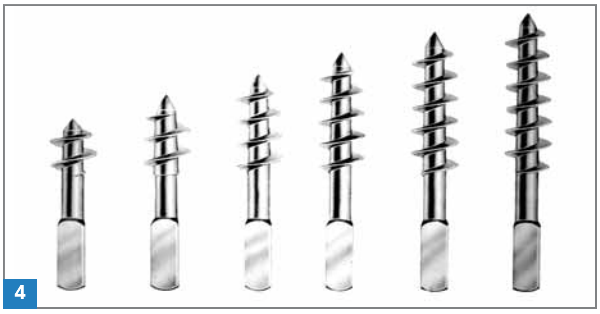
1

2

Fig. 1 The Tramonte screw, made of titanium since 1964.
Fig. 2 The first chromium-cobalt screws.

3

Fig. 3 A titanium screw (left; T), and the corresponding screw in chromium-cobalt (right; A).
Fig. 4 A complete set of Tramonte screws with a 5-mm diameter, ranging from 2 to 7 threads.



4

[1] The previous chapters noted that Cherchève, Muratori and Linkow also employed titanium. Although their implants have been cited here for informative purposes, since they derived directly from the Formiggini spiral, on a historical level they came after Tramonte's titanium screws.

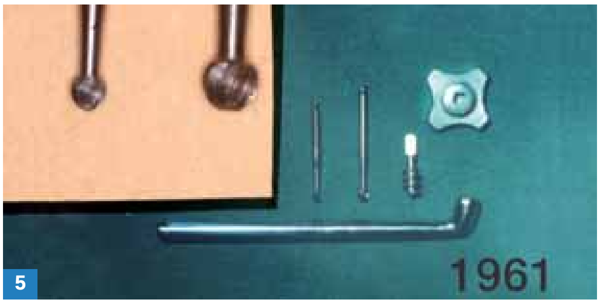
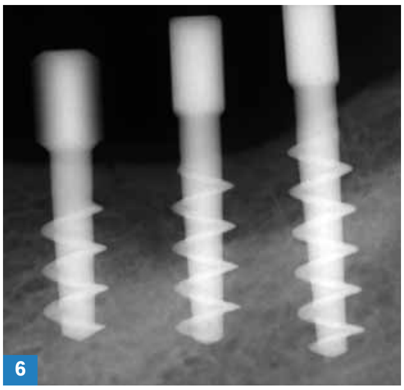
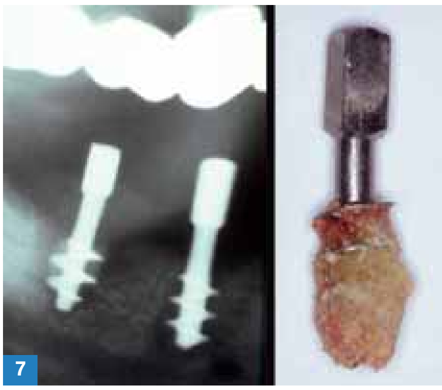


Fig. 5 The first round drills and hand ratchets for placement of chromium-cobalt screws.

Tramonte and Ugo Pasqualini had been schoolmates and friends for years. As a result, Pasqualini was immediately informed of the interesting opportunities offered by the new titanium screws, illustrated by Tramonte himself when he placed three demonstrative implants at his friend's practice in two of the latter's patients.
Pasqualini had completed his research on dogs three years earlier, demonstrating that vented implants made of biocompatible material (and with short emerging posts) became perfectly osseointegrated, exactly like the completely buried implants with internal threading (8). Since it took six months before the prosthetic abutment could be replaced, he was very interested in Tramonte's screws, which—directly inserted into the bone through the mucosa—were immediately stable. Compared to Pasqualini's two-step implants, the advantages offered by the "automotive" screws, as their inventor jokingly referred to them, seemed enormous. Fitted with a solid prosthetic abutment, which extended into a sturdy shaft with sharp cylindrical helical threads, they could immediately be loaded without waiting for complete reparative osteogenesis.
Tramonte's idea was to increase the implant's stability by self-tapping the screw into bone tunnels with a reduced diameter, exploiting the "screw-unscrew" movements transmitted by a special hand ratchet. To facilitate implant insertion, he initially used a round drill; passing through the mucosa, the drill perforated the bone up to the desired depth and was followed by a round drill with a larger diameter, in order to enlarge the bore slightly and then insert the screw (Fig. 5).
In spite of the extraordinary initial stability and good metallic sound at percussion, nearly all of the screws were expelled after a month of terrible pain. Anyone else would have given up, but not Tramonte who, despite the numerous failures, did not underestimate the few absolutely painless cases that demonstrated the permanent stability of his screws. Of the three implant surgeries performed at Pasqualini's practice, two were destined for utter failure, whereas the third one, without any postoperative pain and placed in the same hemimandible where the adjoining implant had been expelled (Figs. 6–8), could be used as support for a bridge and worked for more than twenty years, until the patient's death.
In the second patient the failure occurred in the same time frame (one month), with painful expulsion of the screw, which had been loaded immedi-





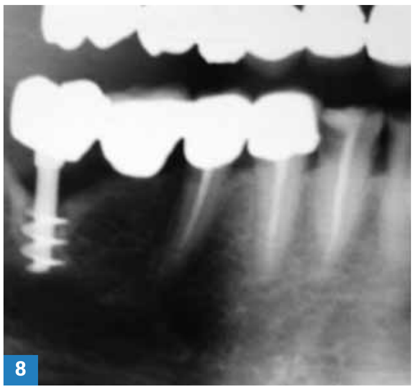
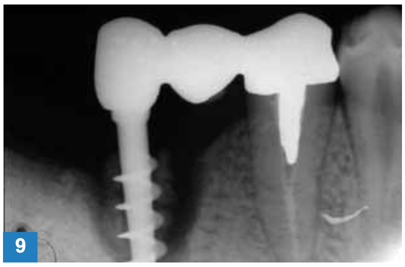
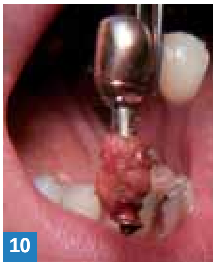


Fig. 6 Three implants immediately after placement. **Fig. 7** At four weeks, expulsion of two of the three implants, with severe bone loss around one of them due to compression ischemia, necrosis and subsequent bone resorption.
Fig. 8 The third implant, in service for more than 20 years (1966–87). Note the bone apposition around the threads, and the mild conical resorption around the neck.

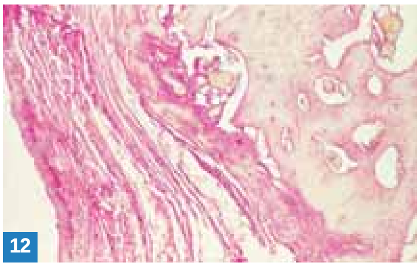


Fig. 9 Another surgical failure. **Fig. 10** Implant avulsion after cutting of the Richmond crown on the second premolar. **Fig. 11** Histological specimen of the bone loss area before analysis. **Fig. 12** Histological analysis confirms the presence of a fibrous layer in disarray and bone tissue in hyaline-like degeneration (1966).

ately. The pain was excruciating. The intraoral radiographies showed that around the screw there was a bone layer that was separate from the surrounding tissue. The bone had adhered to the explanted screw and had to be unscrewed from it. The two bone fragments, split using a carborundum disk, preserved the thread marks. The histological examination confirmed that the bone resorption area consisted of a fibrous layer in disarray and bone tissue in hyaline-like degeneration (Figs. 9–12). Given that the chromium-cobalt used for the screw was unquestionably a biocompatible material, the cause of failure was attributed to excessive compression during screw insertion. Today, however, we know that the mistake was improper surgical technique, due not to excessive bone compression but to screwing the implant in too much, which caused what Pasqualini defined years later as a "corkscrew effect." When the screw tip reaches the bottom of the surgical insertion socket and resistance to penetration exceeds the bone fracture limit, the implant rotates without penetrating, and the bone within the threads is literally torn out in a coronal direction, remaining among the threads when the implant is removed (Fig. 13).

Nevertheless, the few successes that were achieved—among the failures of identical screws that "fell like autumn leaves"[2]—suggested to the author that there were also positive qualities that had yet to be detected.

In an attempt to pinpoint the defect, Tramonte continued to perform implant surgeries free of charge, until he ascertained that failure was not ascribable to the implant itself but to the surgical technique: It was essential to avoid compressing the bone too much or "ripping it out" by forced screwing.

Success was achieved only when the screws were


Fig. 13 A screw in the expulsive phase due to the "corkscrew effect."
Fig. 14 Left: a lance drill. Right: a calibrated helical drill.

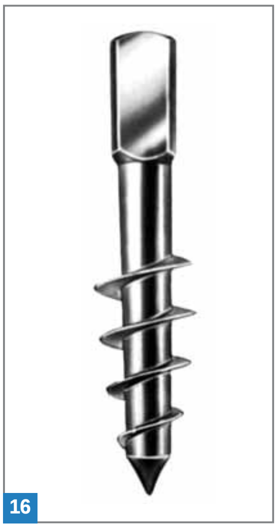



Fig. 15 Detail of the helical drill.
Fig. 16 The steel tapper.

[2] Tramonte's joking remark.

placed in larger bone tunnels, but were also tight enough to stabilize them without excessive compression. He then got rid of the inaccurate round drills, and replaced them with a three-faceted lance drill, followed by a second calibrated helical drill (Fig. 14). Using the first one, similar to the type proposed by Muratori, he performed the initial perforation of the mucosa and underlying bone. He wrote, "Its pointed tip prevents slipping on the ridge surface, avoiding the risk of false routes in both the labial and buccal fibromucosa" (9–12).

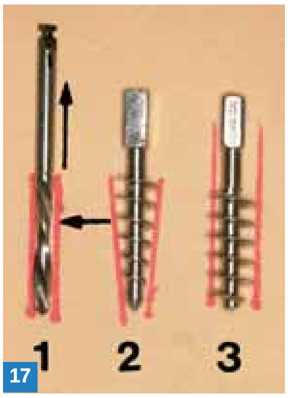
The tunnel was then widened with the helical drill (Fig. 15), which in addition to preparing the proper diameter site for implant insertion, also removed the bone chips along the grooves, further freeing the space for the screw. The round drill created the perforation by crushing the bone tissue, most of which was left inside the hole and obstructed its lumen. The third modification was the addition of a steel drill with conical spirals (Fig. 16) that had the same screw pitch as the cylindrical spirals of the titanium screws, which eased screw progression.

The steel drill is known as a tapper, but the term is incorrect: tappers pave the way for the screws by removing bone, whereas Tramonte's device facilitates progression by means of a primary incision, without removing tissue from the tunnel walls. Therefore, this aspect sets it apart both from industrial tappers and from any other tapper used to prepare the site for every type of implant screw.

The tapper carves the compact cortical bone like a knife, cutting it with spirals of progressive diameters from 0 to 4–5 mm, corresponding to the diameters of the first and last titanium screws threads, respectively. Therefore, it carves its conical profile into the tunnel, which is later completed by the final cuts made with the self-tapping screw threads, giving the implant enormous stability that permits immediate loading. The technique required the use of four steel tappers, respectively with three, four, five and six threads, which could be used—according to the instructions—for all titanium screws (Figs. 17, 18) Overall, the sequence of instruments was very logical and fast, and permitted easy screw placement (Figs. 19–21).

Tramonte's drive screw is one of the most important dental implant concepts of the 1960s, and it is still valid today (Figs. 22, 23) (13).

The complete toolkit now comprises two lancet drills and a set of calibrated drills for the various implant sizes, Grade 5 titanium tappers for screws for diameters 4 and 5, a set of ratchet keys for the



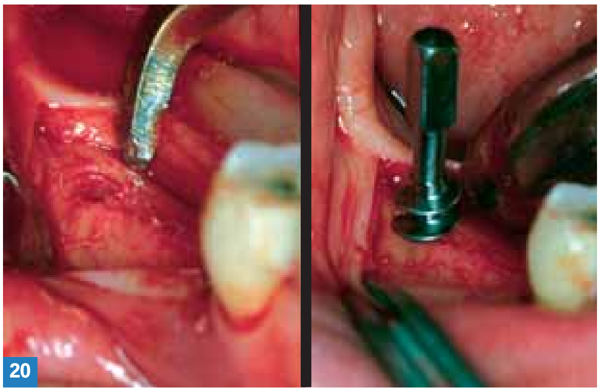
17

18

Fig. 17 In the middle, the tapper (2), whose progressive threads penetrate the bone tissue precisely, paving the way for subsequent insertion of the screw with cylindrical threads (on the right) (3).

Fig. 18 Sets of tappers with different numbers of threads.

19



20

21

Figs. 19, 20 Example of tapper insertion followed by the screw. In Fig. 20, on the right side note the precise cut made by the tapper threads into the bone tunnel.

Fig. 21 Suture and loading of the previously illustrated case.

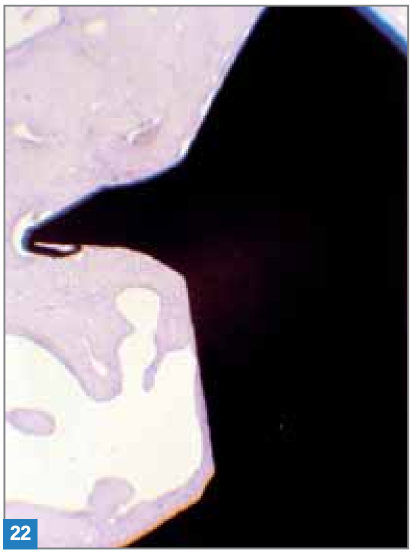
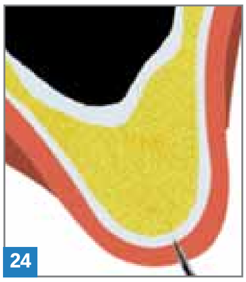

22

Fig. 22 Beautiful histological appearance of a Tramonte screw tip, fractured after years of service and perfectly osseointegrated with the bone tissue (toluidine blue).

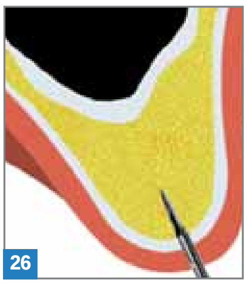

23

Fig. 23 Screw thread and bone tissue, with no gaps between them. The block section histological specimen taken after several years of functional service (toluidine blue).


24


25

Figs. 24, 25 Beginning of flapless penetration with lance drill.


26


27

Figs. 26, 27 Further deepening with the same drill.

two different abutment sizes, the jack and a complete set of accessories.

The implants in the catalogue have a diameter ranging from 2.5 to 6 mm, and standard lengths between 11.5 mm and 22.75 mm, but implants as short as 4 mm can be requested if needed. There are implants with threads for ball attachments for overdentures, implants with neck lengths reduced from 5 to 3 mm, and implants with cores enlarged to 3.1 and 3.5 mm (the standard diameter is 2.25 mm).

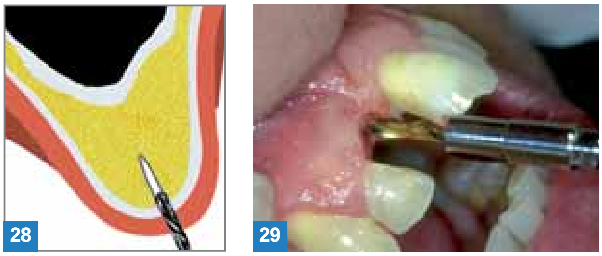
The author suggests using the bigger screws from the second series to replace a mobilized "normal" screw. In this case, removal of the latter will be sufficient, followed by replacement with a screw with a larger diameter a few days later. This last indication represents an implant innovation that the dental world owes exclusively to Stefano Tramonte (14).

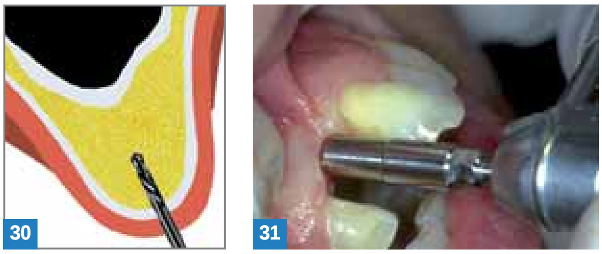
Notes on surgical technique

Following anesthesia, and after drying and cleaning the surgical field, the pilot drill, mounted on a speed-reducing contra-angle handpiece, is forced through the mucosa until it comes into contact with the cortical bone (Figs. 24, 25). At this point the handpiece is operated with the specific micromotor at the appropriate speed to allow the drill tip to penetrate the cortical bone with the entire cutting portion of the drill (Fig. 26, 27).

The purpose of the pilot lance drill is to prepare a precise opening for the calibrated drill, which is designed to create the surgical tunnel. Upon completion of the first perforation, the calibrated drill—whose length corresponds to the selected implant—is mounted on a micromotor (note that the drill is 1 mm longer than each implant size, in order to create a "safety" chamber). In the most frequent cases of flapless surgery, which do not permit a precise landmark for calculating the insertion depth, this type of device allows for a slightly deeper bone tunnel, which minimizes the risk of tissue lesions caused by overscrewing ("corkscrew effect"). Consequently, all measurements of the distance between the ridge and the mandibular alveolar nerve should be made in relation to drill length rather than the length of the implant. The surgical socket is finalized by perforating the bone to the required depth (Figs. 28–31), up to the point where the handpiece head slightly compresses the mucosa.

The axis of the implant, and thus the direction of perforation, should correspond to the axis of greatest bone thickness. The primary aim is optimal positioning of the implants, and not that the





Figs. 28, 29 Use of the calibrated drill to create the surgical tunnel.
Figs. 30, 31 Another step in the procedure.

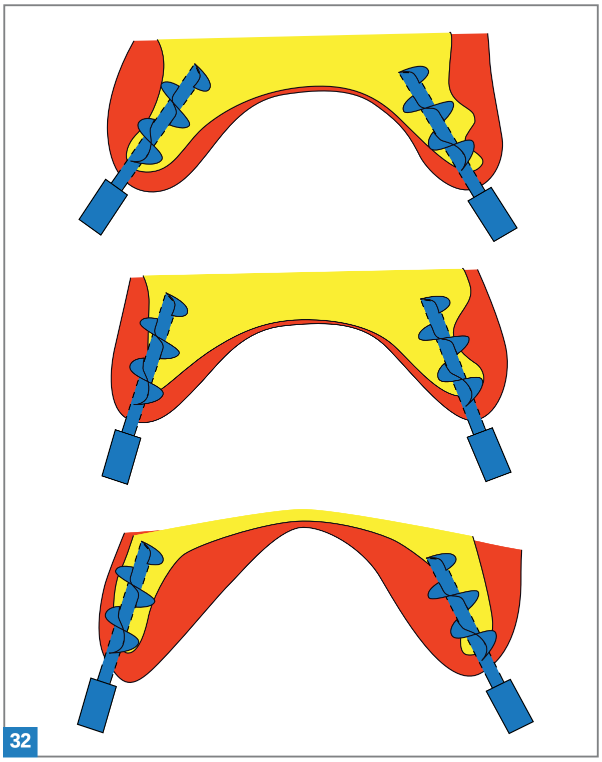
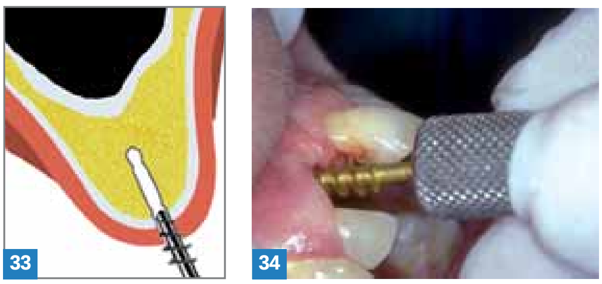


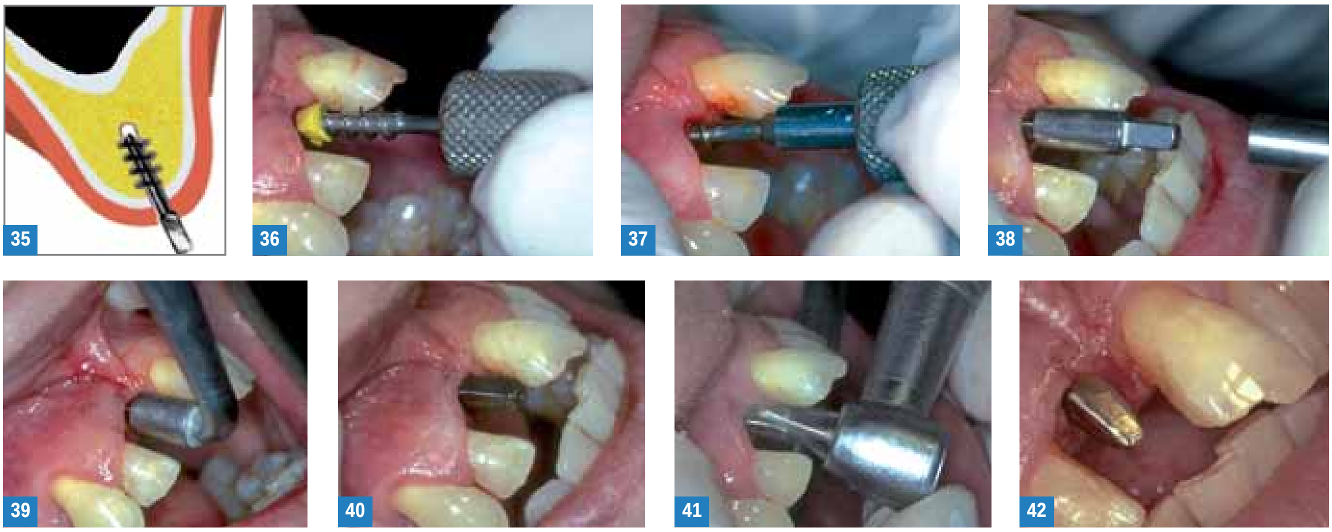
Fig. 32 The implant axis must correspond to the axis of greatest available bone thickness, without worrying about parallel placement.



Figs. 33, 34 Use of the Tramonte tapper.

implant abutments should immediately be parallel (Fig. 32).
Following removal of the calibrated drill, the tapper is mounted on the finger key, or the ratchet wrench in the event of difficult insertion, and screwed into the socket until bone resistance can be felt (Fig. 33, 34).
As the finger key no longer exerts the required driving force at this point, it must be replaced by the knob key. In cases where tapping with the ratchet wrench is needed, it is advisable to switch to the knob key or the standard key as soon as possible, since use of the ratchet wrench during this step is not safe and does not permit prompt unscrewing in case of emergency.
When the tapper has been placed firmly in the bone, the knob key is replaced by the standard one, which exerts greater driving force and permits the safe alternating movement of screwing-unscrewing, or sudden reverse movement if necessary. If the presence of natural teeth or abutments interferes with the procedure, the special extension provided can be mounted on the standard key. The tapper, now manufactured in Grade 5 titanium, serves manifold purposes.

1) It creates female threads in the walls of the surgical socket made with the calibrated drill, profitably reducing implant insertion force, since the Ti2 screw does not have high resistance to torsion.
2) The tapper, which is conical, is easy to place in the surgical bore, creating conical counter threading with the base of the cone towards the alveolar ridge. The base width (represented by the last thread of the tapper) corresponds to the implant diameter. Thanks to this design, the first implant spiral will be engaged in progressively narrower bone, threading it as it proceeds apically, and this permits self-tapping when needed in order to achieve the optimal primary stability;
3) Use of the tapper enables testing and measurements, so that the subsequent implant insertion will be of the greatest precision in relation to available bone tissue, while maintaining a margin of safety from important anatomical structures. This is a fundamental principle of the Tramonte's technique. The implant width is chosen based on the bone density of the future implant site, taking the Misch scale into account, so that implants with a diameter of 2.3–3 mm diameter will be inserted into D1 bone, implants with a diameter of 3–3.5 mm into D2, 4-mm implants into D3 and 5-mm implants into D4.



Figs. 35-42 The screw is placed in the surgical socket (note the yellow antibiotic ointment); parallelism with the contiguous teeth is achieved by filing the implant abutment with a tungsten carbide bur and water jet cooling. This technique, which has been used for many years, has never created any problems for titanium's inherent structure.

The tapper is then withdrawn once the threading of the surgical socket is complete, and the procedure is repeated with the selected implant—without applying excessive force to the socket walls—until it is fully set in its site.
Both the tapping procedure and implant placement involve certain risks. In very spongy bone the danger lies in overscrewing, leading to partial or total fracture of the bone portions contained within the threads. Overheating, and locking and fracture of the implants are instead the risks that are run with compact bone, caused by the friction developed between the threads and the bone during implant advancement, especially when larger screws are involved.
The parallel position of the abutments cannot be addressed until the implants have been positioned. With the Tramonte screws, this can be done by bending the abutment using a standard key or a pair of pliers, and/or with the aid of tungsten carbide bur mounted on a high-speed handpiece, with abundant water cooling. A temporary crown is then mounted immediately[3] (Fig. 44). The temporary prosthesis can be replaced by a definitive one about 60–90 days later.

Observations and conclusions

Tramonte did not perfect his technique through divine inspiration. In the interval between the very humble presentation of his drive screw and its current success—which rightly places him among the pioneers of implantology as the inventor of one of the most intelligent, simple and stable implant concepts—he suffered humiliation and faced sarcasm, but he never doubted that his

[3] Counterbending of the abutment should be avoided because titanium cannot withstand this type of stress, and subsequently undergoes fracture.

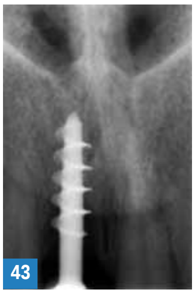
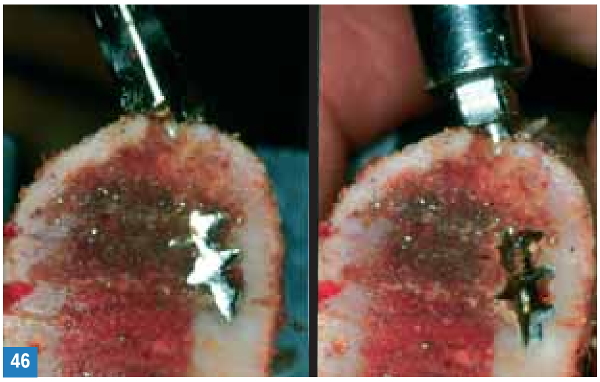


Fig. 43 Radiographic checkup following surgery.
Fig. 44 Immediate temporary crown.

Fig. 45 Checking with a bone caliper, which is indispensable for the flapless technique.

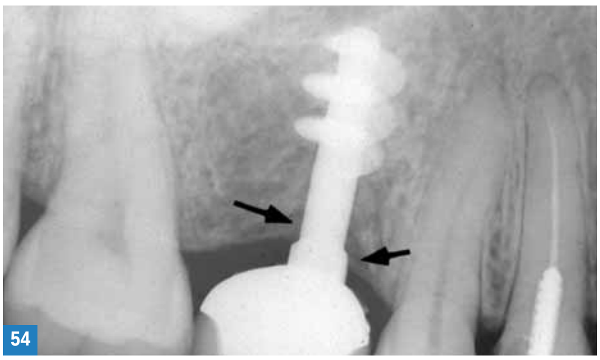


Figs. 46-48 The impact of the screw threads on an area of compact bone can divert the ideal screw insertion path outside the surgical tunnel, leading to necrosis, ischemia and resorption of the compressed bone tissue, which will subsequently be expelled with the implant (Fig. 48) and cause excruciating pain.

Figs. 49, 50 Edentulism of the left lower quadrant treated with three Tramonte screws and a gold-porcelain bridge (1981).

Fig. 51 Replacement of a molar with a three-thread Tramonte screw. The flapless technique was used.

Fig. 52 The primary stability of this implant can withstand the tension of five orthodontic elastics.



Figs. 53, 54 Case treated with a single gold-porcelain crown. The arrows indicate the complete osseointegration of this immediate-load implant.

implant would gain the recognition it deserved (15–19).

Tramonte's screws, like all implants, are not entirely risk-free. One of their limitations, albeit a relative one that is easy to surmount, is a consequence of the fact that they can be inserted into the bone directly through the soft tissue, with a rapid and almost bloodless surgical procedure. This means that surgery must be performed on suitably large alveolar ridges free of undercuts. In case of doubt or based on personal preference, the operator can detach the mucosa for direct vision of the underlying bone. The flapless approach is not compulsory for this protocol, but represents a variant of the traditional technique, and the surgeon should evaluate its use carefully while planning the procedure. Tramonte also added an ingenious bone caliper to his toolkit (now available from all suppliers), which permits good assessment of any undercuts even during closed surgery (Fig. 45).

The last risk connected with the use of a self-tapping screw—fortunately quite rare but also the most serious—is the monolateral impact of the screw threads with an area of compact bone. This can potentially divert the screw insertion path outside the surgical tunnel, leading to necrosis, ischemia and resorption of the compressed bone tissue, which will subsequently be expelled with the implant itself (Figs. 46–48). An attentive operator will always perceive displacement of the screw and, being aware of the consequences, he/she must immediately remove it and modify the tunnel path, choose another implant site or replace the cylindrical screw with a conical implant.

In any event, self-tapping screws offer:

1) virtually bloodless surgery, which can often be performed with a flapless approach;
2) immediate stability, permitting immediate loading with a temporary prosthesis and then a definitive one, without waiting for later stabilization by reparative osteogenesis;
3) high resistance to occlusal loads, counterbalanced by the long lever arm of the implant as well as stress dispersion along the wide horizontal planes of the threads;
4) a longer control period than any other current implant, since Tramonte's screws have been used successfully by hundreds of professionals for more than four decades (Fig. 49–54).

References

1. TRAMONTE S.M. L'impianto endoosseo a vite autofilettante. Trent'anni di esperienza personale. Milano: Editrice Cominplant;1991.

2. IGLESIAS J.G. La epoca heroica de la implantologia en Espana. Los pioneros. Madrid: Ed. SEI; 1997. p. 136.

3. TRAMONTE S.M. Un nuovo metodo d'impianto endoosseo. Proceedings of the 5th National SIOCMS Congress SIOCMS; Naples, Italy. 1962.

4. TRAMONTE S.M. L'impianto endoosseo razionale. Milano: Ed. Lusy; 1964.

5. STROCK A.E., STROCK M.S. Experimental work on a method for the replacement of missing teeth by the direct implantation of a metal support into the alveolus. Am J Orthod Oral Surg 1939;25:467.

6. GOLA L. Impianti alloplastici endoossei ammortizzati. Proceeding of the 2nd Symposium on Alloplastic Implants; Pavia, Italy. 1959.

7. TRAMONTE S.M. Intrabone implants with drive screws. J Oral Impl Traspl Surg 1965;4:126.

8. PASQUALINI U. Reperti anatomo-patologici e deduzioni clinico-chirurgiche di 91 impianti alloplastici in 28 animali da esperimento. Riv Ital Stomatol 1963;3-98.

9. TRAMONTE S.M. A further report on intraosseus implants with improved drive screws. J Oral Impl Transp Surg 1966;9:78.

10. TRAMONTE S.M. Implantologie endo-osseuse: préjugées et craintes. L'Information Dentaire 1966;8:148.

11. TRAMONTE S.M. Su alcuni casi particolarmente interessanti d'impianto endoosseo con vite autofilettante. Ann Stom 1966;15(4):320.

12. TRAMONTE S.M. L'impianto a vite autofilettante. Riv It Implant 1966;1:95.

13. BIANCHI A., SANFILIPPO F., ZAFFE D. Implantologia e implantoprotesi. Basi biologiche. Biomeccanica. Applicazioni cliniche. Torino: UTET; 1999. p.159-257.

14. Tramonte S.M. Intraosseous self-threading implantations. Personal method. Dent Cadmos 1971 Feb;39(2):192-208.

15. CAMERA A., PASQUALINI U. Impianti endoossei: istologia comparata della "zona del colletto" in un dente naturale, due monconi di Linkow e tre viti di Tramonte. Associazione Italiana Impianti Alloplastici 1972;3.

16. TRAMONTE S.M L'impianto a vite autofilettante nella sostituzione di un solo dente mancante. Riv Eur Implant 1978;4:15-21.

17. TRAMONTE S.M. A proposito di una modificazione sugli impianti alloplastici. Rass Trim Odont 1963;44(2)129:36.

18. TRAMONTE S.M. L'impianto endoosseo a vite a carico immediato. Proceedings of the 27th GISI International Meeting on Dental Implants and Transplants. Bologna, Italy: 1997. p. 71.

19. TRAMONTE S.M. Vite endoossea autofilettante. Attualità Dentale 1989;7:44-9.

Figs. 22, 23 Courtesy of Andrea Bianchi, Francesco Sanfilippo and Davide Zaffe. From Implantologia e Implantoprotesi. Turin: UTET, 1999.
Figs. 24–45 Courtesy of Silvano Tramonte.