Initial stability after placement of a new buttress-threaded implant

A case series study

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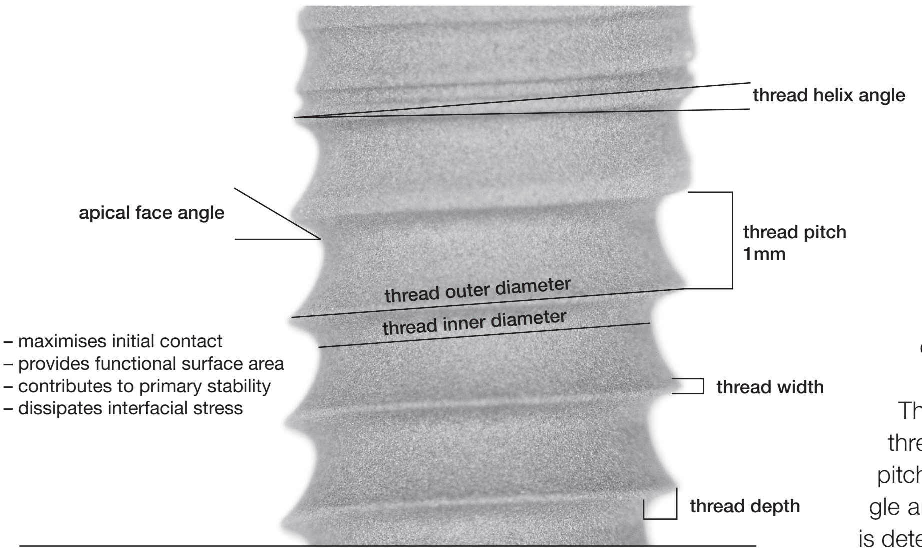


Fig. 1: Basic implant macro-design features.

In implant dentistry, high primary stability is considered to be the most crucial requirement for implant success,[1] especially when applying restorative concepts like immediate restoration and loading. Implant design features are one of the most fundamental elements that can be influenced by the clinician, by the choice of implant, to have an effect on implant primary stability. It is also the implant design which affects the implant's ability to be able to withstand loading during or after its osseointegration.

Implant design can be divided into two major categories: macro-design and micro-design. Macro-design includes the body shape and thread design.[2,3] Implant stability is obtained thanks to the interlocking between threads and bone, and is influenced by surgical technique and by implant, as well as recipient bed characteristics. Tapered and partially tapered implants are known for their ability to achieve good primary stability,[4] but the importance of thread design should also not be underestimated. Implant threads have multiple functions, all of which are to be perfectly equilibrated to meet the respective clinical demand. Threads steer the initial bone-to-implant contact and surface area, determine the compression of bone and facilitate the dissipation of loads to the bone or implant. In other words, the thread design and its interaction with the bone is one of the key factors for the success, in order to provide primary stability and thus minimise micro-movements—but respecting the biology and not at any cost.

Literature

The thread-related characteristics, also called thread geometry,[5] are thread shape, thread pitch, thread depth, thread width, thread face angle and thread helix angle (Fig. 1). Thread shape is determined by the thread width and thread face angle. Different threads are available on the market and many of them are derived from concepts used in orthopaedic surgery. The most common thread types are V-shape, trapezoidal shape, buttress shape, reverse buttress shape, round shape and square shape.[6] For application in dental implantology, the thread shape is adapted to the most prominent needs which are to be fulfilled by the particular implant.

Thread shape determines the face angle. The face angle is the angle between a face of a thread and a plane perpendicular to the long axis of the implant. In the implantological literature, the most studied face angle is that of the apical face, where most of the loading forces are dissipated. Thread pitch refers to the distance from the centre of the thread to the centre of the next thread, measured parallel to the axis of the implant. It may be calculated by dividing the implant length by the number of threads.[7] In implants of equal length, smaller pitch indicates more threads, leading to greater surface area, but this needs to be equilibrated with the insertion time, which can be reduced with a higher pitch. The thread depth is defined as the distance from the tip

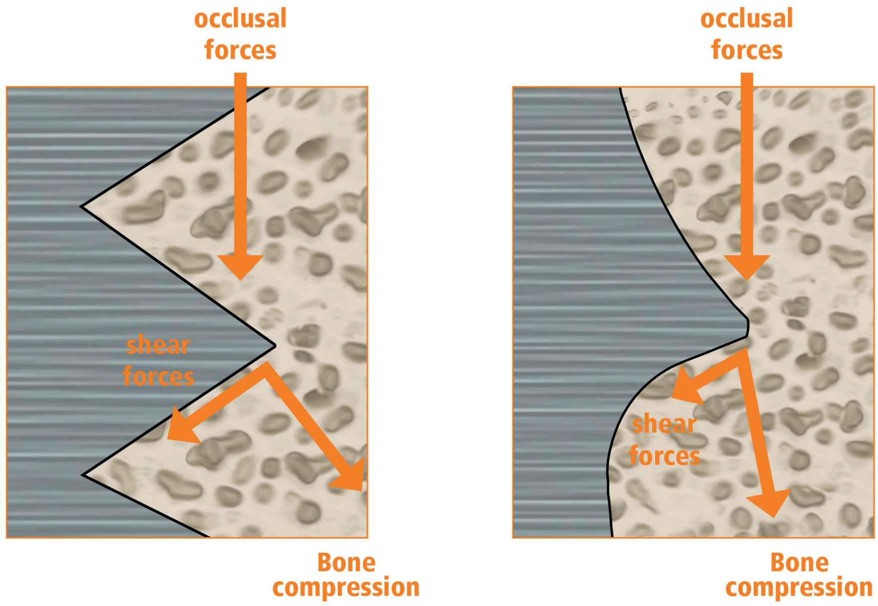


Fig. 2: V-thread in comparison with buttress thread: the buttress design has a large, deep thread and a low surface face designed for stronger compression and minimal shear force.

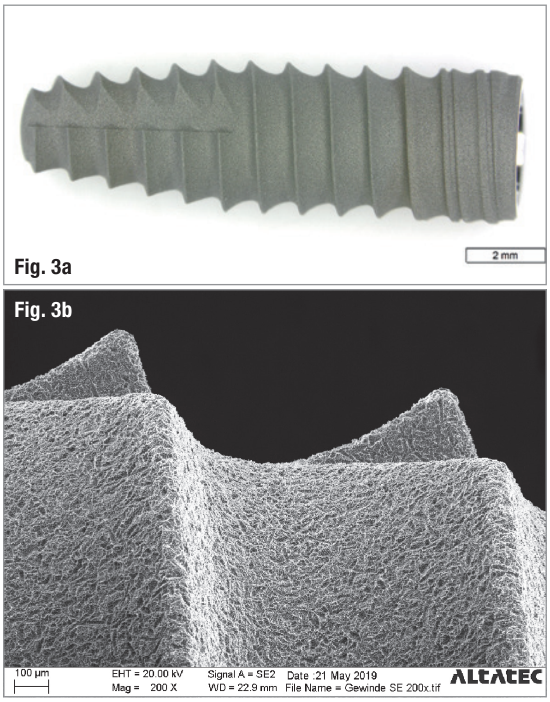
of the thread to the body of the implant. Thread width is the distance in the same axial plane between the coronal-most and the apical-most part at the tip of a single thread (thickness).

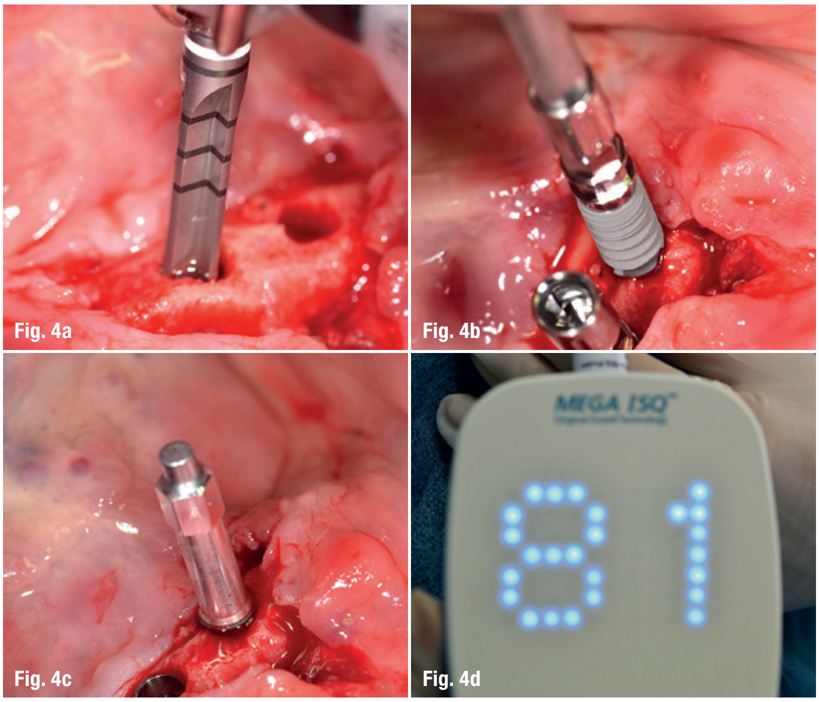
An optimal thread design, from a biomechanical point of view, must have the following characteristics: a thread pitch of no less than 0.80 mm, (a 0.80/1.0 mm pitch has been shown to have a stronger resistance to vertical loading[8]), a thread width of between 0.18 and 0.30 mm, a thread depth of between 0.34 and 0.50 mm (generates less stress during axial loading[8]) and a thread apical face angle of less than 30° to better dissipate loading forces.[9] Thus, the tread design is much more than just an interface to provide primary stability and, thus, to minimise micro-movements.

Different non-invasive methods of measuring implant stability have been suggested, including Periotest[10] and Implatest[11], but the most utilised are insertion torque value (ITV)[12] and resonance frequency analysis (RFA)[13]. ITV measures the frictional resistance of the implant during insertion through a rotatory movement on its axis, whereas RFA measures resistance to lateral micro-movement. RFA is performed by measuring the response of a magnetic device (SmartPeg), screwed into the implant, when excited by small sinusoidal signals. The peak amplitude is recorded and transformed into a numeric value on the Implant Stability Quotient (ISQ) scale, ranging from 0 to 100.[14] The literature supports a range of values between 57 and 82 as indicating better implant anchorage, and an ISQ > 70 as indicating high initial stability, allowing for immediate loading.[15] In other studies, it was shown that all implants with an initial ISQ > 54 osseointegrated when immediately loaded, indicating that it is not possible to define a unique "threshold ISQ" as a decision-making factor for the loading protocol.[16] The aim of this preliminary case series study was to assess the primary stability of a new hybrid design implant with buttress threads (Fig. 2) by measuring the ITV and the ISQ in order to investigate the achievable results with this new implant.

Materials and methods

Eleven implants (CONELOG PROGRESSIVE-LINE, CAMLOG Biotechnologies) were consecutively placed in seven patients (four men and three women; mean age: 59.29 ± 11.25 years) in this study. All implants, except the reduced-diameter implants, were placed immediately after atraumatic tooth extraction, whereas the implant bed was prepared conventionally in healed bone for the





Figs. 3a & b: Stereomicroscope image of CONELOG PROGRESSIVE-LINE implant and scanning electron microscope image of thread particular at 200× magnification. **Fig. 4a:** Implant bed preparation in dense bone without tapping—creating recipient bed characteristics with reduced pressure on the dense bone. **Figs. 4b–d:** Implant insertion and measurement of ISQ value.

four reduced-diameter implants (Table 1). Under local anaesthesia with 1:100,000 adrenaline, a full-thickness mucoperiosteal flap was elevated and the osteotomy was performed with the drills (Figs. 4a–c) according to the manufacturer's recommendations. Implant insertion was performed using a surgical motor with torque control (Elcomed SA-310, W&H). The ITV level was set at 60 Ncm, and the insertion speed at 15 rpm. During the entire process of inserting the fixture, the ITV was recorded on a USB memory device.

The ISQ value was measured with a resonance frequency analyser (Mega ISQ, Osstell; Fig. 4d) using SmartPeg Type 58 for platforms 3.8 and 4.3 and SmartPeg Type 65 for platform 3.3 (Osstell). All measurements were performed both parallel and perpendicular to the bone crest by a single operator. The strength of the association between the ITV and the ISQ was assessed by Spearman's rho correlation coefficient. The level of significance was set at $p < 0.05$.

Results

The results are shown in Table 2. The ITV values ranged between 36 and 55 Ncm, with a mean ± SD value of 46.73 ± 5.90 Ncm, and the ISQ values ranged between 74 and 87, with a mean value of 81.64 ± 3.38. All implants could be immediately restored (Fig. 5). We found no statistical correlation between ITV and ISQ ($r_s = 0.037212$; $p = 0.91351$ [NS]).

Patient I sex I age	Implant diameter (mm)	Implant length (mm)	Tooth no.	Post-extraction
No. 1 I M I 47	3.8	9	46	Yes
No. 2 I F I 72	3.3	11	33	N/A
No. 2 I F I 72	3.3	11	31	N/A
No. 2 I F I 72	3.3	11	41	N/A
No. 2 I F I 72	3.3	11	43	N/A
No. 3 I M I 66	4.3	7	26	Yes
No. 3 I M I 66	3.8	13	25	Yes
No. 4 I F I 51	4.3	11	36	Yes
No. 5 I M I 56	4.3	13	11	Yes
No. 6 I F I 74	3.8	13	12	Yes
No. 7 I M I 49	4.3	13	15	Yes

Table 1

Implant diameter (mm)	Implant length (mm)	ITV (Ncm)	ISQ	
3.8	9	45	79	
3.3	11	47	80	
3.3	11	50	81	
3.3	11	53	84	
3.3	11	48	81	
4.3	7	38	82	
3.8	13	45	74	
4.3	11	36	87	
4.3	13	55	82	
3.8	13	45	84	
4.3	13	52	84	
Mean ± SD			46.73 ± 5.90	81.64 ± 3.38
Variance s^2			34.82	11.45
Spearman's rho			$r_s = 0.037212$;	p = 0.91351 (2-tailed; NS)

Table 2

Discussion

Several methods of measuring implant primary stability have been suggested. The most commonly used are ITV and RFA, which determine the ISQ. Among the numerous papers published about these measurement systems, there is no evidence of a correlation between these measuring methods; thus, they are considered independent and incomparable methods of measuring primary stability.[17] This study investigated the primary stability of a new hybrid design implant with buttress threads by measuring the ITV and ISQ values. This implant demonstrates excellent stability. Compared with other published studies which analysed both the ITV and ISQ values, the results were much better (mean ITV = 46.73 Ncm and mean ISQ = 81.64). Baldi et al. analysed a knife-edge-threaded implant and found a mean ITV value of 42.73 Ncm and a mean ISQ value of 75.13.[14] Sarfaraz et al. studied a sharp-cutting, double-threaded implant and reported a mean ITV value of 39.08 Ncm and a mean ISQ value of 78.26.[18] Sargolzaie et al. investigated the relationship between ISQ and bone quality with regard to a buttress-threaded implant and reported mean values of 77.21 for Type I, 74.40 for Type II, 76.61 for Type III and 73.50 for Type IV.[19] Kim et al. reported an overall average ISQ value after implant placement of 72.65. We too found no correlation between the two measurements.[20]

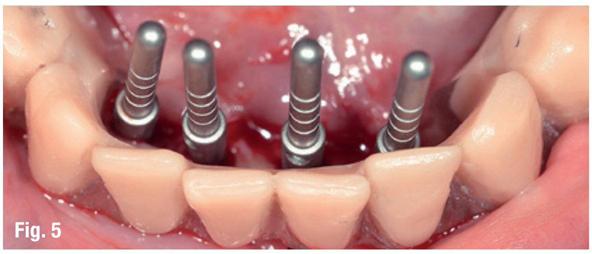


Fig. 5

Fig. 5: Immediate restoration of implants, in this case by modifying the existing denture.

Conclusion

Within the limitations of this case series study, it can be concluded that the new buttress-threaded implant tested showed a very good primary stability in extraction sockets. There was no correlation between ISQ and ITV.

about the author

In 1987, **Dr Enrico Conserva** graduated from the dental school of the University of Turin in Italy. As assistant professor, he taught implants and fixed prosthodontics at the dental school of the University of Genoa in Italy between 2001 and 2011. He also lectured in the second-level master's degree in implantology programme at the same university. From 2014 to 2017, he was a researcher and teacher at the University of Modena and Reggio Emilia in Italy, and he has been a contracted lecturer at the same university since 2017. He is also in private practice at his own clinic, Sphera Center, in Albenga in Italy, specialising in prosthodontics and implantology. He is a published author and editorial board member of two international journals, and his fields of scientific interest include implant surfaces, biomechanics, bone substitutes, stem cells and peri-implantitis.

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