# WHAT WORKS IN IMPLANT DENTISTRY

## *An Analysis of 2,235 Implants Placed in a Private Periodontal Practice*

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## INTRODUCTION

*How can a dentist working in private practice know how to optimize successful results in implant dentistry?*

This article will address this question and will focus on the information gained from implants placed in a private periodontal practice setting and restored using the team approach. A dental implant management software system called Triton DIMS (designed and owned by Martin Lumish, 1487 Westview Dr., Yorktown Hts., NY 10598), which can generate many types of reports including "lifetable reports," will be highlighted. The lifetable reports, in particular, display data that is invaluable in allowing the practitioner to identify factors that have a significant impact on implant survival. Some representative clinical examples will also be presented.

## SOURCES OF INFORMATION

When dentists evaluate a product or technique, they may rely on published data and/or clinical experience. Information can be gained from one's personal clinical experience as well as that of colleagues. The importance of clinical experience is invaluable; however, the contemporary dentist should, as much as possible, carry out clinical treatment based on sound scientific evidence. This has been referred to as "evidence-based decision-making." Published studies can be ranked for scientific validity and it is generally agreed that double-blind placebo-controlled trials are the strongest. Longitudinal and cross-sectional studies that do not incorporate a double-blind study design are weaker; clinical case reports are considered to be weaker still. Private practice studies are usually clinical case reports but may be longitudinal-type studies. However, when ranking different types of studies for their scientific validity and clinical applicability, there are other significant issues to consider.

## STUDIES (FUNDED) BY IMPLANT COMPANIES

In the field of implant dentistry, published studies are often financed, supervised and analyzed by a supporting implant manufacturer. There can be a potential conflict of interest with these types of studies. It is clearly not in the best interest of the implant manufacturer (that supports the study) to publish data that would reflect poorly on its product. While accusations are not being made, it is possible that a study might only enlist the "best" clinicians; not accept high-risk patients; delete the data from the poor clinicians and/or centres; not account for all implants placed; or, not describe a part of the study protocol that might artificially optimize a successful-appearing result (for example, not counting implants that were removed at initial placement because they were considered "risky" — that is, not *extremely* stable). Therefore, the astute clinician should have an attitude of healthy scepticism when confronted with potentially biased studies and data.

## STUDIES (NON-FUNDED) CARRIED OUT IN PRIVATE PRACTICE

Compared to funded institutional studies, private practice non-funded studies potentially have advantages as well bone quantity and/or quality. Despite this, the survival rates with this system exceeded all other systems (Table 14).

One particular patient accounted for 60 per cent (six out of 10) of all ITI failures. If this one patient was not included in the analysis, the survival rate would have been greater than 98 per cent. As with the titanium-threaded Branemark, Screw-Vent and Steri-Oss designs, "late" failures were not seen. It is noteworthy that the ITI implant surface was unlike the aforementioned designs in that it had a TPS coating.

## Lifetable Analysis #15: Immediate Extraction Socket Placement — All Implant Types

Implant placement immediately after extraction accounted for over 15 per cent of all implants placed (Table 15). Most implants were titanium-threaded designs replacing single-rooted teeth, with anterior sites being more frequent than bicuspid sites. The survival rates compared very favourably to implants placed in healed sites. In most immediate implant cases, relatively wider and longer implants were placed, as the recipient site had not undergone post-extraction ridge resorption. A strict patient selection and surgical protocol were adhered to. In the majority of cases, guided bone regeneration was not carried out, yet osseous fill of any existing peri-implant space was seen in almost all cases.

## Lifetable Analysis #16: Failed Implant — Immediate Replacement — All Implant Types

In a small number of cases, failed implants were removed and wider and/or longer implants were immediately placed in the same sites (Table 16). This technique was only considered in selected cases where, for example, one of the prerequisites was that the failed implant had to be associated with minimal peri-implant bone loss. Although the small number of cases limits the reliability of any conclusions, the prognosis for success with this particular technique seems drastically reduced. One should also take into account that the "risky" nature of this procedure may be compounded by the likelihood that the initial implant failed because there were pre-existing risk factors. Although this latter technique was associated with a higher risk of implant failure, it was deemed warranted at times because the ease and convenience of the procedure outweighed the associated risks.

## Lifetable Analysis #17: Failed Implant — Delayed Replacement — All Implant Types

In some cases, failed implants were removed and after three or more months of healing and new implants were placed in the same site (Table 17). Although the small number of cases limits the reliability of any conclusions, the prognosis for success of this particular technique seems to be significantly reduced. One should also take into account that the "risky" nature of this procedure may have been compounded by the likelihood that the initial implant failed because there were pre-existing risk factors.

**Table 19**
**Patient Age at Implant Placement**

| Age Interval | Number of Patients |
|---|---|
| 15-30 | 78 |
| 31-40 | 93 |
| 41-50 | 163 |
| 51-60 | 209 |
| 61-70 | 150 |
| 70+ | 83 |
| Average = 51 | Total = 776 |

**Table 20**
**Prosthesis Types**

| | |
|---|---|
| Single Fixed Crown | 287 |
| Splinted Fixed Crown & Bridge | 271 |
| Cantilevered Fixed Crown & Bridge | 59 |
| Bar Overdenture | 60 |
| Single Overdenture | 150 |
| Splinted Implant to Natural Tooth | 10 |

## Summary

This article has presented the results that the author has obtained with dental implants placed in his private practice in a format that may be of value to others. Hopefully, additional private practice studies (that can add valuable and practical information for private practice dentists) will be published to complement other types of published studies and research. ◆

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**Table 16**

**Lifetable Analysis #16: Failed Implant — Immediate Replacement — All Implant Types**

| Time Period | Patients | Implants | Lost | Sr-% | Csr-% |
|---|---|---|---|---|---|
| 0 Years | 15 | 19 | 4 | 78.9 | 78.9 |
| 0-1 Years | 9 | 13 | 3 | 76.9 | 60.7 |
| 1-2 Years | 5 | 7 | 0 | 100 | 60.7 |
| 2-3 Years | 5 | 7 | 0 | 100 | 60.7 |
| 3-4 Years | 3 | 5 | 0 | 100 | 60.7 |
| 4-5 Years | 1 | 3 | 0 | 100 | 60.7 |
| 5-6 Years | 1 | 3 | 0 | 100 | 60.7 |
| 6-7 Years | 1 | 3 | 0 | 100 | 60.7 |
| 7-8 Years | 1 | 3 | 0 | 100 | 60.7 |

**Sr = Survival rate; *Csr = Cumulative survival rate; *0 Years = Before 2nd stage; *0-1 Years = After 2nd stage*

**Table 17**

**Lifetable Analysis #17: Failed Implant Replacement — Delayed (>3 months) — All Implant Types**

| Time Period | Patients | Implants | Lost | Sr-% | Csr-% |
|---|---|---|---|---|---|
| 0 Years | 7 | 13 | 2 | 84.6 | 84.6 |
| 0-1 Years | 5 | 8 | 0 | 100 | 84.6 |
| 1-2 Years | 3 | 5 | 0 | 100 | 84.6 |
| 2-3 Years | 2 | 4 | 0 | 100 | 84.6 |
| 3-4 Years | 1 | 3 | 0 | 100 | 84.6 |
| 4-5 Years | 1 | 3 | 0 | 100 | 84.6 |
| 5-6 Years | 1 | 3 | 0 | 100 | 84.6 |
| 6-7 Years | 1 | 3 | 0 | 100 | 84.6 |
| 7-8 Years | 1 | 3 | 0 | 100 | 84.6 |
| 8-9 Years | 1 | 1 | 0 | 100 | 84.6 |

**Sr = Survival rate; *Csr = Cumulative survival rate; *0 Years = Before 2nd stage; *0-1 Years = After 2nd stage*

**Table 18**

**Bone Quality/Quantity Distribution — All Implant Types (A = greatest density; D =least density; 1 = greatest volume; 4 = least volume)**

| Quality → / ↓Quantity | A | B | C | D | TOTAL |
|---|---|---|---|---|---|
| 1 | 47 | 44 | 22 | 6 | 116 |
| 2 | 119 | 374 | 160 | 32 | 685 |
| 3 | 113 | 334 | 514 | 74 | 1,040 |
| 4 | 37 | 104 | 132 | 121 | 394 |
| **TOTAL** | **316** | **853** | **833** | **233** | **2,235** |

seem to reach a "steady state" and additional analysis (not shown in this article) has indicated further implant loss is anticipated.

## Lifetable Analysis #11: Steri-oss Implants — All Types

The author achieved a higher survival with this system compared to the overall average. There may be several explanations to account for this. The author had almost five years of experience prior to starting with this system. As well, this implant system is extremely versatile in that a wide variety of implant sizes and types are available. By carrying a large inventory of implant sizes and types, the author was able to choose the specific implant that best suited the implant site; thus, likely enhancing the chances for implant initial stability, short- and long-term survival.

## Lifetable Analysis #12: Steri-oss Implants — 3.8 mm HL-Diameter Titanium-Threaded

The Steri-Oss 3.8 mm HL is similar to a Branemark implant in terms of the prosthetic platform and endosseous macrostructural design. In some respects, although not identical in the thread design, titanium grade and surface treatment, the threaded titanium portion of the implant is comparable to the Branemark and titanium Screw-Vent. As with the titanium threaded Branemark and Screw-Vent designs, there were no "late" failures and a "steady state" seems to have been achieved.

## Lifetable Analysis #13: Steri-oss Implants — 3.25 mm Small-Diameter Titanium-Threaded

Typically, narrow diameter implants were placed when the width of the osseous recipient ridge was 5.5 mm or less. Despite the relatively narrow ridge, the survival rate compared favourably to wider implants. There have not been any implant fractures to date despite many anterior single-tooth restorations. This may be due in part to the titanium-alloy composition. The favourable results may also reflect overall case selection, selective bone augmentation procedures and stabilization in cortical bone. As with the titanium threaded Branemark and Screw-Vent designs, there were no "late" failures and a "steady state" seems to have been achieved.

## Lifetable Analysis #14: Straumann ITI Implants — All, Single Stage and TPS-Coated

The Straumann ITI system had been used almost exclusively in posterior sites which, as a result, may have presented a higher frequency of sites with relatively poor

## Lifetable Analysis #8: Titanium-Threaded "Screw-Vent" Implants

The Screw-Vent implant was originally introduced by the Core-Vent Corporation, which is currently the Paragon Implant Company. While this implant has undergone some modifications since its introduction, the endosseous threaded macrostructural design is based on the original Branemark titanium screw. The data shows that only one implant had been lost beyond the one-year time-period following initial implant placement, indicating a "steady state" had been reached (Table 8). This steady state pattern of survival is consistent with the data published in many long-term studies with the Branemark implant.

## Lifetable Analysis #9: HA-Coated 3.25 mm Narrow Diameter "Micro-Vent" Implants

The narrow diameter Micro-Vent implant was originally introduced by the Core-Vent Corporation, which is currently the Paragon Implant Company. This implant has recently undergone significant design changes, notably changing from a straight-walled design to a tapered design. For this article, the original straight-walled design has been documented (Table 9). This implant has mostly ledges rather than threads and is primarily pushed rather than threaded into the recipient site. The Micro-Vent mid-portion is coated with hydroxyapatite. These implants seemed to be associated with a low, early but "ongoing" failure rate. Under the specific conditions of this study, this particular implant did not seem to reach a "steady state" and additional analysis of the data (not shown in this article) indicated further implant loss is anticipated.

**Table 13**

**Lifetable Analysis #13: Steri-Oss Implants — 3.25 mm Small-Diameter Titanium-Threaded**

| Time Period | Patients | Implants | Lost | Sr-% | Csr-% |
|---|---|---|---|---|---|
| 0 Years | 109 | 205 | 4 | 98.0 | 98.0 |
| 0-1 Years | 92 | 176 | 4 | 97.7 | 95.8 |
| 1-2 Years | 62 | 130 | 1 | 99.2 | 95.1 |
| 2-3 Years | 42 | 92 | 0 | 100 | 95.1 |
| 3-4 Years | 17 | 40 | 0 | 100 | 95.1 |
| 4-5 Years | 8 | 24 | 0 | 100 | 95.1 |
| 5-6 Years | 3 | 13 | 0 | 100 | 95.1 |

**Sr = Survival rate; *Csr = Cumulative survival rate; *0 Years = Before 2nd stage; *0-1 Years = After 2nd stage*

**Table 14**

**Lifetable Analysis #14: Straumann ITI Implants — All, Single Stage and TPS-Coated**

| Time Period | Patients | Implants | Lost | Sr-% | Csr-% |
|---|---|---|---|---|---|
| 0 Years | 117 | 287 | 9** | 96.9 | 96.9 |
| 0-1 Years | 90 | 227 | 1 | 99.6 | 96.4 |
| 1-2 Years | 50 | 142 | 0 | 100 | 96.4 |
| 2-3 Years | 32 | 102 | 0 | 100 | 96.4 |
| 3-4 Years | 8 | 34 | 0 | 100 | 96.4 |
| 4-5 Years | 2 | 5 | 0 | 100 | 96.4 |
| 5-6 Years | 1 | 2 | 0 | 100 | 96.4 |

**Sr = Survival rate; *Csr = Cumulative survival rate; *0 Years = Before 2nd stage; *0-1 Years = After 2nd stage*

**Table 15**

**Lifetable Analysis #15: Immediate Extraction Socket Placement — All Implant Types**

| Time Period | Patients | Implants | Lost | Sr-% | Csr-% |
|---|---|---|---|---|---|
| 0 Years | 211 | 358 | 3 | 99.2 | 99.2 |
| 0-1 Years | 172 | 305 | 8 | 97.4 | 96.6 |
| 1-2 Years | 121 | 223 | 2 | 99.1 | 95.7 |
| 2-3 Years | 100 | 183 | 0 | 100 | 95.7 |
| 3-4 Years | 91 | 170 | 0 | 100 | 95.7 |
| 4-5 Years | 78 | 152 | 0 | 100 | 95.7 |
| 5-6 Years | 54 | 110 | 0 | 100 | 95.7 |
| 6-7 Years | 36 | 78 | 0 | 100 | 95.7 |
| 7-8 Years | 20 | 47 | 0 | 100 | 95.7 |
| 8-9 Years | 12 | 30 | 0 | 100 | 95.7 |
| 9-10 Years | 6 | 11 | 0 | 100 | 95.7 |
| 10-11 Years | 1 | 1 | 0 | 100 | 95.7 |

**Sr = Survival rate; *Csr = Cumulative survival rate; *0 Years = Before 2nd stage; *0-1 Years = After 2nd stage*

## Lifetable Analysis #10: HA-Coated 4.25 mm Wide-Diameter "Micro-Vent" Implants

The wide diameter Micro-Vent implant was originally introduced by the Core-Vent Corporation. This implant has recently undergone significant design changes, notably changing from a straight-walled design to a tapered design. For this article, the original straight-walled design has been documented (Table 10). This implant has mostly ledges rather than threads and is primarily pushed rather than threaded into the recipient site. The Micro-Vent mid-portion is coated with hydroxyapatite. These implants seem to be associated with a low, early but "ongoing" failure rate. Under the specific conditions of this study, this particular implant did not

**Table 10**
**Lifetable Analysis #10: HA-Coated 4.25 mm Wide Diameter "Micro-Vent" Implants**

| Time Period | Patients | Implants | Lost | Sr-% | Csr-% |
|---|---|---|---|---|---|
| 0 Years | 50 | 74 | 0 | 100 | 100 |
| 0-1 Years | 49 | 73 | 0 | 100 | 100 |
| 1-2 Years | 47 | 70 | 1 | 98.6 | 98.6 |
| 2-3 Years | 47 | 69 | 1 | 98.6 | 97.1 |
| 3-4 Years | 46 | 67 | 0 | 100 | 97.1 |
| 4-5 Years | 43 | 64 | 5 | 92.2 | 89.6 |
| 5-6 Years | 37 | 52 | 2 | 96.2 | 86.1 |
| 6-7 Years | 24 | 32 | 1 | 96.9 | 83.4 |
| 7-8 Years | 10 | 14 | 0 | 100 | 83.4 |
| 8-9 Years | 2 | 4 | 0 | 100 | 83.4 |

**Sr = Survival rate; *Csr = Cumulative survival rate; *0 Years = Before 2nd stage; *0-1 Years = After 2nd stage*

**Table 11**
**Lifetable Analysis #11: Steri-Oss Implants — All Types**

| Time Period | Patients | Implants | Lost | Sr-% | Csr-% |
|---|---|---|---|---|---|
| 0 Years | 329 | 930 | 17 | 98.2 | 98.2 |
| 0-1 Years | 254 | 710 | 19 | 97.3 | 95.5 |
| 1-2 Years | 150 | 464 | 2 | 99.6 | 95.1 |
| 2-3 Years | 88 | 270 | 1 | 99.6 | 94.8 |
| 3-4 Years | 43 | 146 | 0 | 100 | 94.8 |
| 4-5 Years | 21 | 68 | 0 | 100 | 94.8 |
| 5-6 Years | 6 | 28 | 0 | 100 | 94.8 |

**Sr = Survival rate; *Csr = Cumulative survival rate; *0 Years = Before 2nd stage; *0-1 Years = After 2nd stage*

**Table 12**
**Lifetable Analysis #12: Steri-Oss Implants — 3.8 mm HL-Diameter Titanium-Threaded**

| Time Period | Patients | Implants | Lost | Sr-% | Csr-% |
|---|---|---|---|---|---|
| 0 Years | 99 | 202 | 2 | 99.0 | 99.0 |
| 0-1 Years | 87 | 177 | 7 | 96.0 | 95.1 |
| 1-2 Years | 61 | 139 | 1 | 99.3 | 94.4 |
| 2-3 Years | 41 | 100 | 0 | 100 | 94.4 |
| 3-4 Years | 16 | 53 | 0 | 100 | 94.4 |
| 4-5 Years | 7 | 15 | 0 | 100 | 94.4 |
| 5-6 Years | 2 | 6 | 0 | 100 | 94.4 |

**Sr = Survival rate; *Csr = Cumulative survival rate; *0 Years = Before 2nd stage; *0-1 Years = After 2nd stage*

reported significantly lower success rates in the maxilla compared to the mandible. In the author's practice, perhaps the availability of several implant systems and a wider range of implant types and sizes accounted for the results.

## Lifetable Analysis #4: All Mandibular Implants

Slightly more than half of the total number of implants were placed in the mandible (Table 4). Implants were placed both in anterior and posterior sites exhibiting varying degrees of bone quality and quantity. In the mandible, a larger proportion of titanium and a smaller proportion of hydroxyapatite implants were placed compared to the maxilla. This may explain why the mandible exhibited a somewhat lower incidence of "late" failures. See also Tables 8, 9 and 10 for a more in-depth analysis of this issue.

## Lifetable Analysis #5: "Excellent" Bone Quality And Quantity — All Implant Types

Bone quality and quantity was subjectively judged at the time of implant placement (Table 18). Excellent bone Quality (A) was typically associated with very stable initial implant placement (Table 5). Excellent bone quantity (1 or 2) was typically associated with placement of implants with diameters of 3.7 mm or greater and lengths of 13 mm or greater. The results indicated that bone quality and quantity were important determinants for implant survival.

## Lifetable Analysis #6: "Fair" Bone Quality And Quantity ("B-3") — All Implant Types

Bone quality and quantity was subjectively judged at the time of implant placement (Table 18). Fair bone quality (B or C) was typically associated with stable initial implant placement (Table 6). Fair bone quantity (3) was typically associated with placement of implants with diameters of 3.25 mm to 3.8 mm and lengths of 10.0 mm to 13 mm. The results indicated that bone quality and quantity were very important determinants for implant survival.

## Lifetable Analysis #7: "Poor" Bone Quality And Quantity ("D-4") — All Implant Types

Bone quality and quantity was subjectively judged at the time of implant placement (Table 18). Poor bone Quality (D) was typically associated with barely stable initial implant placement (Table 7). Poor bone quantity (4) was typically associated with placement of implants with diameters of 3.25 mm to 3.8 mm and lengths of 6.0 mm to 10.0 mm. The results indicated that bone quality and quantity were very important determinants for implant survival.

and satisfied implant patient to return for regular follow-up examinations. In the author's personal experience, this has been especially challenging as many patients return to their general dentist exclusively for all of their follow-up care. It is critical, nevertheless, to persevere in trying to have patients come in for regular follow-up care, not only for their own benefit but lifetable statistics (and, in particular, cumulative survival rates) become increasingly more meaningful as larger numbers of patients are followed up for longer time periods.

A cumulative survival rate (Csr) should only be presented together with a lifetable. The assumption is that the subset of patients who returned for follow-up can accurately represent the whole group. Thus, the Csr is a prediction of what the true survival rate would be if all the patients eventually returned for follow-up for that particular time period. Conclusions are more valid, however, if 75 per cent or more of the whole group has been followed up. A correctly set-up lifetable should allow the reader to draw his or her own conclusions. (In this article, all the lifetables present survival statistics; thus, Sr = implant survival rate; and Csr = implant cumulative survival rate. For more information, readers are referred to two newsletters from Nobel Biocare: a) 1992, Vol. 6, #1, pg. 7, and b) 1995, Vol. 9, #1, pg. 6.)

**Table 7**
**Lifetable Analysis #7: "Poor" Bone Quality and Quantity — All Implant Types**

| Time Period | Patients | Implants | Lost | Sr-% | Csr-% |
|---|---|---|---|---|---|
| 0 Years | 80 | 121 | 7 | 94.2 | 94.2 |
| 0-1 Years | 66 | 99 | 8 | 91.9 | 86.6 |
| 1-2 Years | 46 | 70 | 7 | 90.0 | 77.9 |
| 2-3 Years | 33 | 42 | 1 | 97.6 | 76.1 |
| 3-4 Years | 23 | 26 | 1 | 96.2 | 73.2 |
| 4-5 Years | 18 | 20 | 1 | 95.0 | 69.5 |
| 5-6 Years | 15 | 17 | 0 | 100 | 69.5 |
| 6-7 Years | 11 | 13 | 0 | 100 | 69.5 |
| 7-8 Years | 8 | 10 | 0 | 100 | 69.5 |
| 8-9 Years | 5 | 5 | 0 | 100 | 69.5 |
| 9-10 Years | 1 | 1 | 0 | 100 | 69.5 |

**Sr = Survival rate; *Csr = Cumulative survival rate; *0 Years = Before 2nd stage; *0-1 Years = After 2nd stage*

**Table 8**
**Lifetable Analysis #8: Titanium-Threaded "Screw-Vent" Implants**

| Time Period | Patients | Implants | Lost | Sr-% | Csr-% |
|---|---|---|---|---|---|
| 0 Years | 161 | 435 | 9 | 97.9 | 97.9 |
| 0-1 Years | 155 | 414 | 15 | 96.4 | 94.4 |
| 1-2 Years | 150 | 392 | 1 | 99.7 | 94.1 |
| 2-3 Years | 143 | 379 | 0 | 100 | 94.1 |
| 3-4 Years | 133 | 351 | 0 | 100 | 94.1 |
| 4-5 Years | 113 | 317 | 0 | 100 | 94.1 |
| 5-6 Years | 89 | 256 | 0 | 100 | 94.1 |
| 6-7 Years | 70 | 200 | 0 | 100 | 94.1 |
| 7-8 Years | 58 | 172 | 0 | 100 | 94.1 |
| 8-9 Years | 41 | 133 | 0 | 100 | 94.1 |
| 9-10 Years | 18 | 59 | 0 | 100 | 94.1 |
| 10-11 Years | 7 | 22 | 0 | 100 | 94.1 |

**Sr = Survival rate; *Csr = Cumulative survival rate; *0 Years = Before 2nd stage; *0-1 Years = After 2nd stage*

**Table 9**
**Lifetable Analysis #9: HA Coated 3.25 mm Narrow Diameter "Micro-Vent" Implants**

| Time Period | Patients | Implants | Lost | Sr-% | Csr-% |
|---|---|---|---|---|---|
| 0 Years | 98 | 197 | 2 | 99.0 | 99.0 |
| 0-1 Years | 96 | 192 | 1 | 99.5 | 98.5 |
| 1-2 Years | 94 | 189 | 7 | 96.3 | 94.8 |
| 2-3 Years | 93 | 182 | 1 | 99.5 | 94.3 |
| 3-4 Years | 91 | 179 | 2 | 98.9 | 93.2 |
| 4-5 Years | 83 | 161 | 0 | 100 | 93.2 |
| 5-6 Years | 72 | 140 | 6 | 95.7 | 89.3 |
| 6-7 Years | 48 | 82 | 0 | 100 | 89.3 |
| 7-8 Years | 28 | 42 | 0 | 100 | 89.3 |
| 8-9 Years | 11 | 16 | 0 | 100 | 89.3 |

**Sr = Survival rate; *Csr = Cumulative survival rate; *0 Years = Before 2nd stage; *0-1 Years = After 2nd stage*

## Lifetable Analysis #2: All Implants

All of the implants placed by the author span up to a 10 to 11 year follow-up period, utilizing five different implant systems (Table 2). In the first five years, Core-Vents (currently Paragon Implant Company) were primarily placed. In the ensuing time period the majority of implants placed were Steri-Oss, with a significant number of Straumann ITI implants. Fewer numbers of implants from the Branemark, 3i and Lifecore systems had also been placed.

## Lifetable Analysis #3: All Maxillary Implants

Almost half of the total number of implants were placed in the maxilla (Table 3). The survival rate in the maxilla compared favourably to the mandible. Several published studies that have used an exclusive implant system have

**Table 4**

**Lifetable Analysis #4: All Mandibular Implants**

| Time Period | Patients | Implants | Lost | Sr-% | Csr-% |
|---|---|---|---|---|---|
| 0 Years | 414 | 1172 | 35 | 97.0 | 97.0 |
| 0-1 Years | 355 | 1001 | 29 | 97.1 | 94.2 |
| 1-2 Years | 278 | 792 | 2 | 99.7 | 94.0 |
| 2-3 Years | 227 | 667 | 3 | 99.6 | 93.5 |
| 3-4 Years | 188 | 551 | 1 | 99.8 | 93.4 |
| 4-5 Years | 148 | 437 | 4 | 99.1 | 92.5 |
| 5-6 Years | 111 | 331 | 1 | 99.7 | 92.2 |
| 6-7 Years | 77 | 231 | 0 | 100 | 92.2 |
| 7-8 Years | 56 | 181 | 0 | 100 | 92.2 |
| 8-9 Years | 39 | 134 | 0 | 100 | 92.2 |
| 9-10 Years | 21 | 65 | 0 | 100 | 92.2 |
| 10-11 Years | 11 | 35 | 0 | 100 | 92.2 |

**Sr = Survival rate; *Csr = Cumulative survival rate; *0 Years = Before 2nd stage; *0-1 Years = After 2nd stage*

**Table 5**

**Lifetable Analysis #5: "Excellent" Bone Quality and Quantity ("A-2") — All Implant Types**

| Time Period | Patients | Implants | Lost | Sr-% | Csr-% |
|---|---|---|---|---|---|
| 0 Years | 76 | 119 | 2 | 98.3 | 98.3 |
| 0-1 Years | 62 | 100 | 1 | 99.0 | 97.3 |
| 1-2 Years | 52 | 88 | 0 | 100 | 97.3 |
| 2-3 Years | 45 | 81 | 0 | 100 | 97.3 |
| 3-4 Years | 37 | 69 | 0 | 100 | 97.3 |
| 4-5 Years | 30 | 54 | 0 | 100 | 97.3 |
| 5-6 Years | 21 | 43 | 0 | 100 | 97.3 |
| 6-7 Years | 14 | 25 | 0 | 100 | 97.3 |
| 7-8 Years | 10 | 18 | 0 | 100 | 97.3 |
| 8-9 Years | 10 | 18 | 0 | 100 | 97.3 |
| 9-10 Years | 4 | 5 | 0 | 100 | 97.3 |
| 10-11 Years | 2 | 2 | 0 | 100 | 97.3 |

**Sr = Survival rate; *Csr = Cumulative survival rate; *0 Years = Before 2nd stage; *0-1 Years = After 2nd stage*

**Table 6**

**Lifetable Analysis #6: "Fair" Bone Quality and Quantity ("B-3") — All Implant Types**

| Time Period | Patients | Implants | Lost | Sr-% | Csr-% |
|---|---|---|---|---|---|
| 0 Years | 209 | 334 | 3 | 99.1 | 99.1 |
| 0-1 Years | 162 | 268 | 8 | 97.0 | 96.1 |
| 1-2 Years | 122 | 207 | 1 | 99.5 | 95.7 |
| 2-3 Years | 95 | 161 | 1 | 99.4 | 95.1 |
| 3-4 Years | 66 | 115 | 0 | 100 | 95.1 |
| 4-5 Years | 49 | 87 | 0 | 100 | 95.1 |
| 5-6 Years | 36 | 67 | 0 | 100 | 95.1 |
| 6-7 Years | 23 | 45 | 1 | 97.8 | 95.1 |
| 7-8 Years | 17 | 36 | 0 | 100 | 93.0 |
| 8-9 Years | 10 | 23 | 0 | 100 | 93.0 |
| 9-10 Years | 6 | 13 | 0 | 100 | 93.0 |
| 10-11 Years | 3 | 5 | 0 | 100 | 93.0 |

**Sr = Survival rate; *Csr = Cumulative survival rate; *0 Years = Before 2nd stage; *0-1 Years = After 2nd stage*

patite surfaces are equivalent. As well, every dentist, practise environment, laboratory and patient are not identical and therefore, there is no guarantee that other dentists will experience the same results. However, despite these issues, the author suggests data obtained from a particular private practice can still be of value to other private practitioners. The challenge in a private practice, as mentioned before, is to document, analyze and present the data (with the help of a computer program) in a way that it can be easily understood by other dentists. A brief description of the Triton DIMS is included so that readers will have a better understanding of the information that follows.

## Triton DIMS

It is not within the scope of this article to describe Triton DIMS in detail. More information on the program can be obtained by contacting the author. Triton DIMS is a relational database program and entries are made onto the system at the time each implant is placed and at every follow-up visit. The system allows an easily expandable and almost unlimited number of attributes that can be applied to a large number of implant variables. Once data is entered, the Triton DIMS system can easily generate many different reports. In this article, one of these reports will be primarily highlighted, namely the lifetable analysis.

## Lifetables

The lifetables in this article (Tables 1 to 17) represent only a small sample of the reports that can be generated from the Triton DIMS database; however, the author has attempted to select specific examples that represent potentially significant and interesting results.

In a lifetable, the implant subjects are placed in groups based on the actual follow-up time. For example, a patient treated five years ago, but only seen most recently at two-and-a-half years following initial implant placement, would be categorized in the two- to three-year follow-up period in the lifetable. Patients may not be followed up for a number of reasons other than implant failure. Perhaps the biggest challenge in private practice is to motivate the completed and recorded on the Triton DIMS dental implant management software system (up to the time of submission of this article). The author has no direct financial or contractual obligation to any of the implant systems or to Triton DIMS. It is suggested that the information presented in this article is non-biased.

All of the surgical aspects of the treatment were carried out by the author in his private practice. Only local anaesthetic was used and aseptic surgical technique was incorporated. While it is not within the scope of this article to describe the details of the surgical protocol, certain significant issues do warrant being mentioned. Reasonable clinical judgement and informed patient consent were instituted at all times; however, patients and/or procedural protocols that presented a higher risk of implant failure were not necessarily excluded. With patient selection, for example, heavy smokers were advised of the higher risk of implant failure. They were given smoking cessation options but were treated even if they continued smoking. As well, sites exhibiting very poor bone quality and quantity were often treated (Table 7). With procedural protocol for example, certain "risky" treatments were also undertaken but only where clinical circumstances warranted the risk. For example, in selected cases, when a failed implant was removed, an "immediate implant replacement technique" was carried out (Table 16). Although this latter technique was associated with a higher risk of implant failure, it was deemed warranted at times because the ease and convenience of the procedure outweighed the associated risks. Thus, in the author's private practice, the primary concern was treating all patients in a way that was judged to be in their best interests. The practitioner's concern about the overall survival statistics did not take precedence over the patient's best interests. As a result, some of the clinical decisions and treatments carried out (as in the above examples) resulted in the lowering of the author's overall survival rate statistics.

The restorative treatment and most of the supportive maintenance care was carried out by a large number of private practice dentists who had varying degrees of experience. The results presented in this article may reflect what a private practice dentist working with the team approach could experience but only if treatment conditions were identical. For example, the different implant survival rates presented in the lifetables of this article are applicable only to the exact implant type used at that time. It is noteworthy that some implant surfaces have undergone significant change compared to some of the implant surfaces presented in the lifetables of this article. It should *not* be assumed, for example, that all hydroxya-

**Table 1**

**Lifetable Analysis Table #1: Sample Lifetable**

| Time Period | Patients | Implants | Lost | Sr-% | Csr-% |
|---|---|---|---|---|---|
| 0-1 Years | 45 | 100 | 5 | 95.0 | 95.0 |
| 1-2 Years | 40 | 90 | 3 | 96.7 | 91.8 (95.0x96.7) |
| 2-3 Years | 29 | 75 | 1 | 98.7 | 90.6 (91.8x98.7) |
| 3-4 Years | 18 | 40 | 0 | 100.0 | 90.6 (90.6x100.0) |
| 4-5 Years | 4 | 10 | 0 | 100.0 | 90.6 (90.6x100.0) |

**Table 2**

**Lifetable Analysis #2: All Implants**

| Time Period | Patients | Implants | Lost | Sr-% | Csr-% |
|---|---|---|---|---|---|
| 0 Years | 776 | 2235 | 46 | 97.9 | 97.9 |
| 0-1 Years | 662 | 1883 | 47 | 97.5 | 95.5 |
| 1-2 Years | 516 | 1498 | 13 | 99.1 | 94.7 |
| 2-3 Years | 425 | 1223 | 3 | 99.8 | 94.4 |
| 3-4 Years | 343 | 978 | 2 | 99.8 | 94.2 |
| 4-5 Years | 276 | 794 | 5 | 99.4 | 93.6 |
| 5-6 Years | 215 | 636 | 8 | 98.7 | 92.5 |
| 6-7 Years | 153 | 446 | 1 | 99.8 | 92.3 |
| 7-8 Years | 105 | 331 | 2 | 99.4 | 91.7 |
| 8-9 Years | 66 | 221 | 0 | 100 | 91.7 |
| 9-10 Years | 31 | 102 | 0 | 100 | 91.7 |
| 10-11 Years | 14 | 46 | 0 | 100 | 91.7 |

**Sr = Survival rate; *Csr = Cumulative survival rate; *0 Years = Before 2nd stage; *0-1 Years = After 2nd stage*

**Table 3**

**Lifetable Analysis #3: All Maxillary Implants**

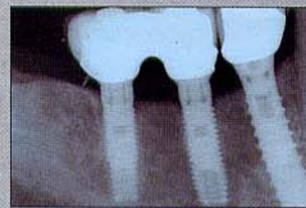
| Time Period | Patients | Implants | Lost | Sr-% | Csr-% |
|---|---|---|---|---|---|
| 0 Years | 442 | 1063 | 11 | 99.0 | 99.0 |
| 0-1 Years | 369 | 882 | 18 | 98.0 | 96.9 |
| 1-2 Years | 285 | 706 | 11 | 98.4 | 95.4 |
| 2-3 Years | 235 | 556 | 0 | 100 | 95.4 |
| 3-4 Years | 188 | 427 | 1 | 99.8 | 95.2 |
| 4-5 Years | 155 | 357 | 1 | 99.7 | 94.9 |
| 5-6 Years | 129 | 305 | 7 | 97.7 | 92.8 |
| 6-7 Years | 93 | 215 | 1 | 99.5 | 92.3 |
| 7-8 Years | 64 | 150 | 2 | 98.7 | 91.1 |
| 8-9 Years | 36 | 87 | 0 | 100 | 91.1 |
| 9-10 Years | 16 | 37 | 0 | 100 | 91.1 |
| 10-11 Years | 5 | 11 | 0 | 100 | 91.1 |

**Sr = Survival rate; *Csr = Cumulative survival rate; *0 Years = Before 2nd stage; *0-1 Years = After 2nd stage*

**Case VIII: Core-Vent (currently Paragon) machined acid-etched titanium-threaded Screw-Vent and ITI Straumann TPS coated solid screw**

**Slide 1.** Periapical radiograph taken shortly after placement of three 3.7 mm diameter Screw-Vent implants. There were no initial indications that any implants would not osseointegrate.

**Slide 2.** Six months after initial implant placement, despite lack of obvious bone loss, the mesial implant apparently failed, as it could be unscrewed with minimally applied counter-torqueing force.



**Slide 3.** Periapical radiograph taken two years after the "immediate replacement" of the 3.7 mm diameter Screw-Vent with a 4.1 mm diameter Straumann ITI solid screw. Crestal bone levels were stable.

**Slide 4.** Clinical view illustrating a single tooth screw retained crown on the Straumann ITI implant and a two-unit screw retained splint on the remaining two Screw-Vent implants.

**Case IX: Branemark machined titanium-threaded implant**

**Slide 1.** Periapical radiograph of the implant just two weeks after restoration. The implant exhibited obvious bone loss, mobility and deep pockets (which has been atypical for machined titanium implants).

**Slide 2.** The failed implant was easily removed and the "socket" was thoroughly curetted. As the circumferential bone was intact, adjunctive regenerative materials were not employed.

**Slide 3.** Histological analysis of the removed implant revealed a continuous layer of soft tissue interposed between the bone and the implant, indicating osseointegration likely never occurred initially.

**Slide 4.** Periapical radiograph taken one year after removal of the failed implant. Note the mm grid lines which helped to measure the bone more accurately in the mesio-distal and apico-coronal dimensions.

**Slide 5.** Periapical radiograph taken five years after restoration of the "delayed" implant replacement. The excellent crestal bone level indicates a "steady state" had been achieved.

**Slide 6.** Clinical view of the Cera-One prosthetic restoration.

to attain the full potential value of the data.

With contemporary implant dentistry, it is not uncommon to see reports of high survival rates. One could then get the impression that achieving an additional small incremental increase in implant survival (for example, two per cent) might not be clinically relevant. However, analyzing survival rates from another perspective, *if the survival rate increased from 96 per cent to 98 per cent, a reduction in failures of 50 per cent would have been achieved.* In private practice, every failure represents a traumatic experience for both the patient and the dentist. The serious clinical investigator should, therefore, continually evaluate and modulate clinical protocol in an effort to achieve the best possible results.

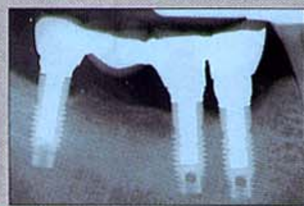
In summary, contemporary implant dentistry should be evidence-based as much as possible. The value of data from private practice can be immensely enhanced when it is documented and analyzed in a scientifically and clinically meaningful way. Hopefully, in the future, more private practitioners who treat implant patients will incorporate an organized scientific approach to the gathering and analysis of their clinical data. If these practitioners were to standardize and pool their results, larger databases and, hence, potentially more reliable information could be published. This would add to the value and scientific credibility of results achieved in the private practice setting with the ultimate goal of benefiting both the profession and patients.

## Conditions Of The Author's Private Practice Study

This article reports on *every* implant the author has placed

### Case IV: Core-Vent (currently Paragon) acid-etched titanium-threaded Screw-Vent implants

**Slide 1.** Clinical view of the mandibular posterior four-unit splinted prosthesis at ten years post-insertion. The abutments and suprastructure were cemented.



**Slide 2.** Periapical radiograph taken 10 1/2 years after initial implant placement, demonstrating extremely stable crestal bone levels; that is, a "steady state" seems to have been achieved.

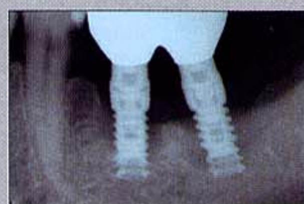
### Case V: Branemark machined titanium-threaded implants

**Slide 1.** Lower right single tooth implant in the first molar site demonstrating extremely stable crestal bone levels after eight years in function; that is, a "steady state" seems to have been achieved.

**Slide 2.** Lower left single tooth implant in the first molar site demonstrating extremely stable crestal bone levels after eight years in function; that is, a "steady state" seems to have been achieved.

### Case VI: Core-Vent (currently Paragon) hydroxyapatite-coated wide (4.25 mm) diameter Microvents

**Slide 1.** Radiograph taken shortly after prosthetic insertion of a two-unit, screw-retained, porcelain fused to metal, splinted suprastructure.

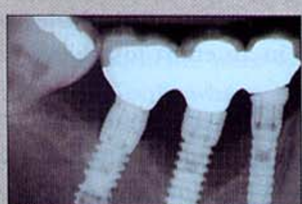


**Slide 2.** Radiograph taken four years after initial prosthetic insertion. The severe bone loss had developed on an ongoing basis; that is, a "steady state" had not been achieved.

**Slide 3.** Clinical view taken four years after initial prosthetic insertion, corresponding to the previous radiograph. The deep pockets exhibited suppuration upon probing.

**Slide 4.** Radiograph taken 4 1/4 years after initial prosthetic insertion illustrating further bone loss. One implant had already been lost and the second implant was removed shortly thereafter.

### Case VII: Core-Vent (currently Paragon) hydroxyapatite-coated 4.25 mm and 3.25 mm diameter Microvents



**Slide 1.** Periapical radiograph taken two years after initial placement, illustrating advanced bone loss at the middle 4.25 mm diameter Microvent.

**Slide 2.** Clinical view with the prosthetic suprastructure removed. Note the "peri-implant acute abscess" associated with the middle implant.

**Slide 3.** Periapical radiograph taken seven years after explantation of the middle implant. The mesial and distal implants had not exhibited significant crestal bone loss.

**Slide 4.** Clinical view of the new prosthesis seven years after initial implant placement. Despite the loss of one implant, the remaining two implants allowed the fabrication of an acceptable new prosthesis.

challenge can be more easily met if all the relevant data is recorded on an appropriate computer program.

Without computer assistance, it is difficult to imagine how any large database can be properly managed. With the extremely large number of variables in the field of implant dentistry, the process of data collection and analysis becomes extremely challenging. Compounding this difficulty is that as improvements in products and techniques result in higher implant survival rates, it become progressively more difficult to recognize significant differences of smaller magnitudes. Thus, when one embarks on a process of detailed documentation and analysis, it becomes obvious that an appropriate computer software system is essential if one is committed

## Case I: Steri-Oss machined acid-etched threaded titanium implants

**Slide 1.** Panoramic view taken immediately after initial placement of 16 implants. The most distal implant site at the patient's upper right demonstrated the poorest bone quality and quantity.

**Slide 2.** At six weeks following initial implant placement, the most distal implant on the patient's upper right exhibited obvious mobility and was removed.

**Slide 3.** Occlusal view of the final prosthesis after two years in function. The implants were fitted with custom abutments and the full arch splinted bridge was transitionally cemented.

**Slide 4.** Periapical radiograph of the upper right posterior area taken three years after the prosthesis insertion. Sinus bone grafting was declined, thus limiting the available bone in the area of the only failed implant.

## Case II: Core-Vent (currently Paragon) acid-etched titanium-threaded Screw-Vent implants

**Slide 1.** The patient exhibited a missing maxillary left second bicuspid, first and second molar. A partial upper denture and sinus bone grafting were both declined and the patient desired a minimum of two additional "fixed" teeth.

**Slide 2.** Two implants were placed in the maxillary left second bicuspid and first molar sites. The crowns were splinted and careful attention was paid to the occlusion and biomechanical force distribution.

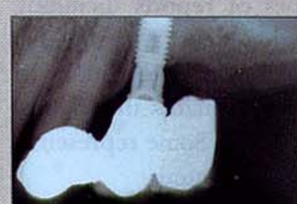
**Slide 3.** This periapical radiograph was taken shortly after prosthetic restoration. The available bone in the first molar site only allowed for placement of an 8.0 mm-length implant.

**Slide 4.** This periapical radiograph was taken five years after prosthetic restoration. Note the long-term stable crestal bone level despite the limited bone quantity at the first molar site.

## Case III: Core-Vent (currently Paragon) acid-etched titanium-threaded Screw-Vent implants

**Slide 1.** Completed implant prosthesis in centric occlusion. The distal unit was designed as a cantilever pontic which was joined to the two implants anteriorly. The pontic was adjusted to have no centric or excursive occlusal contacts.

**Slide 2.** Periapical radiograph taken shortly after prosthetic insertion. Sinus osseous grafting was declined and thus only a 7.0 mm-length implant was placed at the second bicuspid site.



**Slide 3.** The distal implant was lost after nine months in function and a new prosthesis was fabricated. Poor bone quality and quantity, prosthetic design and overloading likely caused this "late" implant failure.

**Slide 4.** An attempt was made to minimize overloading to the implant by designing the occlusion with cuspid rise in left lateral excursion. However, rigid splinting of the implant-to-natural-tooth should have been avoided by placing additional implants.

as disadvantages. An advantage is that the operating conditions of the study, and therefore the results of the study, may be more likely to be applicable to other private practice dentists' operating environment. A disadvantage is that there may be more financial and time restraints present in the private practice setting. Thus, it is unlikely that the private practice dentist could institute a strict study design protocol that would totally control for bias and the multitude of variables encountered. As a result, it is extremely rare to see a double-blind placebo-controlled study carried out in private practice. Another challenge for the private practice dentist and/or staff is to document, analyze and report all the data in a scientifically meaningful way. This