

A Computer-Controlled Anesthetic Delivery System in a Periodontal Practice: Patient Satisfaction and Acceptance

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ABSTRACT

Background: Many dental patients are fearful about receiving intraoral injections of local anesthetic. In fact, many patients cite injections as their primary reason for avoiding dental treatment. In late 1997, however, a computerized local anesthetic delivery system was introduced to address the problems of pain and anxiety associated with these injections. The author initiated a year-long assessment study, in which patients evaluated and rated injections administered with the computerized device as compared to previously administered standard injections.

Methods: One hundred and fifty randomly selected patients received local anesthesia delivered via the computer-controlled anesthetic delivery system. All patients had at some time received standard injections during treatment at the practice. Different types of injections were administered to all quadrants, enabling the researcher to qualify results according to injection type and location. Patient responses were recorded and evaluated to assess the levels of anxiety and pain associated with the computer-driven system.

Results: Overall, 71.4% of patients reported the experience to be superlative, positive, or somewhat positive. Results indicated that the system was highly preferred to traditional injection techniques, regardless of the arch and quadrant receiving the injection. Several factors may have contributed to this preference, including increased patient comfort, the nonthreatening appearance of the instrument, and the lack of residual facial numbness commonly associated with oral anesthetic injections.

CLINICAL SIGNIFICANCE

By removing the discomfort associated with the dental injection, which is a common source of patient anxiety, use of the computer-controlled anesthetic delivery system may encourage patient acceptance of recommended periodontal treatment modalities.

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According to a study in which subjects were asked to rank 25 dental scenarios from "least fearful" to "most fearful," the fourth

most fearful experience cited was the situation in which a dentist is holding a syringe and needle. Additionally, up to 14% of residents in

the United States avoid dental treatment because of fear.^{1,2} Therefore, it is incumbent upon the dental industry to address this fear that

may be preventing patients from seeking dental treatment. An instrument that provides a significant improvement in the delivery of anesthetic addresses that fear, and it should prove to be a great benefit to the practice of dentistry.³

A computerized anesthetic delivery system (The Wand, Milestone Scientific, Deerfield, IL) has been developed to address the anxiety and fear resulting from the sight and sensation of conventional injection systems; administer local anesthetic at a consistent volume and rate regardless of tissue density or resistance; and permit controlled, highly effective, comfortable injections. Introduced to the dental market in the last quarter of 1997, the anesthetic delivery system consists of a computer-controlled drive unit and a sterile, disposable handpiece assembly. The drive unit is engineered to deliver precise pressure and volume ratios (flow rate) of anesthetic from standard cartridges and needles, even in areas of dense tissue, such as the palate and periodontal ligament. The lightweight, pen-grasp handpiece is shaped to provide maximum tactile feedback, precision, operator ease, and patient comfort.⁴

When activated, the computer-controlled delivery system produces an anesthetic drip that precedes the needle, initiates a slow flow rate, and thus, creates an anesthetic

pathway.⁴ Once the target point for injection has been located, the needle is inserted, twirled slightly to facilitate positioning and counteract needle deflection, and slowly moved forward. This procedure is said to produce a virtually imperceptible injection and a rapid onset of profound anesthesia.

A competing device (Comfort Control Syringe, Dentsply Professional, Des Plaines, Illinois), also purported to provide controlled anesthetic delivery, also recently reached the dental marketplace.

Such innovations in anesthesia administration have promised to eliminate the fear and pain often associated with injections, thereby altering patient perceptions and experience. According to a study conducted by Hochman and colleagues on the original computer-controlled device, precise control of anesthetic flow rate minimizes the perception of pain during intraoral injections of local anesthetic.³ Traditional injection systems that use metallic aspirating cartridge syringe assemblies do not allow consistent accuracy or control because the flow rate and fluid pressure tend to be dependent on the individual operator's manual strength and dexterity as well as on the force exerted during an injection procedure.

In their research, Hochman and colleagues evaluated the percep-

tions of 50 dentists, each of whom was injected with both the computerized anesthetic delivery system (the test injection) and a conventional syringe (the control injection). Subjects were blindfolded, and an audible tone was produced during both injections to eliminate the possibility of subjects identifying either system by sight or by sound. Following the injections, subjects assessed their pain intensity, ranking it according to a verbal scale and a visual analogue scale. Of the 50 subjects, 48 reported the computer-driven delivery system was more comfortable than the traditional syringe; one found the computer-controlled system to produce a pain intensity equal to the traditional system; and one reported the injection with the system to be less comfortable than that from the conventional syringe.³

More recently, a study using an animal model found that the same computer-controlled device for local anesthetic delivery resulted in less postinjection tissue inflammation than traditional injections.⁵ Researchers found only limited localized inflammation in the first 24 hours after injection; by 7 days, all inflammation has resolved, and the ligament appeared within normal limits.

In an effort to acquire further evaluative data, a preliminary study was conducted in a private perio-

dental practice. This study was undertaken in an effort to further clinically assess the validity of manufacturer claims and the device's capacity to comfortably deliver local anesthetic for use in a range of surgical procedures.

MATERIALS AND METHODS

Study Population

Between February 1998 and February 1999, 150 patients were selected at random from the patient population of a periodontal practice in Philadelphia to receive local anesthesia delivered via the computer-controlled anesthetic delivery system. In previous visits to the practice, each patient had experienced traditional dental injections. Patients ranged in age from 13 to 80 years, and all injections were administered by the same clinician.

Equipment and Techniques

The Wand microprocessor-controlled anesthetic delivery system (Milestone Scientific) was used for this study. The device is designed not only for traditional local anesthesia procedures, but also for providing comfortable, rapid, and predictable anesthesia through site-specific anterior middle superior alveolar (AMSA), modified periodontal ligament (PDI), and palatal anterior superior alveolar (P-ASA) injections with minimal anesthetic dosage, often significantly minimizing or even eliminating facial numbness.^{4,6,7} Prior to the study,

the computerized local anesthetic delivery system had been employed in the practice for 1 year.

Unless otherwise stated, the techniques described below as used in this study are consistent with the device manufacturer's instructions for use.

Block and Infiltration Injections.

Block and infiltration injections, which can be administered with the computer-controlled anesthetic delivery system in either the maxilla or the mandible, are performed in the traditional manner. For an inferior alveolar block injection (mandibular block), the system's handpiece was held in a modified pen-grasp, and the thumb and forefinger were used to rotate the handpiece 180 degrees in a back and forth movement during needle advancement. Bidirectional rotation negated needle deflection of up to 5 mm from the target injection site and significantly reduced the number of "missed" mandibular blocks, which can occur when a linear insertion technique is employed with a traditional syringe.⁸ For infiltration injections, the handpiece of the anesthetic delivery system was rotated gently between the thumb and the forefinger as the needle penetrated the mucosa.

Periodontal Ligament Injections.

A gauze pad or cotton roll was positioned at the injection site. The

injection was initiated on the distal line angle of the tooth. The distolingual and mesiolingual line angles served as the primary injection sites on mandibular teeth; for maxillary teeth, the distobuccal and mesiobuccal sites served as primary injection sites. Using the line angles as guides helped minimize the occurrence of needle deflection into the interproximal space.⁴

A 27- or 30-gauge, extra-short needle was oriented with the bevel against the tooth into the sulcus between the tooth and bone in the periodontal ligament space. Using the slow flow rate throughout the injection, the needle was advanced into the periodontal ligament space until it could advance no further. If no resistance was encountered, the needle was repositioned to ensure proper placement within the periodontal ligament space. Moderate pressure was maintained to ensure an adequate "seal" of the needle track, and the slow flow rate was continued until approximately 0.9 mL of anesthetic had been deposited in the injection site. The procedure was repeated on the mesiolingual or distolingual line angle for mandibular teeth or on the distobuccal or mesiobuccal line for maxillary teeth.⁴

Anterior Middle Superior Alveolar Injections. With AMSA injections, profound pulpal anesthesia is achieved from the central incisor through the second premolar as

well as in the palatal tissues within approximately two minutes, from a single palatal site with approximately one-fourth of the amount of anesthetic conventionally required.⁶

The technique, which reportedly causes patients little to no discomfort, is said to provide comfort for scaling and root planing, palatal soft-tissue, and restorative procedures.⁷

Palatal Anterior Superior Alveolar Injections. A palatal approach to the anterior superior block, with the injection site lateral to the incisive papilla, is used for P-ASA injections. Although the manufacturer of the system recommends use of a pre-puncture technique, in this study a topical anesthetic was instead applied prior to introduction of the system's handpiece and needle into the patient's oral cavity.

A 30-gauge, extra-short needle was positioned lateral to the incisive papilla at a 45-degree angle with the needle bevel against the tissue. The needle was rotated slowly as it penetrated the incisive papilla and slow anesthetic flow was initiated. Slow rotation was continued as the needle penetrated the tissue. Slow anesthetic delivery was continued until tissues were visibly blanched. The needle then was reoriented to gain access to the nasopalatine canal and advanced slowly until bone was reached. The system's foot control then was released to achieve aspiration. Needle pressure was

maintained, allowing continued contact with bone, and the remaining amount of required anesthetic was delivered at the slow rate.

After sufficient anesthetic (between three-fourths and one-full cartridge) was delivered, the foot control was released, and time was allowed (approximately 5 seconds) for the fluid pressure to dissipate. After pressure had dissipated, the needle was removed. Once palatal and facial tissues blanched, pulpal anesthesia was accomplished within approximately 5 minutes.⁷

Between three-fourths and one-full cartridge of anesthetic is generally needed to produce optimal anesthesia for sufficient duration,⁷ although dosage requirements may vary from case to case.

The P-ASA injection has been reported to provide optimal comfort for scaling and root planing, for palatal soft tissue procedures, and for restorative procedures.⁷

Outcome Measure

Patient reaction to injection with the computer-controlled anesthetic delivery system was recorded in 211 cases (i.e., 211 patient visits) comprising an array of procedures typically performed in a periodontal practice. The procedures were predominantly surgical and included implant surgery, sinus grafts, and guided bone regeneration with the

use of pins. Forty-eight patients underwent multiple treatments; 102 patients underwent a single periodontal procedure requiring local anesthetic.

The following data were recorded at each patient visit: treatment sextant (mandibular anterior, mandibular left, mandibular right, maxillary anterior, maxillary left, maxillary right); quadrant (upper left, upper right, lower left, lower right); injection site or sites (palatal, buccal, facial, lingual); and tooth number. Also recorded were the date of treatment, patient identifying information, injection type (block or infiltration), needle gauge, needle size, and each patient's verbal assessments of how injections were perceived at each visit.

For each case in which the computerized local anesthetic delivery system was employed, patient comments on the injection experience were recorded verbatim. Comments were classified into four response categories: superlative, positive, somewhat positive, and negative. These responses were grouped according to injection site and assessed according to the total number of cases performed. Verbatim responses were grouped according to similarities in wording or in implicitly accepted meanings. Comparisons between comment groups according to the various treatment sites were undertaken as well.

RESULTS

Overall, the cases provided a representative range of anesthesia requirements, including buccal, facial, lingual, and palatal anesthesia as well as infiltration and block injection techniques.

Ninety-eight procedures involved mandibular treatment (46.4% of all cases recorded). Of this group, six were mandibular anterior cases (2.8% of the total cases; 6.1% of mandibular cases); 44 were mandibular left cases (20.9% of the total cases; 44.9% of mandibular cases); and 48 were mandibular right cases (22.7% of total cases; 49% of mandibular cases).

A total of 113 maxillary procedures were recorded (53.6% of all cases studied). Of these, 12 were maxillary anterior cases (5.7% of total cases; 10.6% of maxillary cases); 39 were maxillary left cases (18.5% of total cases; 34.5% of maxillary cases); and 62 were maxillary right cases (29.4% of total cases; 54.9% of maxillary cases).

As an additional note, a 30-gauge, 1-inch needle was employed in more than 95% of all cases treated in this study, and thus was not considered a variable in the assessment of patient comfort.

Figures 1 through 6 present patient responses sorted by total cases and quadrant of injection site. In all

cases, adequate anesthesia was achieved to allow treatment to proceed.

Overall, the highest percentage of patients (71.4%) verbally ranked the computerized anesthetic delivery within the categories ranging from somewhat positive to superlative. Only one patient (0.5% of the total cases) expressed distinct dissatisfaction with the system, although it should be noted that a few patients noted minor dissatis-

faction or no change as compared to standard injections. Still, only 2.3% of responses could be grouped in the negative category.

For all cases, the highest percentage of responses (15.2%) was found in the group describing the injections as okay and fair. This group was followed by those who made comments classified as superlative (13.3%). The group describing the injections as much better than standard injections was next, with a 12.8% response.

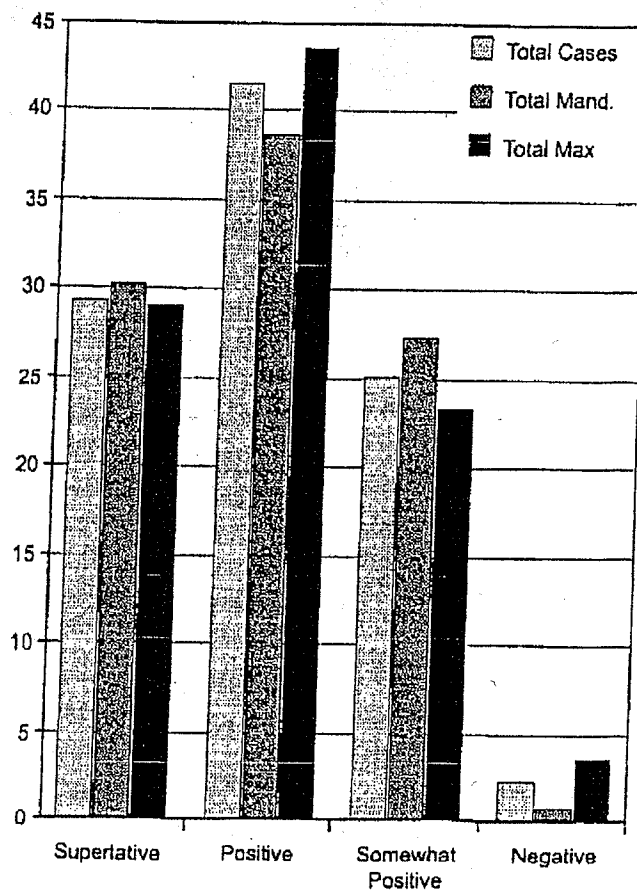


Figure 1. Comment rankings comparing total cases, total mandibular cases, and total maxillary cases.

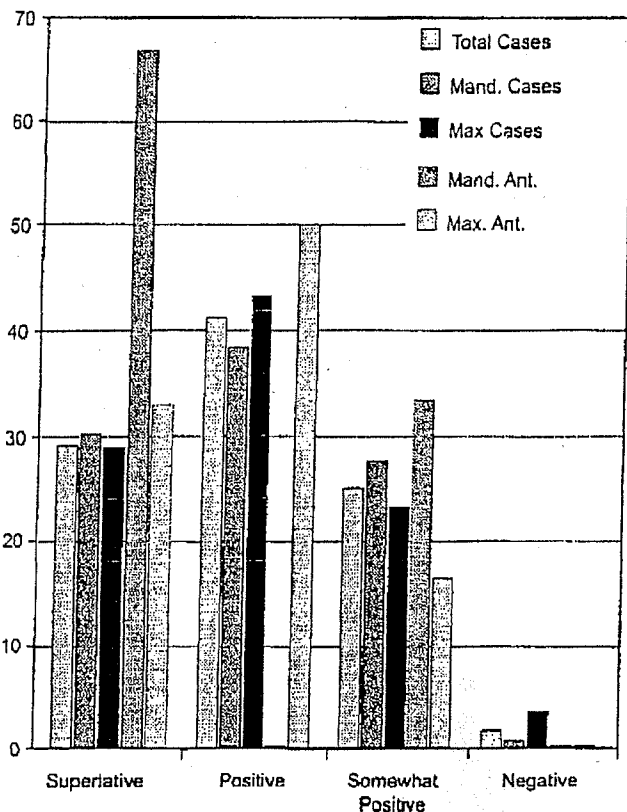


Figure 2. Comment rankings comparing total cases, total mandibular cases, total maxillary cases, total mandibular anterior cases, and total maxillary anterior cases.

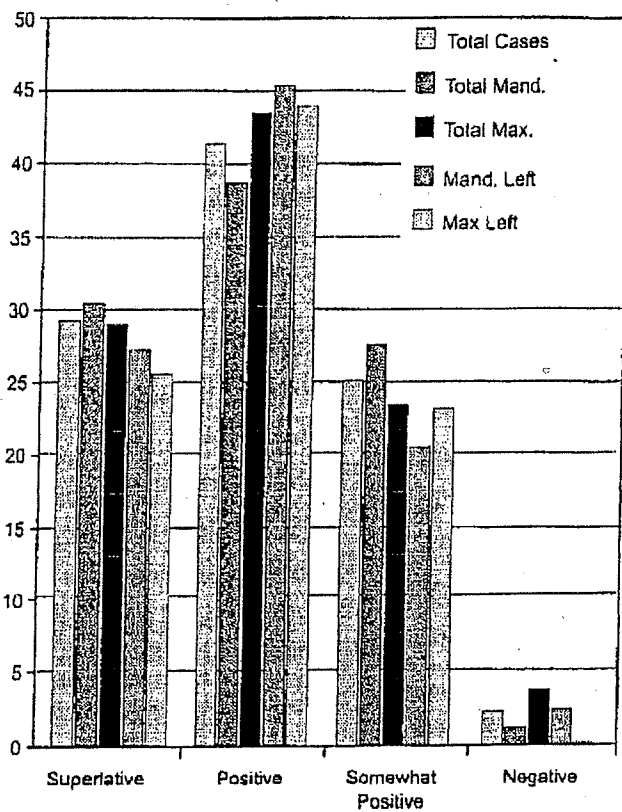


Figure 3. Comment rankings comparing total cases, total mandibular cases, total maxillary cases, total mandibular left cases, and total maxillary left cases.

The data provided minimal evidence of variation in perceptions between mandibular cases and maxillary cases, implying that treatment site is not a significant factor in patient perception of injection discomfort.

DISCUSSION

Although verbally assessed patient opinion may be maligned by some, the percentage of comments categorized in this study as negative mirrors the 2% negative response found in a blinded, controlled study

by Hochman and colleagues.³ Likewise, the overwhelming number of positive comments supports earlier findings.^{3,9}

To facilitate comparisons between comments made in different treatment categories, response categories were developed. Although it is recognized that the comment groupings present inherent risks of over- or underinterpretation, the results clearly show that patients found their experience with the microprocessor-controlled device

to be more positive than previous experiences with traditional dental injections. In the future, researchers may wish expand the response categories to include neutral and somewhat negative options, to provide more detailed classification of responses and more balanced choices. Such modifications to study design, along with the appropriate statistical analysis of results, likely would help to improve the credibility of current and future research.

During the course of this study, it was noted that the recommended and actual use of the anesthetic delivery system was somewhat slower than conventional anesthetic injection systems at the initiation of the injection procedure. This quality was actually found to be an advantage during periodontal surgical procedures. After one-fourth of the anesthetic was delivered with the controlled delivery system, injection and onset of anesthesia occurred at a more rapid rate than with conventional systems.

Although it fell outside the scope of this study, perhaps this phenomenon should be further investigated.

CONCLUSIONS

Despite its limitations, this study clearly demonstrates that computer-controlled delivery of local anesthetic, with the flow rate precisely controlled, can significantly lower patients' perceptions of pain as associated with anesthetic injections.

The clinical relevance of this technology appears clear. Additional

controlled studies using blinded, well-defined patient populations will likely support existing data and show computer-controlled anesthetic delivery to be statistically superior to traditional dental injections in terms of patient comfort. Because computer-controlled local anesthesia remains an innovation rather than the norm in dentistry, additional study in this area should be encouraged.

A periodontal practice generally treats patients following referral by

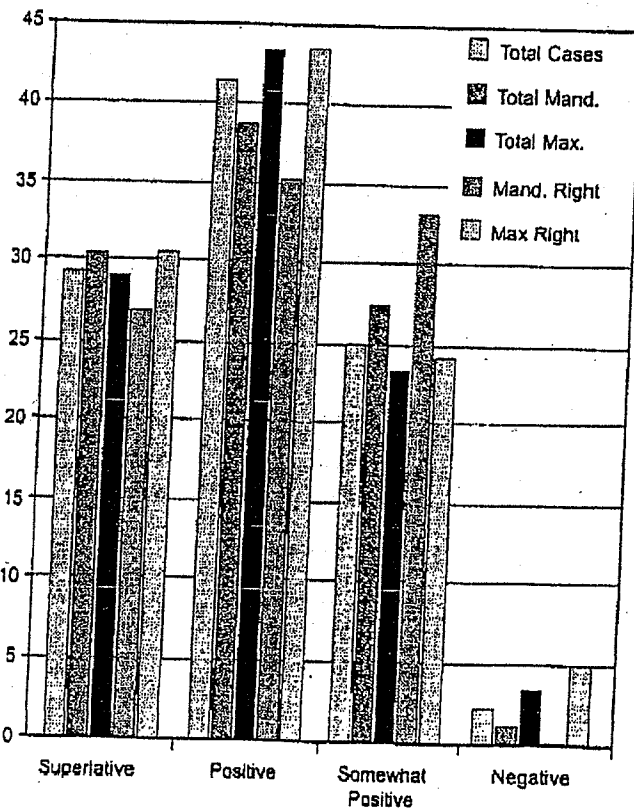


Figure 4. Comment rankings comparing total cases, total mandibular cases, total maxillary cases, total mandibular right cases, and total maxillary right cases.

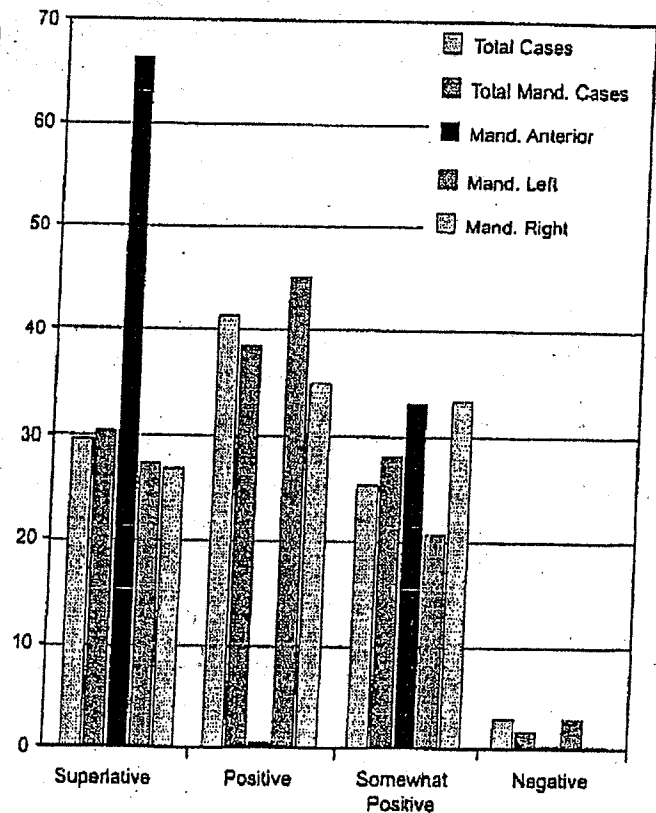


Figure 5. Comment rankings comparing total cases, total mandibular cases, total mandibular anterior cases, total mandibular left cases, and total mandibular right cases.

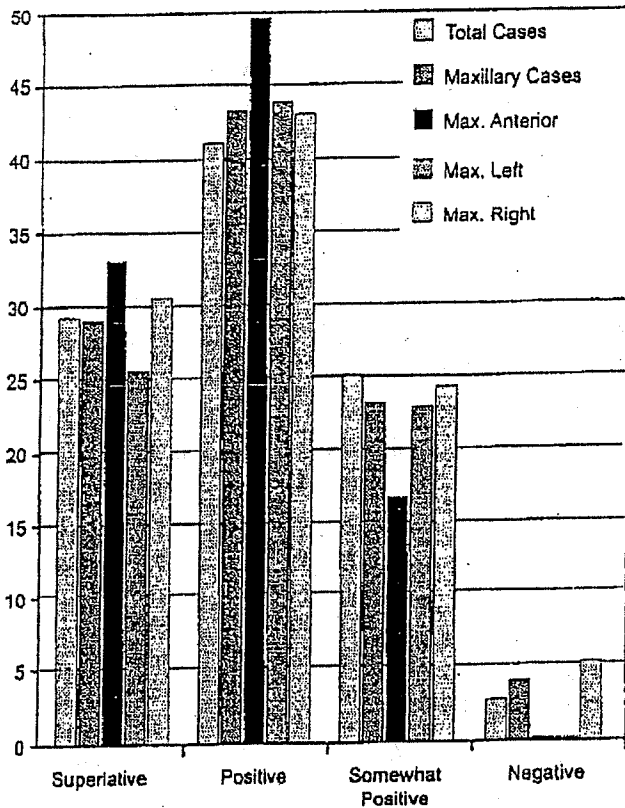


Figure 6. Comment rankings comparing total cases, total maxillary cases, total maxillary anterior cases, total maxillary left cases, and total maxillary right cases.

another dentist. Like dental anesthetic injections, periodontal procedures are not commonly perceived as "pleasant" experiences, and any means that the periodontal practice can use to make treatment more comfortable for patients should be closely evaluated for its potential practical value. The computer-controlled anesthetic delivery system has proven value as an important component of the armamentarium that enhances patient comfort in periodontal practice.

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