Objective: To construct a reliable, accurate, and easy-to-use handheld computer database that facilitates the point-of-care acquisition of perioperative text and image data specific to rhinoplasty.

Methods: A user-modified database (Pendragon Forms [v.3.2]; Pendragon Software Corporation, Libertyville, Ill) and graphic image program (Tealpaint [v.4.87]; Tealpaint Software, San Rafael, Calif) were used to capture text and image data, respectively, on a Palm OS (v.4.11) handheld operating with 8 megabytes of memory. The handheld and desktop databases were maintained secure using PDASecure (v.2.0) and GoldSecure (v.3.0) (Trust Digital LLC, Fairfax, Va). The handheld data were then uploaded to a desktop database of either FileMaker Pro 5.0 (v.1) (FileMaker Inc, Santa Clara, Calif) or Microsoft Access 2000 (Microsoft Corp, Redmond, Wash).

Design: Patient data were collected from 15 patients undergoing rhinoplasty in a private practice outpatient ambulatory setting. Data integrity was assessed after 6 months' disk and hard drive storage.

Results: The handheld database was able to facilitate data collection and accurately record, transfer, and reliably maintain perioperative rhinoplasty data. Query capability allowed rapid search using a multitude of keyword search terms specific to the operative maneuvers performed in rhinoplasty.

Conclusions: Handheld computer technology provides a method of reliably recording and storing perioperative rhinoplasty information. The handheld computer facilitates the reliable and accurate storage and query of perioperative data, assisting the retrospective review of one's own results and enhancement of surgical skills.

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Among facial plastic operations, rhinoplasty is one of the most challenging to learn, in part because of the dynamic postoperative relationships between the skin-soft tissue envelope and underlying cartilage and bone. Documenting these evolving and dramatic changes through accurate perioperative records will ultimately influence whether selected operative maneuvers are used in future procedures. Thus, learning to achieve predictable results in rhinoplasty is as much a part of understanding nasal aesthetics and nasal anatomy and its underlying deformity as is the precise recording of operative maneuvers.

Any methods that provide reliable, consistent, and meaningful perioperative documentation will likely assist the rhinoplastic surgeon in achieving this goal of superior results. Present methods to record intraoperative surgical maneuvers include dictated operative reports, line anatomical diagrams, and text-based data sheets. All too often, the operative note is dictated long after the procedure's completion, when the surgeon cannot exactly recall subtle, important operative details or can only provide a generic description of the procedure. Moreover, important adjunctive diagrammatic representation of operative events is often omitted. Therefore, any tool that promotes recording of intraoperative maneuvers will enhance the surgeon's appreciation of postoperative results and lead to a better understanding of the outcomes expected in this complex operation.

These recording methods provide an essential adjunct to standardized perioperative photodocumentation, but owing to their paper format, they do not allow for rapid information retrieval when retrospectively reviewing and critiquing results. Furthermore, if the surgeon desires to collectively analyze any one or a group of intraoperative maneuvers, not only is it inefficient to hand retrieve and collate...
data but it is more likely that patient candidates will be overlooked and excluded. A similar dilemma exists in the event of a product recall when retrieving information on patients who have undergone alloplastic implantation.

Computerized rhinoplasty operative records greatly enhance the ability to query large amounts of text and graphic data, significantly diminishing the time required to perform retrospective review of results and collect data on specific intraoperative maneuvers. It is critically important that in building this database the surgeon at the point of patient contact must electronically collect data.\textsuperscript{1,2} To this end, handheld computers (personal digital assistants [PDAs]) are particularly well suited for the task because they are portable, able to maintain complex databases, store both text and graphic image data, and can accurately, reliably, and securely transmit this data to a desktop computer database.

**METHODS**

**PATIENTS**

Fifteen patients undergoing primary rhinoplasty between July 2000 and October 2001 in an ambulatory setting had their perioperative text and operative diagrammatic data recorded on the handheld computer with subsequent transfer to the desktop database.

**HANDHELD OPERATING SYSTEM AND HARDWARE**

The Palm OS (v.4.1) was tested in this system, using either a Palm Vx (PalmOne Inc, Milpitas, Calif) or Sony Clie PEG-T615C (Sony Corporation, Tokyo, Japan) handheld computer. The Sony Clie with its higher screen resolution of 320 × 320 pixels and 16-bit color provided a more easily viewed anatomic diagram than the Palm Vx, which offers a 160 × 160 pixel backlit monochromatic display. Although these differences exist between the 2 handheld computers, the quality of the diagrammatic information captured was essentially the same.

**HANDHELD DATABASE**

**Text Format**

Database application development tool Pendragon Forms v.3.2 (Pendragon Software Corporation, Libertyville, Ill) was used to construct 66 database fields that recorded patient demographics, disease classification and procedural coding, and specific rhinoplasty operative maneuvers (Figure 1). These 66 individual fields collectively described over 100 descriptors pertaining to anesthetic type, surgical approach, incisions, type of implants and grafting, and linked fields describing International Classification of Diseases and Current Procedural Terminology coding. Unique linking between the diagnosis or procedure data fields and their numerical code allowed for automatic data entry after either was selected (Figure 2 and Figure 3). An anatomic approach was adopted in defining the text fields in an effort to avoid eponyms and confusing nonstandard terminology. Data consistency was assured by the use of “pick lists” and “pop-up menus” throughout the database (Figure 4).

**Image Format**

Four individual line-drawn anatomic views of the nasal bony and cartilaginous skeleton were scanned and then uploaded to and stored on the handheld computer as templates comprising the image portion of the database. The surgeon could draw directly onto the templates using any desired legend or convention and clearly indicate where incisions, excisions, graft placement, or sutures had been made (Figure 5).
Figure 2. Linked fields between selected diagnosis and automatic display of International Classification of Diseases (ICD) code. As the description for the diagnosis is selected from the “pick list,” the corresponding ICD code is automatically entered into the subsequent ICD field (digitally enhanced image).

Figure 3. Automatic linking between procedure description and Current Procedural Terminology (CPT) code fields (digitally enhanced image). See also Figure 2.
separate software programs were tested individually in modifying and storing these rhinoplasty operative templates. Clie Paint v.1.04 (Sony Corporation) (used with the Clie PEG-T615C) and TealPaint v.4.95 (TealPoint Software, San Rafael, Calif) (used with the Palm Vx) were evaluated as to their ease of use, ability to render accurately the operative maneuvers, and reliability to store the images on the handheld computer and then transfer the images to the desktop database.

HANDHELD AND DESKTOP DATA SECURITY

Patient data security on both the handheld and desktop computer was maintained using a 128-bit encryption protocol supplied by PDASecure and GoldSecure (Trust Digital LLC, Fairfax, Va). Each time data were entered on the handheld or desktop computer, the database was first decrypted and then data were entered and subsequently encrypted. Only when data were being entered was the handheld or desktop database unencrypted. The data were uploaded to a desktop computer and stored in either Microsoft Access (Microsoft Corp, Redmond, Wash) or FileMaker Pro 5.0 (Filemaker Inc, Santa Clara, Calif) desktop databases (Figure 6).

RESULTS

The PDA was able to capture specific text and image operative data for all patients undergoing rhinoplasty. The data reflected accurately the specifics of patient demographics and details of specific anatomic-based and diagrammatic representation of operative maneuvers. Data contained on the handheld computer were then reliably uploaded to a desktop database for further analysis.

The ability of the desktop database to provide a query-capable format was tested subsequent to handheld upload to the desktop. The individual and collective patient data were searched for a variety of descriptors pertaining to the operative maneuvers performed. For example, all patient data were searched within the fields “tip/supratip” and “LLC” (lower lateral cartilage) for the terms Dome—interdomal suture and Cephalic Excision—complete, respectively. The desktop database was able to rapidly and accurately find those patients who had undergone both procedures. The desktop database also

Figure 4. Data entry consistency was enhanced by adopting an anatomic approach incorporating “pick lists” or “pop-up menus” for each of the specific anatomic sites and operative maneuvers (digitally enhanced image).
demonstrated a similar ability to locate patients with a variety of grafting materials and other anatomic-specific procedures.

**COMMENT**

The rhinoplastic surgeon uses a series of aesthetic principles to first identify nasal disproportion and then predicts what underlying nasal anatomy likely accounts for the nasal function and cosmetic appearance. The decision to use selected surgical maneuvers to modify this anatomy is influenced by prior knowledge of the dynamic relationship between nasal anatomy and scar contracture, since it is these 2 interdependent factors that determine in part how the nose will appear and function over an extended postoperative period. Being able to consistently and accurately follow these evolving postoperative changes will also allow the surgeon to better comprehend the complex nasal structural relationships between skin, bone, and cartilage and to subsequently apply this knowledge to better control the results of future rhinoplasty. Finally, the importance of retrospective evaluation is even more appreciated by recognizing the significant role attributed to the aesthetic illusions that surgical maneuvers may produce.3

Understanding these evolving postoperative changes follows from a consistent and critical evaluation of one’s own results and is the basis for obtaining superior long-term results. Maintaining an accurate text and graphic account of intraoperative maneuvers is essential to this understanding. Available methods include standardized perioperative photodocumentation, dictated operative note, anatomic text descriptors, and graphic information about the operative maneuvers. The importance of taking standardized perioperative photographs have been clearly explained elsewhere and will not be further discussed.4,5 It is interesting to note, however, that while uniform photographic documentation standards have been suggested, no one standardized rhinoplasty operative database has been suggested by governing surgical societies or their members.

The operative note usually provides little useful information, since it is either a wordy description or a generic summary of the complex maneuvers performed. Therefore, valuable adjuncts to the dictated operative note are supplementary text descriptors and anatomic diagrams of the nasal cartilaginous and bony skeleton that the surgeon may sketch on, defining the operative maneuvers performed.

The maximum benefit from any rhinoplasty operative database comes from being able to rapidly access, selectively review, and compare differing operative maneuvers and their influence on the long-term appearance and nasal function. In contrast, a paper-based format is inadequate in this regard primarily because it impedes a comprehensive, retrospective review of which specific operative maneuvers produce corresponding changes. Moreover, a paper-based format does not facilitate broad demographic comparisons between patient groups, allow disease classification and procedural coding, and query the identity of patients who have undergone specific types of alloplastic implantation.

The idea of an operative rhinoplasty database is not new, but little recent research has been published about either paper-based or electronic formats. Kamer et al6 in

![Figure 5. Operative templates provide standardized graphic representation of the nasal cartilaginous and bony skeleton (digitally enhanced image). Templates may be drawn on by the surgeon indicating the specific operative maneuvers performed and subsequently stored as part of the patient record.](http://archfacial.jamanetwork.com/pdfaccess.ashx?url=/data/journals/faci/11759/)
1979 described a rhinoplasty record and retrieval system that used a “punch card” mechanism to record operative information. With an anatomic approach, this paper-based format system included over 35 individual descriptive fields for nasal history, physical examination, and operative maneuvers performed.

Subsequent publications have addressed the role of computer technology in facial plastic surgery, but they have focused primarily on the use of computer graphics and not database technology. Constantian et al7 and Constantian8 in 1987 described the “Expert Teaching System,” which is essentially a method to learn judgment in rhinoplasty using interactive computer graphics. This system allowed the surgeon to “preoperatively” assess nasal deformity and then select incremental degrees of surgical resection. The results of these changes could then be “followed” over a simulated 1-year period.

Larrabee9 in 1987 made brief mention of a rhinoplasty data form that was, on the basis of its numeric designations, particularly amenable to computer database use. The data form included text descriptions of patient demographics and intraoperative maneuvers. Moreover, 3 line diagrams of the nasal anatomy were also maintained separately in the patient record but were not, however, entered into the computer database.

In 1988, Gunter10 elegantly described a text and graphic paper format to record intraoperative maneuvers. This system used a rhinoplasty worksheet delineating 4 line diagram views of the nasal anatomy combined with a checklist of intraoperative maneuvers. The information could be subsequently transcribed into an electronic record for further analysis.

Tardy and Broadway11 in 1989 published their experience using a graphic operative form to record intraoperative maneuvers. They emphasized the utility of the intraoperative graphic record and standardized photographs in enhancing judgment and experience. The authors believed that their paper format was well suited to large-scale data retrieval.

A facial plastic surgery database for slides, photographs, clinical features, and rhinoplasty surgical techniques was described by Mendelsohn and Conrad12 in 1994. In this paper-based format database, the surgeon indicated text descriptors regarding facial aesthetics and operative maneuvers, which were then transcribed into a desktop computer database. Largely because of technological limitations including low processor speed, screen resolution, and memory capability, the database did not include either perioperative patient photographs or graphic representation of intraoperative maneuvers. The

Figure 6. FileMaker Pro (FileMaker Inc, Santa Clara, Calif) desktop computer database after integration with handheld data (digitally enhanced image).
Notion of a computer to organize digital photographs was further explored by Mendelsohn\(^\text{13}\) in 2001.

With the recent development and implementation of handheld computer technology, more recent investigators have addressed the use of mobile computing solutions in surgical practice. Although none have specifically addressed the application to facial plastic surgery, these investigators indicated the significant potential of handheld computing in surgical database management.

A database solution for treating multiple patients at geographically different institutions was described by Oyama et al.\(^\text{14}\) They described a mobile wireless network allowing data collection at the patient point of contact that could then be merged with a centralized database. This unique handheld system included important health information, but none of the descriptors important to pediatric surgery including diagnosis and procedural coding, text operative reports, or operative maneuver details. Similarly, Fowler et al.\(^\text{15}\) in 2002 used an Internet-linked PDA database that provided a data entry portal for recording general surgical procedures.

These studies and others indicate a progressive interest in designing, implementing, and maintaining surgical databases applicable to handheld technology that may be used for patient tracking, scientific research, and outcomes analysis.\(^\text{16}\)

**CONCLUSIONS**

As more facial plastic surgeons performing rhinoplasty understand the value of maintaining easily queried, accurate, and complete text and image records, a greater acceptance of the computer methods to do so will follow. Computer databases greatly facilitate the storage and retrieval of rhinoplasty perioperative data and facilitate the process of critically assessing one’s own results. Handheld computers promise to enhance this process by permitting text and image data capture at the point of care and then to reliably and securely transmit these data to a desktop database.