A Novel Approach to Storing Motion Analysis Laboratory Data

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Introduction: Motion analysis laboratories produce large quantities of data. It has been estimated that the average laboratory that sees 300 patients per year will accumulate approximately a half of a gigabyte of data per year [1]. These data are typically stored in many different files using many different file types and there are no widely accepted standards for storing these data. As a result, storage, retrieval, and manipulation of these data for clinical and research purposes can be very cumbersome and time consuming. A novel approach to storing these data using relational database technology is presented here.

Statement of Clinical Significance: Efficient data storage, retrieval, and manipulation can reduce the time and expense required for operating a clinical motion analysis laboratory. This increase in efficiency can also be realized for research data.

Methodology: A database structure for storing the data generated by a motion analysis laboratory was developed (Figure 1). This structure consists of a hierarchy of database tables. Each table is used to store a particular subset of the data. The tables are linked together using one-to-many relationships to create the hierarchy. The patient table stores information about the patient that does not change, or does not need to be tracked over time, for example, name, medical record number, data of birth, and address. This table is then linked to the visit table with a one-to-many relationship. This means that many visits can be associated with a single patient. As the name implies, data concerning a single visit is stored in the visit table (e.g. date of visit and physical exam data). The visit table is linked to the trial table in which information about each trial is stored (e.g. trial number and sampling frequency). The trial table is linked to the gait cycle table. Finally, the gait cycle table is linked to the kinematics, kinetics, and EMG tables. A routine was written to import data into the database from the many files generated in the lab. Routines can also be written to export data in any file format. A graphical user interface was also developed to make it simple for a user to interact with the database. Queries can be written saved to perform routine data retrievals and/or manipulations (e.g. creating patient reports or generating statistics for a research project). Lastly, custom queries can be written very quickly using Structured Query Language.

Results: The database structure described above was implemented using Microsoft SQL Server 2000. A graphical user interface was developed using Visual Basic 6.0. It is possible to implement this database structure and interface using other software packages as well. However, the Microsoft SQL Server software allows for virtually unlimited database sizes and concurrent users. Using relational database technology, the time needed to retrieve and manipulate motion analysis data can be greatly reduced. For example, if you wanted to compile a list of the last names and maximum knee flexion angles for all patients with a diagnosis of Cerebral Palsy – Diplegia, currently you would need to assemble all of the data files for all of the relevant patients. Then you would have to search through each file for the maximum knee flexion angles. This would likely consume many hours. Using relational

database technology and the structure described here this could be accomplished is seconds with the following SQL command:

```
SELECT Last Name, MAX(knee flexion angle) FROM Kinematics Table
INNER JOIN Gait Cycle Table ON Kinematics Table.Gait Cycle ID = Gait Cycle Table.Gait Cycle ID
INNER JOIN Trial Table ON Gait Cycle Table.Trial ID = Trial Table.Trial ID
INNER JOIN Visit Table ON Trial Table.Visit ID = Visit Table.Visit ID
INNER JOIN Patient Table ON Visit Table.Patient ID = Patient Table.Patient ID
WHERE Patient Table.Diagnosis = "Cerebral Palsy – Diplegia"
GROUP BY Last Name, Gait Cycle ID
```

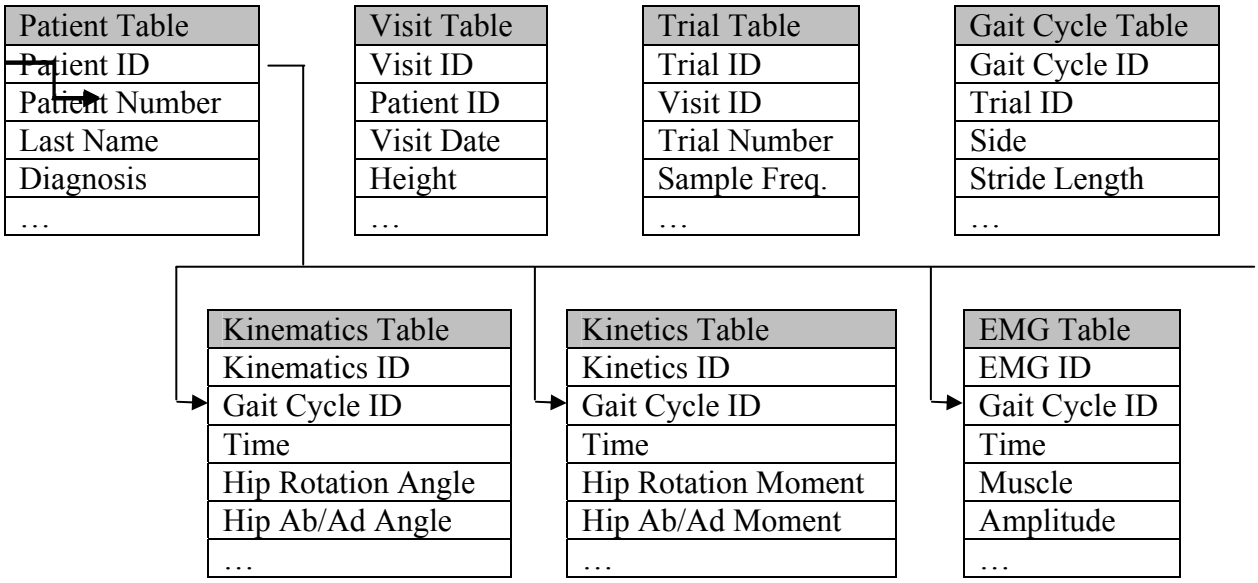

Figure 1: Database Structure

Discussion: An approach for storing motion analysis laboratory data using relational database technology has been described. This method has the potential to eliminate the need for storing and managing most of the data files generated by a motion analysis laboratory. The advantages of this approach to managing data include: very fast data access and manipulation, one database file to back up, data can be imported from and exported to any file format, and the ability to create custom user interfaces using a wide variety of software tools. Furthermore, with the cooperation of vendors that produce data collection and analysis software, data can be written directly to the database. This would eliminate the need to import data into the database.

References:

[1] Davis RB, Õunpuu S & DeLuca, PA (1997) Gait Data: Reporting, Archiving, and Sharing. In Three-Dimensional Analysis of Human Locomotion, P Allard, A Cappozzo, A Lundberg, C Vaughan (Editors), John Wiley & Sons, Ltd., Sussex, England, pp. 389-406.