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Micro vs. macrodiscectomy: Does use of the microscope reduce complication rates?

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ABSTRACT

Objective: A single level discectomy is one of the most common procedures performed by spine surgeons. While some practitioners utilize the microscope, others do not. We postulate improved visualization with an intraoperative microscope decreases complications and inferior outcomes.
Methods: A multicenter surgical registry was utilized for this retrospective cohort analysis. Patients with degenerative spinal diagnoses undergoing elective single level discectomies from 2010 to 2014 were included. Univariate analysis was performed comparing demographics, patient characteristics, operative data, and outcomes for discectomies performed with and without a microscope. Multivariable logistic regression analysis was then applied to compare outcomes of micro- and macrodiscectomies.
Results: Query of the registry yielded 23,583 patients meeting inclusion criteria. On univariate analysis the microscope was used in a greater proportion of the oldest age group as well as Hispanic white patients. Patients with any functional dependency, history of congestive heart failure, chronic corticosteroid use, or anemia (hematocrit < 35%) also had greater proportions of microdiscectomies. Thoracic region discectomies more frequently involved use of the microscope than cervical or lumbar discectomies (25.0% vs. 16.4% and 13.0%, respectively, $p < 0.001$). Median operative time (IQR) was increased in microscope cases [80 min (60, 108) vs. 74 min (54, 102), $p < 0.001$]. Of the patients that required reoperation within 30 days, 2.5% of them had undergone a microdiscectomy compared to 1.9% who had undergone a macrodiscectomy, $p = 0.044$. On multivariable analysis, microdiscectomies were more likely to have an operative time in the top quartile of discectomy operative times, ≥103 min (OR 1.256, 95% CI 1.151-1.371, $p < 0.001$). In regards to other multivariable outcome models for any complication, surgical site infection, dural tears, reoperation, and readmission, no significant association with microdiscectomy was found.
Conclusions: The use of the microscope was found to significantly increase the odds of longer operative time, but not influence rates of postoperative complications. Thus, without evidence from this study that the microscope decreases complications, the use of the microscope should be at the surgeon's discretion, validating the use of both macro and micro approaches to discectomy as acceptable standards of care.

1. Introduction

The concept of microsurgery has revolutionized surgical techniques across multiple surgical specialties. Over three decades ago neurosurgeons were adapting microsurgical techniques to many pathologies in their cranial practice, and at the 1969 American Association of Neurologic Surgeons (AANS) and the Congress of Neurologic Surgeons (CNS) meeting microneurosurgical instrument prototypes and intraoperative microscopes debuted. These tools became staples of the neurosurgical operative armamentarium in subsequent decades [1]. The benefits of magnification, illumination, and use of fine instruments all appeared advantageous in addressing the spectrum of intracranial pathology [1].

Robert Williams' series of lumbar microdiscectomies and cervical microforaminotomies were first presented and published in the late 1970s and early 1980s, leading to eventual popularization

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and wide acceptance of the techniques [2,3]. He proposed minimizing tissue manipulation reduces soft tissue trauma, prevents adhesions, reduces complications, and optimizes outcomes.

Single surgeon series, like Dr. Williams' publications, and single institution cohort studies have examined microdiscectomy compared to macrodiscectomy. An early study of a small cohort of patients suggested that microdiscectomy was associated with a shorter hospital length of stay compared to macrodiscectomy, with no difference in overall clinical results [4]. However, a subsequent study found no difference in hospital length of stay, despite smaller fascial incisions. [5] Another report comparing the techniques in a small patient cohort suggested that microdiscectomy is associated with a faster return to work and less narcotic requirements, again with no difference in outcomes or hospital length of stay [6]. However, results from a later study suggested that there was no difference in frequency of analgesic use when comparing the techniques, and that there were only small, clinically insignificant differences in postoperative pain and duration of hospitalization [7]. The inconsistent and sometimes conflicting nature of these results was highlighted in a 2012 systematic review, which concluded that limited and low quality evidence precludes any firm conclusions on the relative effectiveness of the two techniques, and that there is a need for larger, high quality studies [8]. A recent single-center study of 500 consecutive patients attempted to better characterize the differences between the two techniques, and found no significant differences in clinical outcomes but a shorter length of hospitalization with microdiscecotmy [9].

While surgeon and single institution experiences of microdiscectomies have been described, to date there have been no large studies of multi-center cohorts. The use of the operative microscope in current practice patterns vary by surgeon preference and can even differ on a case-to-case basis. The study presented here seeks to fill a void in the literature with a multi-center derived cohort of over 20,000 discectomies to compare the microsurgical and macrosurgical approaches, examining for associations with complications and postoperative outcomes.

2. Patient and methods

2.1. Database

The multi-center database of the American College of Surgeons National Surgical Quality Improvement Program (ACS-NSQIP) was utilized for this retrospective cohort analysis. With over 500 participating centers in 2014, the program has grown tremendously in both institution participation and annual case volume since its inception in 2005, when it was adapted from collaboration of the ACS with the Veterans Affairs surgical quality program. Matching its growth in participation and case volume, high reliability of the data is established with audits as a routine component of database maintenance. With over 250 variables, the ACS-NSQIP data provides an ideal milieu to critically evaluate surgical outcomes and contributing factors across national practice patterns [10]. Further details regarding the ACS-NSQIP can be found at https://www.facs.org/quality-programs/acs-nsqip.

2.2. Inclusion and exclusion criteria

Current Procedural Terminology (CPT) codes for single level discectomies were utilized to define the initial cohort, querying cases from 2010 to 2014 (Table 1). Our analysis included stand-alone posterior cervical, thoracic and lumbar discectomies. Anterior cervical discectomies were not included as these are very commonly accompanied by interbody fusion. The accompanying *International Classification of Diseases, Ninth Edition* (ICD-9) primary diagnosis codes were reviewed and only those cases with diagnoses related to extruded disc pathology were included (i.e. pain, radiculopathy, root impingement, canal stenosis). More complex surgical cases that included a discectomy were excluded, as were those single level discectomies that were concurrent with other non-spine related procedures. Infectious, traumatic, or neoplastic pathologies were also excluded, as were cases with prior operations within 30 days or a non-spine primary surgeon (not an orthopedic surgeon or neurosurgeon). A flow chart of exclusions can be seen in Fig. 1 [11].

Table 1
Current Procedural Terminology Codes for Inclusion.

CPT	Description
63020	Laminotomy (hemilaminectomy), with decompression of nerve root(s), including partial facetectomy, foraminotomy and/or excision of herniated intervertebral disc; 1 interspace, cervical.
63040	Laminotomy (hemilaminectomy), with decompression of nerve root(s), including partial facetectomy, foraminotomy and/or excision of herniated intervertebral disc, reexploration, single interspace; cervical.
63055	Transpedicular approach with decompression of spinal cord, equina and/or nerve root(s) (eg, herniated intervertebral disc), single segment; thoracic.
63064	Costovertebral approach with decompression of spinal cord or nerve root(s) (eg, herniated intervertebral disc), thoracic; single segment.
63030	Laminotomy (hemilaminectomy), with decompression of nerve root(s), including partial facetectoforaminotomy and/or excision of herniated intervertebral disc; 1 interspace, lumbar.
63042	Laminotomy (hemilaminectomy), with decompression of nerve root(s), including partial facetectomy, foraminotomy and/or excision of herniated intervertebral disc, reexploration, single interspace; lumbar.
63056	Transpedicular approach with decompression of spinal cord, equina and/or nerve root(s) (eg, herniated intervertebral disc), single segment; lumbar (including transfacet, or lateral extraforaminal approach) (eg, far lateral herniated intervertebral disc).

2.3. Covariates

The CPT code for intraoperative use of the microscope, 69990, was used to divide the cohort into macro and microdiscectomies (denoting the use of the microscope for the procedure). The gathered variables available in the ACS-NSQIP Participant Use Data File include patient demographics, comorbidities, operative data, and 30-day outcomes. Patient age, sex, gender, race, body mass index (BMI), functional status, and smoking status are among the demographic variables available. Patient health status markers including previous diagnoses of chronic obstructive lung disease (COPD), congestive heart failure (CHF), diabetes, hypertension, corticosteroid use for a chronic condition and American Society of Anesthesiologists (ASA) physical status classification scores were also included [12,13]. Hematocrit, platelet count, white blood cell count, albumin, International Normalized Ratio (INR), blood urea nitrogen (BUN), and creatinine from preoperative lab draws were also available for analysis. [12,13] Specifically, the clinical definition of anemia, with a hematocrit <35% was used for this study. Operative time was analyzed in continuous fashion, with median times derived for both sub-groups, with and without microscope use. Quartiles were also used in delineating the 75th percentile operative time of greater than or equal to 103 min. The discectomy was also defined in regards to region via CPT code (cervical, thoracic, or lumbar) and re-explorations could also be defined for cervical and lumbar discectomies via CPT code. Surgeon specialty, neurosurgery or orthopedic surgery, and year of surgery were also identified.