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To evaluate practice patterns and hospital charges for anesthesia in arthroscopic ACL reconstruction

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Study Type: Cross-sectional study.

Methods: The PearlDiver Patient Records Database, a national database of insurance billing records, was searched using the current procedural terminology (CPT) codes for arthroscopic ACL reconstruction in combination with different types of anesthesia. The search included the years between 2004 and 2009. Age, sex, number of procedures performed, geographic region, and hospital charges for each type of anesthesia were recorded and compared. Anesthetic types were categorized as general anesthesia (GA) only, GA with concomitant single femoral injection, GA with concomitant other regional anesthesia (RA), single femoral injection only, or other RA only.

Results: Between 2004 and 2014, a total of 53,968 arthroscopic reconstructive procedures were identified. The mean per patient hospital charge for GA alone, GA in combination with single femoral injection, GA in combination with other RA, single femoral injection alone, and RA alone was $1065 (63% of cases), $1614 (29%), $1849 (4%), $630 (3%), and $612 (1%), respectively. The use of GA in combination with RA or single femoral nerve injection significantly increased during this time period (P ¼ .004 and P < .001, respectively).

Conclusion: The mean per patient hospital charges for arthroscopic ACL reconstruction varied with the mode of anesthesia utilized, where regional anesthetic techniques alone were least expensive. RA alone was utilized infrequently, and there was a significant increase in the rate of utilization of GA in combination with any form of RA.

Clinical Relevance: This study provides information on current trends and hospital charges for anesthesia in arthroscopic ACL reconstruction.

Keywords: anesthesia; demographics; ACL; cost analysis

Anterior cruciate ligament (ACL) reconstruction is commonly performed as an outpatient surgery. Advances in anesthesia/analgesia and arthroscopic techniques have facilitated the transition from an inpatient open surgical approach to an outpatient arthroscopic procedure. This has resulted in reduced hospital costs.[9] Importantly, providing adequate, reliable, and safe analgesia postoperatively is required for ACL reconstruction in the ambulatory setting. Inadequate pain control or excessive use of narcotic medications may cause unnecessary morbidity, alter the efficacy of the procedure, reduce patient satisfaction, increase readmission rates, and increase hospital costs. Regional anesthesia (RA) has been used in an effort to reduce intraoperative nar-cotic requirements, improve postoperative pain control, reduce hospital readmission rates, and reduce postoperative narcotic medication use.[5,9-11]

Several intra- and postoperative analgesic modalities can be used and have been evaluated in arthroscopic ACL reconstruction.[2,5-10,13,15,16,19,20] These include intra-articular and incision-site injection of local anesthetic, general anesthesia (GA), RA, as well as nonnarcotic and narcotic analgesic medications. Dichotomous results have created controversy with regard to the efficacy of RA in

reducing postoperative pain and narcotic require-ments.[5,8-11,13,15,16,18,20] As a result, variability in regional anesthetic use is common. The purpose of this study was to evaluate the hospital charges and demographic trends in the utilization of general and regional anesthesia for arthroscopic ACL reconstruction.

MATERIALS AND METHODS

The current procedural terminology (CPT) codes for patients undergoing arthroscopic ACL reconstruction were searched using the PearlDiver Patient Record Database (PearlDiver Technologies, Inc, Fort Wayne, Indiana, USA). This database is a publicly available national insurance database with the largest contribution from United Health Group. Between 2004 and 2009, more than 216 million orthopaedic patient records were recorded in the database from more than 11 million patients with orthopaedic Inter-national Classification of Disease, Ninth Revision (ICD-9) or CPT codes.[4] The type of procedure, year performed, sex of the patient, region of the country (West, Midwest, North-east, and South), and per patient hospital charge can be searched using this database.

CPT codes were used to develop a population of patients that underwent arthroscopic ACL reconstruction (CPT 29888) using various modes of general and regional anesthesia. The procedures listed in Table 1 were excluded because they would result in more complex operative procedures than that typically performed during routine arthroscopic ACL reconstruction. Procedures included from the search criteria were those that would typically be performed during an arthroscopic ACL reconstructive pro-cedure and would not require more invasive or extensive surgical treatments. These included loose body removal (29874), chondroplasty (29877), abrasion chondroplasty (29879), medial and/or lateral meniscectomy/meniscal repair (29880, 29881, 29882, 29883), or synovectomy (29875, 29876). In this manner, a population of patients was identified that underwent arthroscopic ACL reconstruction with or without treatments for minor, common concomitant intra-articular injuries.

The type of anesthesia utilized in arthroscopic ACL reconstruction was then examined empirically. The follow-ing CPT codes were searched alone and in combination with the aforementioned surgical procedures to obtain a list of all possible modes of anesthesia utilized: general anesthe-sia (01400, 01340, 01382, 01392, 01380, 01360), injection into a peripheral nerve (64450), single femoral nerve injec-tion (64447), continuous femoral nerve infusion (64448), continuous lumbar plexus infusion (64449), single sciatic nerve injection (64445), and continuous sciatic nerve infusion (64446). Injection into the obturator nerve is frequently coded as 64450, or injection into a peripheral nerve. Of note, local anesthetic is included in the CPT code for the arthroscopic ACL reconstructive procedure. For this reason, use of local anesthesia for intra-articular or inci-sional injections was not evaluated. Furthermore, epidural anesthesia does not have an individual CPT code when used as one of the primary modes of operative anesthesia.

TABLE 1
List of Procedures and Corresponding CPT Codes Excluded From the Search Criteria[a]

Open or extra-articular reconstructive procedures (27331-27333, 27403, 27427- 27429)
Primary ligamentous repair of collateral or cruciate ligaments (27405, 27407, 27409, 29889)
Autologous chondrocyte implantation (27412)
Open or arthroscopic osteochondral allograft transplantation (27415, 29867)
Arthroscopic or open osteochondral autograft transplantation (29866, 27416)
Femoral or tibial osteotomy (27448, 27450, 27455, 27457, 27705, 27707, 27709)
Arthroscopy for infection (29871)
Arthroscopic drilling for an osteochondral defect (29885-29887)

[a]These procedures would involve more complex surgical inter-ventions than the typical arthroscopic ACL reconstruction and were, thus, excluded from the analysis. ACL, anterior cruciate ligament.

Thus, if epidural anesthesia was used for operative anesthesia, the CPT code for GA was used. However, if used for operative analgesia, epidural anesthesia is billed using the CPT codes for GA. Thus, epidural anesthesia used either alone or in combination with another form of RA will be contained within the group of patients referred to in this article as GA.

Patient populations were then grouped based on the type of anesthesia used. RA includes all anesthesia CPT codes excluding GA. Because a minority of patients received a form of RA other than a single femoral nerve injection, RA was further subdivided into patients who received a sin-gle femoral nerve injection and those who received another RA code (continuous femoral nerve infusion, sciatic nerve injection or infusion, injection into a peripheral nerve, con-tinuous lumbar plexus infusion).

Chi-square analysis was used to determine statistical significance with regard to sex, age, and region. Linear regression was performed to test significance of trends over time. The level of significance was $P < .05$. Variations in the total number of orthopaedic patients in the database for a given time, sex, age, or region were accounted for when performing statistical analysis.

RESULTS

A total of 53,968 arthroscopic ACL reconstructive proce-dures (40% in women, 60% in men) were identified between 2004 and 2009. The different forms of RA used in this pop-ulation included GA in combination with: single femoral nerve injection, other peripheral nerve injection, continu-ous sciatic nerve infusion, single sciatic nerve injection, or continuous lumbar infusion. RA use alone included: single femoral nerve injection, single sciatic nerve injection, per-ipheral nerve injection, and continuous femoral nerve infusion.

GA alone was the most commonly used anesthetic (63%), while GA in combination with a single femoral nerve

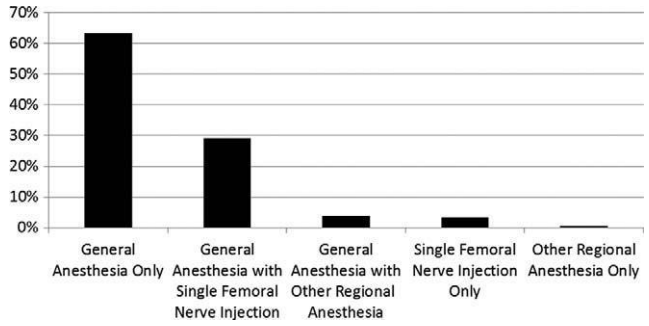

Figure 1. The type of anesthesia used in arthroscopic anterior cruciate ligament reconstruction as a percentage of all cases. Single femoral nerve injection represents a 1-time injection of anesthetic into the femoral nerve. Other regional anesthesia represents any other form of regional anesthesia.

injection was the second most common (29%). All other forms of anesthesia were infrequently utilized (Figure 1). Sex and age did not affect choice of anesthetic (P > .05).

Figure 2 displays regional variation in arthroscopic ACL reconstruction by anesthetic technique. Variability in the number of patients in each region was controlled for by using the operation rate (number of operations in that region/ number insured in that region) to standardize data across regions. Values greater than expected have a positive opera-tive rate and represent a higher than expected use of that form of anesthetic relative to the national operation rate. The West utilized RA alone, while the South used RA alone or in combination with GA more frequently than expected.

Between 2004 and 2009, there was a significant increase in the rate of arthroscopic ACL reconstruction (P ¼ .005). There was also a significant increase in the use of GA in com-bination with RA or in combination with a single femoral nerve injection (P ¼ .004 and P < .001, respectively).

The mean per patient hospital charge for the anesthetic types were $1065, $1614, $1849, $630, and $612 for GA alone, GA in combination with single femoral injection, GA in combination with other RA, single femoral injection alone, and RA alone, respectively (Figure 3).

DISCUSSION

Perioperative analgesia should aim at providing adequate pain relief but minimize side effects without adding unne-cessary additional costs. Use of RA in combination with GA introduces additional costs and potential complications but may provide superior analgesia than GA alone. In a health care environment where cost-benefit analysis is increasingly scrutinized, evaluating different modes of analgesia in common orthopaedic procedures is important.

In this study, several findings of clinical relevance were demonstrated. First, the addition of RA will increase hospi-tal charges to the patient by between $549 and $784 more than GA alone. Second, the frequency of arthroscopic ACL reconstruction is increasing, as is the frequency of use of GA in combination with RA. Third, there is regional varia-tion in the mode of anesthesia utilized.

In young, healthy patient populations, such as the prototy-pical patient undergoing ACL reconstruction, complications associated with GA are uncommon. Nausea and vomiting, however, is common.[12] RA has fewer systemic effects than GA. There is concern, however, that RA may provide less effective and reliable pain control.[8,13,15,16,18,20] Rarely, inad-vertent damage to vessels and nerves or injection of the anes-thetic intravascularly can result in severe morbidity or mortality.[5] Systemic toxicity can affect the cardiovascular and central nervous systems as described by Edkin et al.[5] Inadvertent neural injury can result in prolonged pain, dys-esthesias, paresthesias, weakness, and neurapraxia. These side effects are generally transient, with most resolving over a period of several months to years.[3]

The efficacy of RA in ameliorating postoperative pain in arthroscopic ACL reconstruction is controversial. Several studies fail to support RA as beneficial.[8,13,15,16,18,20] Brull et al[3] reviewed the reported complications following femoral nerve block (FNB). All reviewed studies were unblinded and relied on voluntary reporting of complications by the physi-cians who placed the FNB, either at follow-up or by anon-ymous phone calls. Given that RA has been associated with a higher litigation rate, accurate reporting is unlikely.[3] Nonetheless, neural injuries associated with FNB were reported to range from 0.03% to 2% of cases.[3]

Several studies have surveyed orthopaedic surgeons' anes-theticpreferences. Oldmanetal[17] foundthatorthopaedic sur-geons utilized RA as a means to reduce postoperative pain, decrease nausea and vomiting, and decrease morbidity and mortality. Surgeons who chose not to use RA cited delays in operative start times as well as unpredictable success rates as reasons to avoid its use.[1,17] Masursky et al[14] similarly found thatRA was most commonly avoided because ofineffec-tive blockade and delays in operative start times.

Studies evaluating the efficacy of FNB in arthroscopic ACL reconstruction have displayed contradictory results.[8,13,15,16,18,20] Outcome measures, including patient satisfaction, postoperative pain, use of pain medication post-operatively, and days until discharge, are typically used. In a systematic review of the literature, Mall and Wright[13] evalu-ated the efficacy of FNB in ACL reconstruction based on level I and II evidence from randomized controlled trials. Based on the available evidence, they concluded that FNB does not pro-vide additional benefit in terms of pain, narcotic medication use, discharge time, or outcome scores compared with multi-modal pain regimens. Furthermore, given the uncommon, dramatic consequences of FNB, they suggested the risks out-weigh the potential benefits.

Frost et al,[8] in a randomized, placebo-controlled, double-blind trial, found no difference in the amount of analgesic medication required or clinically meaningful difference in pain scores postoperatively. They recommended against FNB use in outpatient ACL reconstruction. Tierney et al[20] used a similar experimental design and found no difference in the amount of narcotic medication required postoperatively. Peng et al[18] evaluated FNB with intravenous ketorlac and placebo in a level I study and found there was no differ-ence between the 3 groups when the authors assessed postoperative nausea and itching, time to sit up, time to reach postanesthesia discharge score of 9, time to

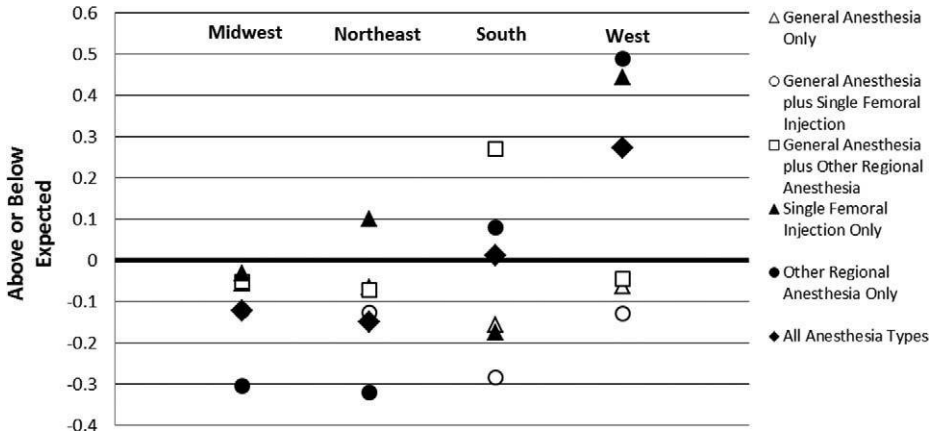

Figure 2. Regional variation in arthroscopic anterior cruciate ligament (ACL) reconstruction by anesthetic technique normalized to the patient population in each region. Values greater than expected have a positive operative rate and represent a larger number of arthroscopic ACL reconstructions than would be expected per patient population in each region.

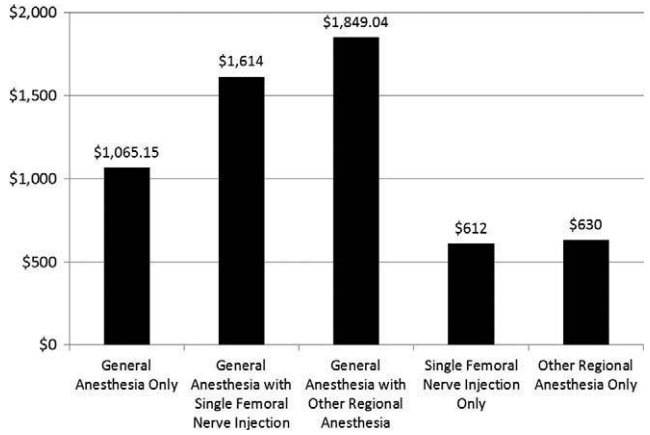

Figure 3. Cost of anesthesia by anesthetic technique. Single femoral nerve injection represents a 1-time injection of anes-thetic into the femoral nerve. Other regional anesthesia repre-sents any other form of regional anesthesia.

ambulate, time to eat, and time to void. O'Leary et al[16] similarly found no difference in postoperative analgesic requirements in patients who received an FNB and intra-articular and incisional injections versus the injec-tions alone. Matava et al,[15] using a prospective, rando-mized, double-blinded, placebo-controlled study design, found no difference in the amount of pain medication, readiness for discharge, patient satisfaction score, hospi-tal cost, or rate of admission between those that received an FNB versus a saline injection.

Other authors have supported RA as efficacious in reduc-ing postoperative pain. Edkin et al[5] found that 92% of 24 patients did not require inpatient parenteral narcotics when given a postoperative FNB. Greenberg[9] found that the use of RA alone, when compared with GA, resulted in shorter recov-ery times, fewer unanticipated hospital admissions, and less nausea and vomiting. Harrisetal[10] foundthatcompared with a control group (application of dressing to groin), the FNB group required less morphine in the 24-hour postoperative period and had lower verbal related scores at 24 hours. Iskandar et al[11] found lower visual analog pain scores in the postanesthesia care unit and with rehabilitation in an FNB group compared with a group that received an intra-articular anesthetic injection. The FNB group also used less morphine and had reduced nausea and vomiting.

This study was not without its weaknesses: (1) using only 1 insurance company could create a potential selection bias;
(2) the study only assessed the cost of anesthesia, not over-all costs of treatment, that is, narcotic use, differences in physical therapy requirements, and length of time taken to give blocks and recovery; and (3) the types of local anes-thetics were not well documented. The major strength of this study was the fact that more than 56,000 arthroscopic ACL reconstructions were included in the nationwide anal-ysis. Conclusions, therefore, can be accurately assumed to represent national or large regional findings. Also, this study addresses the hospital charges of various anesthetic techniques in arthroscopic ACL reconstruction as well as the practice patterns in utilization.

CONCLUSION

There was variability in the use and cost of different anesthetics for operative pain relief in arthroscopic ACL reconstruction. FNB is frequently used in arthroscopic ACL reconstruction. Controversy remains regarding the efficacy and safety of RA use in arthroscopic ACL reconstruction. Serious side effects have been associated with FNB and are likely under reported. RA in combination with GA costs more, and the incidence of use has been increasing.

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