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Retrospective evaluation of functional results and cost analysis of two different anesthesia methods in carpal tunnel syndrome surgery

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ABSTRACT

Objectives: The provision of health services at a satisfactory level and low cost is the main objective of all health systems. For this purpose, we evaluated carpal tunnel surgery performed under local anesthesia in the local procedure room and under a laryngeal mask in the operating room in terms of cost analysis. In this way, we aimed to reveal the controllability of health service expenditures and inadequacies in costing.

Methods: A total of 119 patients who underwent local anesthesia (LA) in the local procedure room (Group I) and 45 patients who underwent laryngeal mask anesthesia (LMA) in the operating room (Group II) were retrospectively evaluated. In the calculation of cost analysis, since there were no hospitalization procedures in Group I cases, total costs were calculated only in minutes, multiplied by a coefficient of 7. In Group II cases, total costs were calculated by multiplying total procedure times in minutes by a coefficient of 12 and adding 50 units of hospitalization cost.

Results: Postoperative Quick Disabilities of the Arm, Shoulder, and Hand score is statistically similar in both groups (P=0.714). The operation duration has an average value of 15.39±2.37 in the group of patients who received local anesthesia and 29.71±4.78 in the group treated in the operating room (P<0.001). It has been found that the intervention performed in the operating room is 2.2 times more costly than the local intervention.

Conclusion: Our study is extremely valuable in terms of demonstrating that health service expenditures can be controlled in appropriately selected patients.

Keywords: Cost analyses, carpal tunnel syndrome, anesthesia, local

The main objective of all health systems is to ensure that health services, which are an indispensable part of human life, are satisfactory and cost-effective. However, especially developed countries allocate a significant portion of their gross national product to health expenditures and these expenditures increase year by year [1]. Therefore, calculating hospital and patient costs in health services and revealing the structure of these costs plays an important role in controlling the costs of health care services [2, 3]. At the same time, today's rapid technological advances have manifested themselves in the production of health services, as in all other areas, and as a result, have further increased the costs of hospitals. However, there are insufficient studies and data on the cost of health services. The variety of surgical methods

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and the complexity of calculations are important obstacles in costing [3].

Carpal tunnel syndrome (CTS) is common among the working population, is often attributed to work, and leads to significant health expenditures and major disability costs [4]. Surgical treatment of CTS is one of the most common operations performed on the hand and patients benefit greatly from this surgery. The objective of surgery is to relieve pressure on the median nerve by releasing tension in the transverse carpal ligament. Although there are open, mini-open, and endoscopic surgical methods for this purpose; there is no significant difference in the results of these surgical methods [5]. However, nowadays mini-open carpal tunnel release is a preferable method today due to its positive aspects such as being applicable in a short time in the local operating room under local anesthesia (LA) or in the operation room under anesthesia with a laryngeal mask anesthesia (LMA) [5-7].

At this point, we evaluated carpal tunnel surgery, which we frequently perform under local anesthesia in the local procedure room and the operating room under anesthesia with a laryngeal mask, to make cost analysis and to be used in planning and control processes. Our objective was to demonstrate both the ability to manage health service expenses and the deficiencies in cost estimation.

METHODS

This study was conducted in accordance with the principles outlined in the Declaration of Helsinki and received approval from the Clinical Research Ethics Committee of Bursa Uludağ University Faculty of Medicine on June 16, 2021, under the reference number 2011-KAEK-26/384.

In this retrospective study, we focused on patients who underwent surgery for CTS between June 2018 and January 2023 at the Orthopedics and Traumatology clinic of our hospital. Patients were selected based on a confirmed diagnosis of CTS through electromyography (EMG) following a clinical examination and a lack of response to conservative treatment. Patients who received anesthesia other than LA or LMA, who had bilateral or additional hand surgery in the same session, who had CTS after fracture, who had peripheral neuropathy, who had revision surgery, who had different surgery techniques other than mini-open and who did not have a QDASH score were excluded from the study. A total of 164 cases were included in our study, with 119 patients undergoing surgery under local anesthesia (LA) in the local procedure room and 45 patients receiving surgery under laryngeal mask anesthesia (LMA) in the operating room. Patients were initially categorized into two groups based on the anesthesia method employed (LA or LMA).

From the patient registration system, we collected data on age, gender, surgery date, type of anesthesia, postoperative complications, total length of hospital stay, total follow-up times, and total surgical costs for all cases. Preoperative Quick Disabilities of the Arm, Shoulder, and Hand (QDASH) scores of all patients included in the study were retrospectively examined and recorded.

Fig. 1. Local anesthesia application on carpal tunnel.

Surgical Procedures

Patients in Group I (LA) had their surgical site cleaned with povidone-iodine while wearing an arm cuff. The surgical area was then draped with a sterile covering. Subsequently, 5 cc of Prilocaine (2%) was injected into the incision site, and another 5 cc was injected into the carpal tunnel (Fig. 1). Sedation was not administered to any patient. The surgical procedure commenced within a minute of local anesthesia, following tourniquet application at 250 mmHg pressure with the extremity elevated immediately before incision.

Patients in Group II (LMA) were positioned supine on the operating table, and LMA was administered by an anesthesiologist while monitoring the patient. Tourniquet application at 250 mmHg pressure, with elevation of the surgical site, was followed by cleaning the surgical area with povidone-iodine and draping it with a sterile cover before the surgery began.

Fig. 2. Standard mini-incision applied to patients.

After these preparatory phases, the same surgical team performed the surgery in both groups. A roughly 2 cm incision was made distally to the flexor line of the volar aspect of the wrist (Fig. 2). Blunt dissection was carried out up to the flexor retinaculum, and sharp dissection opened the flexor retinaculum. The median nerve was protected upon its exposure, and the flexor retinaculum was released proximally and distally. Hemostasis was maintained, and the skin incision was primarily sutured, followed by a sterile dressing application.

Wrist and finger movements were permitted in the early postoperative period. Patients in both groups underwent outpatient follow-ups at the 2-week postoperative mark, with suture removal occurring between days 10 and 15. Preoperative and 3-month postoperative evaluations were conducted for both patient groups using QDASH functional scores to assess surgical success and determine study eligibility. There was one patient in each group who needed surgery again. One patient in the LA group underwent surgery due to a superficial wound infection. The other patient in the LMA group needed surgery due to the persistence of complaints because of insufficient and no additional complications were observed in either patient.

Cost Analysis

To perform a cost analysis, we initially calculated minute costs for both the local (LA) and operating rooms (LMA). This involves determining room usage costs per minute, staff numbers, and unit costs for drugs and consumables used [8]. We aimed to create currency-independent coefficients by calculating room usage costs per minute and determining staff numbers and unit costs for drugs and consumables. In the time calculation, the patients' room entry and exit times were recorded. The standard costs of the rooms (local (LA) and operating room (LMA)); set usage and consumables were considered the same. The drugs used for both anesthesia methods were administered standardly to the patients in each group. Standard 2 personnel were used for local anesthesia and standard 4 personnel were used for general anesthesia. In the cost calculation, we determined coefficients of 7 units per minute for LA cases and 12 units per minute for LMA cases. While determining the coefficients; Minute

costs were calculated based on the monthly expenses of the rooms and staff. In the calculation, staff salaries and monthly usage costs of both rooms were considered equal. The cost per minute of two rooms was found to be 7/12 in proportion. Additionally, in the LMA group; the 4-hour hospital stay was calculated by standardizing the drugs used during hospitalization and for anesthesia. According to this calculation, an additional cost of 50 units was found in the LMA group, proportional to the cost of 7 units. As a result, in LA cases, total costs were calculated by multiplying the total procedure time by a coefficient of 7, and in LMA cases total costs were calculated by multiplying the total procedure time in minutes by a coefficient of 12 and adding 50 units to account for hospitalization costs.

Statistical Analysis

The data analysis was conducted using IBM SPSS Statistics Standard Concurrent User Version 26 (IBM Corp., Armonk, New York, USA). Descriptive statistics were reported, including counts (n), percentages (%), means±standard deviations, and median (minimum and maximum) values. The normality of numerical data distribution was assessed using the Shapiro-Wilk test. The Mann-Whitney U test was employed to compare single-measure numerical variables between the local anesthesia and operating room groups. Categorical variables were compared using the Pearson Chi-square test. A significance level of $P<0.05$ was deemed statistically significant.

RESULTS

The age of patients in the local anesthesia group was significantly lower than that of patients in the surgical group. (P=0.003). Gender distribution was similar in both groups (p=0.866). QDASH scores were statistically similar between the LA and LMA groups for both preoperative, postoperative, and delta values groups (P=0.801).

Preoperative QDASH scores averaged 63.34±6.30 in the LA group and 63.11±7.05 in the LMA group, showing no statistically significant difference (P=0.974). Postoperative QDASH scores were 4.46±5.68 in the LA group and 4.07±2.11 in the LMA group, also with no statistically significant difference (P=0.714). The QDASH score delta (preoperative-postoperative) was 58.87±7.36 in the LA group and was 59.03±7.03 in the LMA group, with no statistically significant difference (P=0.801).

The operation duration was significantly shorter in the LA group, with an average of 15.39±2.37 minutes, compared to 29.71±4.78 minutes in the LMA group ($P<0.001$). It was determined that all of the 4-hour additional hospital stays were in the LMA group.

The unit cost was lower in the LA group, averaging 7±0.09, in contrast to 12±0.001 in the LMA group ($P<0.001$).

Furthermore, the total cost was significantly lower in the LA group, averaging 107.76±16.61, as opposed to 345.11±75.98 in the LMA group ($P<0.001$) (Table 1).

This indicates that interventions performed in the LMA are 2.2 times more costly than those conducted with LA. Superficial infection was encountered in one patient in the LA group and inadequate decompression complications were encountered in one patient in the LMA group. Both patients recovered with repeated surgeries.

DISCUSSION

The existing literature does not provide a consensus on the ideal anesthesia method or surgical approach for the treatment of carpal tunnel syndrome. The choice of anesthesia and surgical approach can often depend on patient-specific factors and surgeon preferences. However, the primary objective remains consistent: achieving the most successful clinical outcome with minimal complications. At this juncture, surgeons select the surgical intervention that aligns most effectively with the patient's needs.

The surgical technique and anesthesia method used in carpal tunnel release (CTR) vary depending on surgeon preference and patient factors [7]. The age difference between the two groups in our study can be explained by the patients' own anesthesia preferences. No criterion was chosen in terms of age, and no study showing a relationship between anesthesia preference and age was found in the literature. A prospective study showed that age, gender or occupation did not affect the outcome of carpal tunnel decompression in

Table 1. Comparison of other variables by anesthesia groups

	Local anesthesia	Larengeal mask anesthesia	Test value	P value
Age (years)	54.56±12.99 56 (26-88)	48.37±10.39 47 (32-76)	*z*=3.003	**0.003**
Gender, n (%)				
Male	94 (72.9)	35(27.1.)	χ^2=0.029	0.866
Female	25(71.4)	10(28.6)		
QDASH preoperative	63.34±6.30 63.60 (48.7-80)	63.11±7.05 63.5 (44.6-72.7)	*z*=0.033	0.974
QDASH postoperative 3. months	4.46±5.68 4.5 (0-54)	4.07±2.11 4.5 (0-9)	*z*=0.367	0.714
QDASH delta	58.87±7.36 60 (14.7-73.2)	59.03±7.03 60.2 (42.3-68.2)	*z*=0.252	0.801
Operation time (min)	15.39±2.37 15 (10-25)	29.71±4.78 30 (14-40)	*z*=9.366	**<0.001**
Unit cost	7.00±0.001 7 (7-7)	12.0±0.001 12 (12-12)	*z*=12.666	**<0.001**
Total cost	107.76±16.61 105 (70-175)	345.11±75.98 360 (168-480)	*z*=9.479	**<0.001**
Hospital total cost	107.76±16.61 105 (70-175)	391.33±87.18 410 (218-530)	*z*=9.475	**<0.001**

Data are shown as mean±standard deviation or median (minimum-maximum) or n (%). QDASH=Quick Disabilities of the Arm, Shoulder, and Hand, %=Row Percent, z=Mann-Whitney *U* test, χ^2=Chi-Square test statistics.

a series of 608 carpal tunnel decompressions, as assessed by the Boston carpal tunnel score [9].

Regardless of which anesthesia is used during a patient's carpal tunnel surgery, the general patient consensus tends toward high rates of satisfaction with the surgery and a proclivity to choose that treatment method again, if necessary. Garrett *et al*. [10] have found no difference in terms of postoperative functional results and complications between local and sedated anesthesia applications. In our study, although there was no postoperative functional difference between the two groups, one complication was encountered in each group and recovery was achieved with repeated surgery.

In addition, various anesthetic modalities are commonly used during CTR, including general, regional, and local anesthesia. Local anesthesia is associated with shorter operative times, higher patient satisfaction scores, and equivalent functional outcomes [7, 11, 12]. In our study, significantly shorter procedure times were achieved in local anesthesia compared to LMA.

CTR under local anesthesia can be safely performed in an office-based setting with minor procedure field sterility and no prophylactic antibiotics. More than 70% of hand surgeons in Canada use local anesthesia for CTR with similar reported outcomes. In addition to cost savings, local anesthesia is associated with shorter surgical wait times and increased convenience [7]. Previous studies estimate the potential for anywhere from 30% to 80% in total cost reduction by shifting appropriate procedures toward ambulatory surgery centers and in-office procedure rooms. The present study evidenced only $390 in anesthesia cost savings; however, with an estimated 700,000 carpal tunnel releases occurring per year, this modest cost reduction would compound to nearly $300 million in

cost savings if local procedures are more widely implemented [13]. In our study, the fact that the LMA group is 2.2 times more costly than the LA group is also compatible with the literature, and we think that it is advantageous to prefer local applications in CTS procedures, primarily in terms of cost.

The practice of outpatient surgery offers several advantages, including reduced patient wait times for procedures, fewer complications associated with anesthesia, and decreased healthcare expenditures due to factors such as the absence of mandatory blood tests and additional consultations [14]. In this regard, the outcomes of our study reinforce the existing literature by highlighting the potential for substantial cost savings in healthcare expenditures associated with carpal tunnel surgery performed under LA.

Evaluating the efficiency of hospitals and healthcare workers necessitates a comprehensive assessment of financial calculations, with a clear distinction between standard and actual costs. Patients diagnosed with the same medical condition may incur vastly different diagnostic and treatment expenses. Introducing cost analysis into healthcare services is challenging, and it remains a significant obstacle to fully understanding the underlying reasons for these variations. While it's acknowledged that human health cannot be measured solely in monetary terms, it is undeniable that meeting the need for good health carries a substantial cost in today's world.

Today, assessing healthcare policy content, which evolves in response to research and development in human resources, necessitates a foundation rooted in cost research. Simultaneously, the central goal of hospital cost management is to deliver healthcare services with the highest quality and quantity at the lowest possible cost [1, 15]. In this context, cost studies often center on surgical procedures, which are generally cost-intensive. Nevertheless, as demonstrated in our study, when the surgical procedure and materials used are identical, the differentiation lies solely in the location where the healthcare service is provided. In this context, the significance of healthcare investment can be assessed more distinctly. Our study, therefore, unveils the extent to which cost discrepancies arise in surgical practice across two distinct environments. By comparing the utilization of operating rooms and staff, two critical cost categories in healthcare expenditures, while applying the same surgical technique and materials, we shed light on the multifaceted nature of healthcare costs.

Limitations

The study is conducted at a single center which may limit the generalizability of the findings to a broader population. Different hospitals and healthcare systems may have varying cost structures and patient populations.

CONCLUSION

In our study, we show that healthcare expenditures can be controlled in selected patients with different anesthesia applications in two different areas within the hospital. Such studies can provide important information for health services planning and management. In this way, we think that our study is valuable in that it can be used in cost analysis and planning and supervision processes in today's world where health expenditures have reached very large dimensions.

Authors' Contribution

Study Conception: BA; Study Design: BA; Supervision: BA; Funding: BA; Materials: BA; Data Collection and/or Processing: BA; Statistical Analysis and/or Data Interpretation: BA; Literature Review: BA; Manuscript Preparation: BA and Critical Review: BA.

Conflict of interest

The author disclosed no conflict of interest during the preparation or publication of this manuscript.

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