Cost Analysis of Stapling Versus Suturing for Skin Closure

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A randomized, prospective study was performed to test the null hypothesis that there is no difference between the cost of stapling and suturing for skin closure of selected linear lacerations. Appropriate wounds were randomly assigned to be closed by staples or sutures. Wound lengths, skin closure times, and the number of staples or the number and types of sutures used were recorded. Costs for materials and labor were calculated. The average total cost per case was $17.69 (with suture kit) and $7.84 (without suture kit) for the staple Group compared with $21.58 for the suture Group ($P = .0001$ for each). It is concluded that stapling is less costly than suturing and that the advantage appears to increase as laceration length increases. (Am J Emerg Med 1995;13:77-81. Copyright © 1995 by W.B. Saunders Company)

An ideal method of wound closure in the emergency department would be rapid, inexpensive, easy to implement for the physician, comfortable for the patient, effective in terms of wound healing, and acceptable in terms of cosmesis. Beginning with the study by George and Simpson in 1984,[1] there have been a series of reports on the use of staples for the repair of selected lacerations in the emergency department.[2-6] These studies appear to indicate that staples fulfill most, if not all, of the above requirements. However, a frequently expressed area of concern is the expense of staples compared with sutures.[1,2,7] It has recently been suggested that, with the advent of smaller stapling units, stapling may actually be a less expensive method of skin closure than suturing,[4] but no direct comparative studies have been performed that address this issue. Additionally, previous studies have examined the issue of cost only in terms of expense for materials. No analyses have been made that include physician time (labor) as a cost factor. The present report involved a randomized, prospective study of 161 lacerations in 128 patients that was designed to test the null hypothesis that there is no difference between the cost of stapling and suturing for skin closure.

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MATERIALS AND METHODS

The study was conducted prospectively on patients presenting to the emergency department with suturable linear lacerations of the extremities (excluding hand, foot, and pretibial area), trunk, and scalp. Random assignment of the method of repair (staple or suture) was stratified by the three anatomic categories. A balanced randomization scheme based on balancing for every six lacerations within each category was used. The Biostatistics Office generated the random assignment, which was written on an index card and placed inside an envelope. The sealed envelopes were arranged and used in numerical order.

Health care providers in the emergency trauma area performed a history and physical examination in the standard fashion including the patient's age, gender, wound site, time and date of injury, mechanism of injury (blunt or sharp), current medications, and coexisting medical problems. The method of repair was revealed by opening the appropriate envelope. Multiple lacerations in the same area were closed by the same method; however, multiple lacerations in different anatomic categories were closed by randomizing the method. The method, number of lacerations, length of each laceration measured to the nearest millimeter, and the time wound preparation began were recorded. All lacerations were prepped, anesthetized, and cleansed; surgical wound edge revision, undermining, and deep layer closure by suture were performed as indicated. The skin layer was closed according to the randomly assigned method, and the amount of time to close the skin was reported together with the number of staples or the number and type (simple *v* mattress) of sutures used. Skin closure times was determined from the initial staple or needle entry through completion of the last staple placement or cut of the last suture. All procedures, including the timing and recording of skin closure, were performed by four physician's assistants who were experienced and competent in both staple and suture techniques. These physician's assistants were selected because they more closely matched practicing community emergency physicians in technical skill and experience than did other available providers. Staples were supplied by US Surgical Corporation (Norwalk, CT), using the Cricket 35W staple gun. Sutures were supplied by Ethicon, Inc (Sommerville, NJ), using 4.0 Ethilon on a conventional cutting needle (PC-5). All wounds were dressed appropriately.

Determination of Costs

Based on the latest available data from the American College of Emergency Physicians, we calculated the average hourly salary of an emergency physician to be $74.00 per hour or $1.23 per minute.[8]

The cost of each suture package was $5.21, based on the latest distributor's retail cost for a high-volume community emergency department (personal communication, sales representative, Ethicon, Inc). The number of suture packages expended per laceration

was based on the following criteria: scalp lacerations, 8 simple or 6 mattress sutures per package; trunk or extremity lacerations, 10 simple or 7 mattress sutures per package. These criteria were derived from multiple observations of laceration repair performed at the respective anatomic site.

The cost of a 15-staple refill unit was $6.91 and for a 25-staple refill unit was $9.96. Again, these figures are based on the latest distributor's retail cost for a high-volume emergency department (personal communication, sales representative, Medical-Surgical Division, 3M Healthcare, Los Angeles, CA). Staple units were expended per laceration according to the number of staples used. The staple gun was reusable and not included in our cost analysis.

A separate issue to be considered in the calculation of material cost is the expense of suture kits. Brickman and Lambert[4] assumed that suture kits need not be used at all when lacerations are repaired by staples. Our own experience is that the incidence of usage is quite variable and may approach 50%. The influence on total cost is considerable. Therefore, we developed two separate scenarios for determining material costs: one in which suture kits were used for all stapled lacerations and one in which they were not used. The cost of these disposable, one-time-use suture kits was figured at $9.85, based on the latest distributor's retail cost for high-volume usage (personal communication, sales representative, Currie Medical Specialties, Monrovia, CA).

The above data elements were recorded in a predesigned data retrieval form and were entered into a mainframe computer for processing and analysis. For testing the difference of characteristics between the two groups of patients or lacerations, the two-sample Student's *t* test and Mann-Whitney nonparametric test were used for continuous variables; the Chi-squared test and the Fisher's exact test were used for categorical variables. Linear regression analysis was performed to study the relationship of speed of stapling or suturing with length of laceration; analysis of covariance was performed to test the difference of the speed of repair between the two methods. The regression analysis was based on the logarithmic values of the speed and the length of laceration. The Statistical Analysis System (SAS) was used for statistical analysis. Specifically, FREQ, UNIVARIATE, NPAR1WAY, REG, and GLM procedures were used.

RESULTS

Patient Characteristics

A total of 141 patients were entered into the study during a 13-month period between 1989 and 1990: 70 were in the staple group and 71 in the suture group. Because of incomplete recording, 6 patients in the staple group and 7 patients in the suture group were excluded from the analysis, leaving 64 patients in each group.

No statistically significant differences between characteristics with respect to age, gender, time from injury to repair, or mechanism of injury were noted. The average age was 28 years (standard deviation [SD] 11) for the staple group and 29 years (SD 13) for the suture group. Approximately 86% of the staple group and 94% of the suture group were male patients. The average time from injury to repair was 10.1 hours (SD 6.2) for the staple group and 9.9 hours (SD 8.0) for the suture group. The mechanism of injury was 29 sharp, 33 blunt, 2 indeterminate for the staple group and 28 sharp, 36 blunt, 0 indeterminate for the suture group ($P = .34$).

Laceration Characteristics

Among the 64 patients in the staple group, 7 (11%) had two lacerations, 2 (3%) had three, and 1 (2%) had four lacerations. Among the 64 patients in the suture group, 6 (9%) had two lacerations, 3 had three (5%), 1 had four (2%), and 1 had five (2%). This resulted in a total of 78 lacerations in the staple group and 83 lacerations in the suture group. Because the randomization scheme was stratified according to anatomic site, the two groups of patients had equal distribution: 56% scalp, 37.5% extremity, and 6.5% trunk. The average length of stapled lacerations was 4.91 cm (SD 4.43) and the average length of sutured lacerations was 4.46 cm (SD 3.40), $P = .47$.

Efficiency of Repair

It was considerably faster to perform skin closure of a linear laceration by stapling than by suturing. The average speed for stapling was 8.3 seconds per centimeter and for suturing was 63.2 seconds per centimeter, ie, 7.6 times longer to suture than staple. Figure 1 shows the regression lines displaying the relationship between speed of repair and length of laceration for stapling and suturing on the logarithmic scale. It can be seen that, as laceration length increased, speed of repair increased, more so for stapling than for suturing. The slopes of the regression lines are significantly different, $P = .0001$.

Cost of Repair

The total cost of repair included two components: cost of material and cost of labor. The cost of material (Table 1) included the expense of suture packs plus suture kits (suture group) versus staple refill units and, when included, the cost of suture kits (staple group). When a suture kit cost was included for stapling, the average material cost was $16.93 for the staple group and $16.27 for the suture group ($P = .0277$). When the suture kit was excluded for stapling, the average material cost was $7.08 for the staple group and $16.27 for the suture group ($P = .0001$). The cost of labor was calculated to be $1.23 per minute with the total labor cost for each case thereby related to the time of closure (Table 2). The relative labor cost of stapling versus suturing was 0.14 (76 cents *v* $5.31, $P = .0001$). The average total cost per case was less for stapling with or without a suture kit ($17.69 and $7.84, respectively) compared with suturing ($21.58), $P = .0001$ for each scenario.

The comparative cost between stapling and suturing over different ranges of laceration length was examined for two

TABLE 1. Material Cost Per Laceration

	Staple Group (n = 78)	Suture Group (n = 83)	*P* Value
Excluding suture kit in staple group			
Average ($)	7.08	16.27	.0001
SD	1.18	2.36	
Minimum	6.91	15.06	
Maximum	16.87	25.48	
Including suture kit in staple group			
Average ($)	16.93	16.27	.0277
SD	1.18	2.36	
Minimum	16.76	15.06	
Maximum	26.72	25.48	

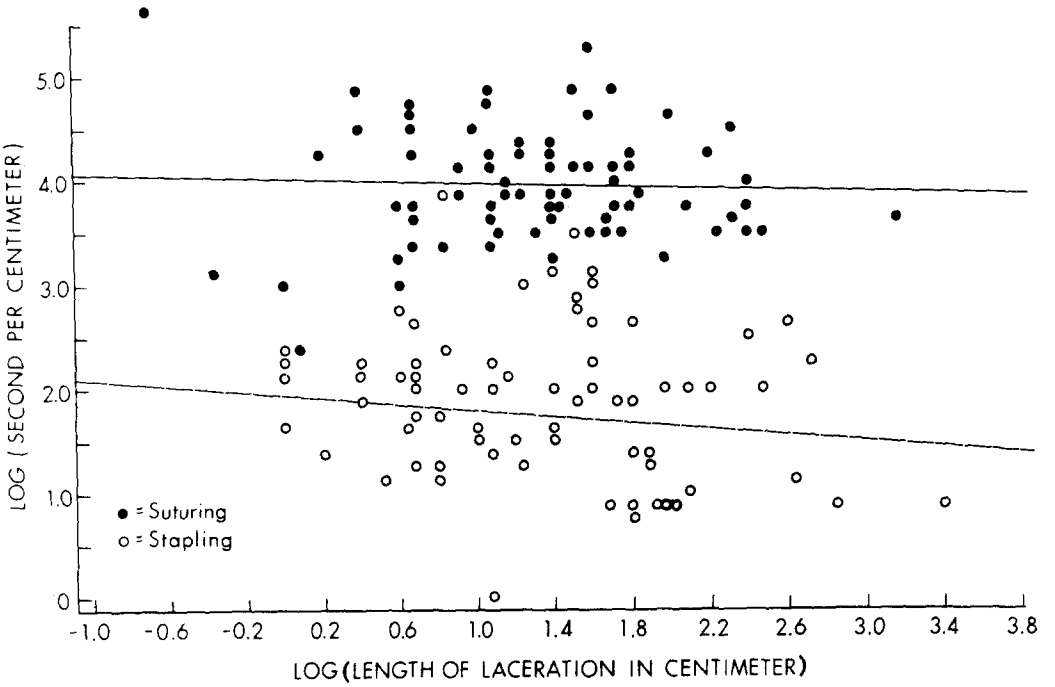

FIGURE 1. Relationship between speed of repair and length of laceration for stapling and suturing.

reasons. First, any change in speed with longer lacerations would ultimately effect the labor cost. Second, staples and sutures come in packages, thus keeping costs flat through certain ranges of laceration length. Therefore, the possibility that longer lacerations might substantially influence material cost was considered. As shown in Table 3, the speed of repair increased with increasing length of lacerations. Also shown was that stapling was less expensive than suturing for all ranges of laceration length. Additionally, with the exception of a single outlier, the advantage appeared to increase as laceration length increased.

DISCUSSION

The idea of using a staple-like device as a method of wound closure goes back at least to the ancient Hindus, who used insect mandibles to close skin wounds.[9] Mechanical suture devices were pioneered in the Soviet Union and introduced into the United States by Steichen and Ravitch in 1973.[10] Since that time, numerous studies have compared the advantages and disadvantages of staples versus sutures in skin closure. Surgical sutures are still felt to be the technique of choice for wounds requiring the most meticulous repair.[3,11,12] However, for most linear, nonfacial lacerations, staples have been found to have the advantage of being faster,[1-7] less damaging to host defenses,[3] and useful in the management of potentially contaminated wounds.[13] It has also been suggested that they do not expose the physician to the risk of needle sticks,[2] and they would be especially well suited for use in mass casualty incidents.[1] Staples would appear to be equal to sutures in terms of incidence of infection,[1,2,4,5,7] comfort in situ,[1-5] and cosmesis.[1,5,6,14] Reported disadvantages of staples include interference with computed tomography scans,[15] less meticulous approximation of wound edges,[12] and, until recently, cost.[1,2,7]

In 1989, Brickman and Lambert[4] presented data suggesting that, with the advent of smaller stapling units, the material cost of stapling was actually less than that of suturing. Notably, their cost figures were influenced by the assumption that a disposable suture kit was not needed for those

TABLE 2. Comparison of Cost per Case

	Staple Group (n = 78)	Suture Group (n = 83)	Staple/Suture Ratio	*P* Value
Avg time per case (sec)	37	259	0.14	.0001
Avg labor cost per case*	$0.76	$5.31	0.14	.0001
Avg material cost per case				
Excluding suture kit in staple group	$7.08	$16.27	0.44	.0001
Including suture kit in staple group	$16.93	$16.27	1.04	.0277
Avg total cost per case				
Excluding suture kit in staple group	$7.84	$21.58	0.36	.0001
Including suture kit in staple group	$17.69	$21.58	0.82	.0001

* Assuming labor cost of physician time is $1.23 per minute.

TABLE 3. Comparison of Cost by Method and Length of Laceration

	Laceration Length (cm)				
	0-6.0	6.1-10.0	10.1-15.0	15.1-25.0	25.1-35.0
Method	Staple/Suture	Staple/Suture	Staple/Suture	Staple/Suture	Staple/Suture
No. of cases	61/70	10/8	5/4	1/1	1/0
Avg speed sec/cm	9.1/65.6	4.3/56.9	9.2/40.3	2.5/37.9	2.5/—
Avg length cm/case	3.2/3.3	7.3/8.5	13.1/11.2	17.0/24.0	30.0/—
Avg time sec/case	30/213	32/483	120†/452	43/909	76/—
Avg labor cost/case	0.62/4.36	0.66/9.91	2.46/9.27	0.88/18.63	1.56/—
Avg material cost/case					
Excluding suture kit for staple group	6.91/15.44	6.91/20.27	7.52/20.27	6.91/25.48	16.87/—
Including suture kit for staple group	16.76/15.44	16.76/20.27	17.37/20.27	16.76/25.48	26.72/—
Avg total cost/case					
Excluding suture kit for staple group	7.53/19.80	7.57/30.18	9.98/29.54	7.79/44.11	18.43/—
Including suture kit for staple group	17.38/19.80	17.42/30.18	19.83/29.54	17.64/44.11	28.28/—
Ratio*					
Excluding suture kit for staple group	0.38	0.25	0.34	0.18	
Including suture kit for staple group	0.88	0.58	0.67	0.40	

* Ratio of stapling to suturing for average total cost per case.
† Influence of a single outlier.

patients whose wounds were stapled. Furthermore, as with other studies on the subject, their analysis did not take physician time (labor) into consideration as a cost factor.

As a follow-up to the work of Brickman and Lambert, we designed a randomized prospective study comparing the expense of staples to sutures, using both labor and material as cost factors, and factoring the expense of suture kits in a variable fashion. Our data suggest the following: (1) for the average laceration, stapling is 0.82 times the expense of suturing if a suture kit is always figured as a cost of stapling and 0.36 times the expense of suturing if a suture kit is never figured as a cost of stapling; (2) the cost advantage of staples over sutures is true for all ranges of laceration length entered into the study; and, (3) the cost advantage of stapling increases as laceration length increases.

An advantage in cost alone is relatively unimportant if the cost-saving technique is less effective, causes a less favorable outcome, or leads to additional complications. Therefore, our study also examined several outcome measures. There was no difference between stapled and sutured lacerations in terms of incidence of wound infection, cosmetic appearance, or incidence of dehiscence. Staples did appear to cause more pain on removal than sutures, although this difference was not statistically significant. We chose not to report our results because some of our data were based on telephone reports and not direct observation; also, there was a statistically significant difference in the patient-return rate between the staple and suture groups. It is unknown to what extent these factors influenced our results, although prior studies have corroborated our findings.[1,2,4-7,14]

Several aspects of our study design should be considered in reviewing our conclusions. First, a major factor influencing our results was the inclusion of physician time as a labor cost factor. Our justification in doing so is based on standard and well-recognized techniques of cost analysis.[16,17]

Second, the issue of suture kits must be recognized as an expense that may vary widely according to local practice habits. At issue is whether or not suture kits are needed to staple lacerations, and if so, how would disposable versus reusable kits or trays affect cost analysis. We restricted our calculation to disposable suture kits because that reflects our community standard. Perhaps future studies need to examine the many cost variables created by different practice habits. Brickman and Lambert[4] assumed that suture kits would not be needed for stapling lacerations, thus increasing considerably the cost advantage of staples. Our own experience suggests that suture kits are needed in approximately 50% of stapled lacerations. However, even if kits were used in 100% of stapled lacerations, the cost advantage of staples would still hold. Finally, it must be noted that vendor costs for staple devices and suture packages are variable. Our demonstrated cost advantage was expressed using the comparatively lower cost staple refill units with a reusable (not costed) staple gun.

CONCLUSION

We conclude that, with respect to emergency department repair of linear nonfacial lacerations, stapling is a less expensive means of skin closure than suturing. Finally, the cost advantage for stapling, although applicable to any range of laceration length, appears to increase as laceration length increases.

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