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Cost Comparison of Scleral Buckle versus Vitrectomy for Rhegmatogenous Retinal Detachment Repair

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Abstract

Purpose: To estimate and compare the costs of scleral buckle (SB) and pars plana vitrectomy (PPV) for treatment of rhegmatogenous retinal detachment (RD).

Design: Cost analysis based on published prospective data comparing SB and PPV for rhegmatogenous RD repair.

Methods: The costs of initial surgery, post-operative retina-affecting procedures and eventual cataract extraction resulting from SB and PPV for rhegmatogenous RD repair were estimated for both phakic and pseudo/aphakic patients and then compared. A univariate sensitivity analysis was also performed to examine the sensitivity of our estimations.

Results: When considering all costs, SB was 10.7% less expensive than PPV for rhegmatogenous RD repair in phakic patients, whereas PPV was 12% less expensive than SB for rhegmatogenous RD repair in pseudo/aphakic patients. These conclusions were robust in the sensitivity analysis.

Conclusions: SB appears to offer a modest cost savings over PPV for repair of rhegmatogenous RD in phakic patients. However, in pseudophakic and aphakic patients, PPV appears to be less expensive than SB.

Introduction

Rhegmatogenous retinal detachments (RD) that cannot be treated with pneumatic retinopexy are usually treated either with scleral buckling alone or pars plana vitrectomy with or without concomitant scleral buckling. Recent data from a randomized, controlled trial suggest that both of these surgical approaches work well in phakic and pseudo/aphakic patients, with similar final retinal reattachment rates.¹

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c. Contributions of Authors: Design of the study (MS, AN, JS), Conduct of the study (MS, AN, JS), Data collection/analysis (MS, AN, JS), Drafting of manuscript (MS, AN, JS), Final approval (MS, AN, JS).

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Although the clinical outcomes may be comparable between scleral buckling and pars plana vitrectomy (PPV) for rhegmatogenous RD, other factors may affect a surgeon's choice of one procedure over another, including personal experience, patient factors, training bias, reimbursement rate, technical difficulty, etc. Due to the rising costs of health care, much attention has been directed toward cost as an important consideration in medical decision-making. The purpose of this study was to estimate and compare the costs of scleral buckling and PPV for treatment of rhegmatogenous RD.

Methods

A societal cost perspective was assumed for this report. The clinical outcomes which serve as the basis for this analysis are derived from the only randomized clinical trial comparing scleral buckling and PPV for the repair of primary RD in both phakic and pseudo/aphakic patients, namely the "scleral buckling versus primary vitrectomy in rhegmatogenous retinal detachment study", abbreviated as the "SPR study"¹. Our analyses are based entirely on published data, therefore no Institutional Review Board approval was obtained. To calculate an estimate for the total cost of scleral buckling and PPV for rhegmatogenous RD, we combined the cost of initial surgery as reimbursed by Medicare with the cost of subsequent procedures needed after the initial surgery during the follow-up interval reported in the SPR study.

Medicare reimbursement rates for surgeon fees were obtained from the American Medical Association's "cpt@" search tool,² using the "National" average reimbursement rates for "non-facility limiting charges". The cost of ophthalmic biometry with intraocular lens selection (Current Procedural Terminology code 76519) was included in the surgeon fee for cataract surgery. The "National Anesthesia Conversion Factor" and appropriate Anesthesia "base units" for scleral buckling, PPV and cataract surgery from 2013 were obtained from the Centers for Medicare and Medicaid Services and used to calculate the cost of Anesthesia.³ Anesthesiology reimbursement is also based on surgical case length. We assumed that primary and repeat retinal detachment repairs took two hours to complete, cataract extraction with intraocular lens placement took thirty minutes to complete and silicone oil removal took thirty minutes to complete. Ambulatory surgery center fees for 2013 for each procedure were also obtained from Centers for Medicare and Medicaid Services.⁴ The costs of topical medications and pre-and post-operative visits were not included in our study because no data regarding the details of these parameters were presented in the SPR study; also, their cost likely does not differ much between patients undergoing scleral buckling and PPV.

The SPR study presents rates of post-operative "retina-affecting procedures" performed following initial rhegmatogenous RD repair. However, the manuscript does not present the types or relative rates of the different procedures performed, and simply implies that they include return to the operating room and "additional laser photocoagulation, intravitreal gas injection"¹. Another SPR publication suggests that the vast majority of retina-affecting procedures in the original study were for retinal re-detachment, but does not detail what types of procedures were performed.⁵ For the purposes of our study it was assumed that 80% of post-operative procedures performed were return to the operating room for recurrent

retinal detachment repair, and the other 20% were an even mix of laser retinopexy, cryopexy or intravitreal gas injection. Using these data, the “average” cost of a post-operative retina-affecting procedure was estimated and used for our analysis.

The SPR study also describes the proportion of patients undergoing silicone oil implantation, and subsequent removal, during study follow-up (in patients originally randomized to scleral buckling, this was placed “during revisional surgery”). Using these data, the average per-patient cost of silicone oil removal was estimated for each surgical subgroup.

The SPR study divided patients treated for rhegmatogenous RD into phakic and pseudo/aphakic groups. Cataract progression in phakic patients was defined as an increase in 1.0 units on the Lens Opacities Classification System III.¹ For the purposes of our cost comparisons, all cataract progression following rhegmatogenous RD repair was considered to be both secondary to rhegmatogenous RD repair and visually significant enough to require cataract surgery.

A one-way sensitivity analysis was performed for the uncertain parameters in our cost model in order to evaluate how sensitive our main conclusions were to the specific values of these parameters. Specifically, each uncertain cost parameter was varied until a cost benefit of either scleral buckling or PPV was eliminated; then the magnitude of change required for this reversal was recorded.

Results

The total reimbursable costs of primary and recurrent rhegmatogenous RD repair, routine cataract extraction and silicone oil (“implanted material, posterior segment”) removal are listed in Table 1. Considering initial cost alone, primary scleral buckling was less costly (\$2,932.32) than primary PPV (\$3,201.73) due to the increased surgeon fee associated with PPV. With all additional costs included, scleral buckling (\$5,461.66) was 10.7% less expensive than PPV (\$6,116.80) in phakic patients. In pseudo/aphakic patients, PPV (\$4,499.82) was 12.1% less expensive than scleral buckling (\$5,117.40) (Table 2).

The average cost of a post-operative retina-affecting procedure was calculated to be \$2,575.76. According to the SPR study, patients who underwent scleral buckling for rhegmatogenous RD required more post-operative retina affecting procedures on average than patients treated with PPV.¹ For phakic patients initially treated with scleral buckling, an average of 0.12 more retina-affecting procedures were required per patient than PPV. For pseudophakic or aphakic patients initially treated with scleral buckling, an average of 0.34 more retina-affecting procedures were required per patient than PPV. Based on our cost estimations, this increased the average cost of scleral buckling for phakic and pseudo/aphakic patients more than it did PPV (Table 2).

In the SPR study, silicone oil tamponade was used in 9.1% of phakic eyes originally randomized to undergo scleral buckling (“during revisional surgery”), and in 17.9% of eyes randomized to PPV, and it was removed from 53% and 57% of eyes initially randomized to scleral buckling and PPV, respectively. In the pseudo/aphakic group, 21.8% of scleral buckle

patients eventually had silicone oil placed, as compared to only 11.3% of eyes undergoing initial PPV, with 34.5% and 60% removed in the pseudo/aphakic scleral buckle and PPV groups, respectively, by the end of the study. The average per-patient cost of silicone oil removal was based on those patients whose oil was removed by the end of the SPR study (Table 2).

During the follow-up period of the SPR study, cataract progressed in 45.9% of phakic patients initially treated with scleral buckling and 77.3% of phakic patients initially treated with PPV. The cost of routine cataract extraction and intraocular lens implantation is outlined in Table 1. The estimated per-patient cost of cataract surgery following retinal detachment repair, based on the data, is presented in Table 2.

Table 3 shows the details of our one-way sensitivity analysis. The analysis revealed that our conclusions regarding the cost of scleral buckling compared to PPV are quite robust despite possible inaccuracy of our cost assumptions. In particular, our assumption that 80% of retina-affecting procedures were a return to the operating room for retinal detachment repair (as opposed to 20% which were intravitreal gas injection, laser retinopexy or cryopexy) could be varied significantly in either direction with our conclusions remaining unchanged. Indeed, our conclusions regarding cost in phakic patients were most sensitive to variability in the proportion of post-operative retina affecting procedures in patients initially randomized to PPV that constituted a return to the operating room, but this variable would have to decrease by 40% before PPV became less expensive than scleral buckling in this group. Our conclusions regarding cost in the pseudo/aphakic group were most sensitive to variability in the number of retina-affecting procedures per patients initially randomized to undergo scleral buckling, but this would need to decrease by 31.2% before scleral buckling became less expensive than PPV in that group.

Discussion

We present a cost comparison of scleral buckling versus PPV for rhegmatogenous RD repair using data from the only randomized, controlled trial comparing them in both phakic and pseudo/aphakic patients (namely, the “scleral buckling versus primary vitrectomy in rhegmatogenous retinal detachment study” or “SPR study”¹). The SPR study found comparable retinal reattachment rates between the two surgical approaches¹, suggesting that the cost of each procedure may be an important issue when comparing them.

According to data from the SPR study, when the cost of post-operative procedures and cataract extraction is considered, the total cost of retinal detachment repair is considerably higher than the initial surgical cost. For phakic patients, scleral buckling ultimately costs 86.8% and PPV 91% more than the initial surgical cost. For pseudo/aphakes, scleral buckling ultimately costs 75.1% more and PPV 40.5% more than the initial surgical cost (Tables 1, 2).

Overall, the cost of scleral buckling and PPV for rhegmatogenous RD repair is similar in both phakic and pseudo/aphakic patients. However, in phakic patients our estimates suggest that scleral buckling may offer a modest cost savings over PPV, with approximately \$655.14

(10.7%) saved per scleral buckling procedure. This savings appears to be attributable to the disproportionate amount of cataractogenesis, and therefore subsequent need for cataract extraction, resulting from PPV. However, in pseudo or aphakic patients, PPV appears to be less expensive than scleral buckling, with \$617.58 (12.1%) saved per PPV due to the significantly reduced cost of post-operative procedures with PPV compared to scleral buckling in this group (Table 2). Both of these cost comparisons were found to be quite robust in sensitivity analysis (Table 3).

Outcomes for rhegmatogenous RD repair in the SPR study are significantly poorer than those in other reports.⁶⁻⁹ Our analyses indicate that failure of initial rhegmatogenous RD repair often significantly increases total surgical cost, so the higher primary failure rate in the SPR study likely inflates our overall cost estimate of rhegmatogenous RD repair. The reasons for the poor results in the SPR study are unclear but may be secondary to its inclusion of only “medium severity” RDs, its strict study definition of primary anatomical success and that the study did not allow investigators to use their preferred rhegmatogenous RD repair method to treat patients. Although the outcomes in the SPR study are poor, they do not seem to favor either scleral buckling or PPV, making bias based on this feature unlikely in our cost comparison. It is possible that data from future randomized controlled trials comparing scleral buckle and PPV for rhegmatogenous RD repair will provide different results, which will in turn affect a cost comparison.

The SPR study allowed a scleral buckle to be placed during PPV for rhegmatogenous RD repair at the discretion of the surgeon. Sub-analysis of the SPR study suggests the addition of a scleral buckle during PPV appeared to improve the success rate in pseudo/aphakic patients¹, although data from other studies has not found a similar association^{9, 10}. The SPR study found the addition of a scleral buckle not to improve success for rhegmatogenous RD repair with PPV in phakic patients¹, although other reports suggest it may¹⁰. Either way, it is clear that the SPR study (and therefore our cost comparison) does not strictly compare primary scleral buckling to PPV for rhegmatogenous RD repair but rather primary scleral buckling to PPV with or without the addition of a scleral buckle.

The bias of our cost estimates is likely directed at counting scleral buckling as more expensive than PPV in both phakic and pseudo/aphakic patients for several reasons. In phakic patients, our data suggest that PPV is more expensive primarily because of the cost of increased cataractogenesis. However, phakic patients were followed for only an average length of 415 days in the SPR study.¹ Literature suggests that cataract formation after PPV is a time-dependent process,¹¹⁻¹³ so the relatively short follow-up of the SPR study may underestimate the cataractogenic effect (and therefore the cost) of PPV. Moreover, we did not include the cost of pre-operative visits or topical medications (because data regarding these parameters was limited in the SPR study), which would be expected to increase the cost of cataract surgery, thus making PPV disproportionately more expensive as well. Additionally, as mentioned previously, PPV for rhegmatogenous RD may be combined with scleral buckling,^{9, 10, 14} which was permitted in the SPR study and which inevitably adds additional time to the procedure. In this report we assumed average anesthesia time between scleral buckling and PPV for rhegmatogenous RD repair to be equal. Consequently, our

estimate of the average length of time for PPV (and therefore the cost of anesthesia for PPV) may be falsely low.

Another way our study may bias results toward PPV appearing less expensive than scleral buckling involves Medicare's rules regarding re-operations. According to Medicare guidelines, if a return to the operating room is prompted by the same problem that required the initial surgery and is performed in the post-operative "global" period following initial surgery (typically 90 days), it is often billed with a modifier -78 and is reimbursed less than the normal rate.¹⁵ According to data from the SPR study, a significant proportion of post-operative procedures were performed within the first 90 days after initial rhegmatogenous RD repair.⁵ However, because precise data regarding the timing of post-operative procedures in the SPR study is unavailable, to minimize our bias we calculated costs of post-operative "retina-affecting procedures" using the full Medicare reimbursable value. For this reason, our estimation of the cost of post-operative retina-affecting procedures (which occur more frequently following scleral buckling) is likely inflated.

We recognize as a limitation that our study does not attempt to account for the inherent medical costs of follow-up visits or the inconvenience to patients of additional post-operative procedures following rhegmatogenous RD repair, including cataract surgery. In addition, the SPR study only included patients with specific types of retinal detachment, notably those that were not appropriate for repair by pneumatic retinopexy or placement of a single episcleral sponge,¹ which may explain why the primary success rates presented in the study were low. Also, retinal detachments that were complex, with advanced proliferative vitreoretinopathy, giant retinal tears or macular holes, were excluded, as were eyes with extreme myopia, visual-acuity affecting eye diseases, significant systemic disease or a history of trauma or previous ocular surgery (besides cataract surgery).¹ In the SPR recruitment study, these included cases of rhegmatogenous RD were considered "medium severity" and only compromised only 28.2% of all primary rhegmatogenous RDs presenting to the study's European centers, but were selected to represent cases where the preferred approach to RD repair was not clear.¹⁶ Certainly our results are only generalizable to the types of patients included in the SPR study.

Our comparison used costs from the United States Medicare system but all data from the SPR study was gathered in Europe. It is therefore possible that this may bias and limit the generalizability of our results due to differences in practice patterns. The greatest limitation of our study is that it is based on a single randomized controlled trial. A cost comparison based on a meta-analysis of several randomized controlled trials would likely be subject to less bias. Unfortunately, the SPR study is the only randomized controlled trial to compare both scleral buckling and PPV for rhegmatogenous RD repair. It should also be noted that our cost comparison is based entirely on current (2013) Medicare reimbursement rates and a change in these rates would produce different results. Also, this report presents a cost comparison from a societal perspective; actual per-patient costs would depend significantly on the patient's insurance provider and access to care.

The decision to recommend PPV or primary scleral buckling for retinal detachment repair for any individual patient certainly depends on many factors including surgeon proficiency

and a myriad of patient characteristics. The cost difference between scleral buckling and PPV found in the present study is modest but may constitute an additional factor to inform a surgeon's decision to pursue one approach for rhegmatogenous RD repair over another.

In conclusion, scleral buckling appears to offer a modest cost savings over PPV for repair of rhegmatogenous RD in phakic patients. However, in pseudophakic and aphakic patients, PPV appears to be less expensive than scleral buckling.

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Table 1–

Baseline costs for retinal detachment repair and associated surgical procedures

CPT ^a Code	Description	Surgeon Fee	ASC ^b Fee	Anesthesiolog y Fee	Total Medicare Reimbursabl e
6710 7	Repair of retinal detachment; scleral buckling	\$ 937.53	\$1,635.0 0	\$ 350.79	\$2,923.32
6710 8	Repair of retinal detachment; with vitrectomy, any method	\$1,215.9 4	\$1,635.0 0	\$ 350.79	\$3,201.73
6698 4	Phacoemulsificati on with intraocular lens implantation	\$ 554.52	\$ 971.02	\$ 175.39	\$1,700.93
6711 2	Repair of retinal detachment; by scleral buckling or vitrectomy, on patient having previous ipsilateral retinal detachment	\$1,004.2 8	\$1,635.0 0	\$ 350.79	\$2,990.07
6712 1	Removal of implanted material, posterior segment ^c	\$ 955.71	\$1,635.0 0	\$ 219.24	\$2,809.95
6710 1	Repair of retinal detachment, cryotherapy or diathermy	\$ 604.77	\$ 346.01	None	\$ 950.78
6710 5	Repair of retinal detachment, photocoagulation	\$ 546.77	\$ 230.51	None	\$ 777.28
6711 0	Repair of retinal detachment; by injection of air or other gas	\$ 658.27	\$ 369.26	None	\$ 1,027.53

^aCurrent procedural terminology, American Medical Association^bAmbulatory surgery center^cIncludes silicone oil removal

Table 2–

Total per patient cost of scleral buckling versus vitrectomy for retinal detachment repair

	Initial Surgical Cost	Average per-patient cost of retina-affecting procedures *	Average per-patient cost of silicone oil removal*	Average per-patient cost of cataract extraction	Average total per-patient cost
Phakic scleral buckle	\$2,923.32	\$1,622.73	\$134.88	\$780.73	\$5,461.66
Phakic vitrectomy	\$3,201.73	\$1,313.64	\$286.61	\$1,314.82	\$6,116.80
Pseudo/aphakic scleral buckle	\$2,923.32	\$1,983.34	\$210.74	\$0.00	\$5,117.40
Pseudo/aphakic vitrectomy	\$3,201.73	\$1,107.58	\$190.51	\$0.00	\$4,499.82

* Average among all patients (not every patient underwent each procedure)

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Table 3–

Sensitivity analysis of the cost of scleral buckling versus vitrectomy for retinal detachment repair

Phakic Retinal Detachment (Baseline = Scleral buckle less expensive)			
Scleral Buckle	Baseline value	Inflection point	Change from baseline
RAPs/pt	0.63	0.89	41.3%
RAP=RD repair in OR	0.80	>1	N/A
Cataract	0.459	0.844	83.9%
Vitrectomy			
RAPs/pt	0.51	0.25	51%
RAP=RD repair in OR	0.80	0.48	40%
Cataract	0.773	0.388	49.8%
Pseudophakic Retinal Detachment (Baseline = Vitrectomy less expensive)			
Scleral Buckle	Baseline value	Inflection point	Change from baseline
RAPs/pt	0.77	0.53	31.2%
RAP=OR repair	0.80	0.50	37.5%
Vitrectomy			
RAPs/pt	0.43	0.67	55.8%
RAP=RD repair in OR	0.80	>1	N/A

RAPs/pt: Post-operative retina-affecting procedures per patient

RAP=OR repair: Proportion of post-operative retina-affecting procedures that were a return to the operating room for retinal detachment repair (as opposed to intravitreal gas injection, laser retinopexy or cryopexy performed in clinic) in this subgroup

Cataract: Proportion of patients developing cataract post-operatively

Inflection point: Value at which alternative procedure for retinal detachment repair becomes less expensive

Change from baseline: Amount variable would have to change from baseline to reach inflection point