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PCL Retaining vs. PCL Sacrificing in Total Knee Arthroplasty: A Study on Functional Results

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Abstract
Background: Total knee arthroplasty (TKA) is a common procedure for joint replacement, with controversy surrounding the retention or sacrifice of the Posterior Cruciate Ligament (PCL). The study aimed to prospectively compare functional outcomes in patients undergoing TKA with PCL retention versus sacrifice.
Methods: A prospective study was conducted from June 2022 to August 2023, involving 20 knees in 19 patients. Functional outcomes were evaluated using Knee Society Knee Score, Functional Knee Score, and WOMAC questionnaire. Preoperative and postoperative assessments were conducted, and statistical analysis was performed using IBM SPSS Version 22.0.Postoperative follow-up was conducted on a monthly basis for the first three months.
Results: The study included 10 males and 9 females, with mean ages of 62.13 years and 55.65 years, respectively. Patients underwent TKA due to osteoarthritis, with a mean BMI within the normal range. Preoperative assessments showed varus deformity in all cases. Significant improvements were observed in knee scores, functional knee scores, and pain relief in both groups. However, the PCL sacrificing group demonstrated superior outcomes across various parameters, including knee scores, pain relief, and stair climbing.
Conclusion: Both PCL retaining and sacrificing procedures led to significant improvements in functional outcomes and pain relief. However, statistical analysis favoured the PCL sacrificing group, indicating superior outcomes in terms of pain relief and functional performance. Sacrificing the PCL may contribute to better functional outcomes and pain relief in TKA. Further research with larger cohorts and extended follow-up periods is recommended for validation.

Introduction

Total knee arthroplasty (TKA)are widely recorded as effective interventions for reducing pain and enhancing functionality in individuals experiencing end-stage arthritis of the knee joint.(1) It is widely recognized that, despite the success of total knee arthroplasty in providing pain relief, normal knee function is not fully recovered following these procedures(2). Osteoarthritis (OA) affecting the knee stands as a prominent contributor to disability among individuals aged 65 and above(3,4). Patients with OA experience significantly greater pain and functional deficits during normal daily activities, leading to a loss of productivity and worsening quality of life(5-7).

The significance of retaining the Posterior Cruciate Ligament (PCL) in total knee replacement is a matter of controversy. Theoretical arguments propose that preserving the PCL can lead to femoral rollback, thereby enhancing the flexion range and preventing posterior translation. This, in turn, may reduce the risk of loosening and excessive wear of polyethylene by diminishing shear stresses at the fixation surfaces. Although retaining the posterior cruciate ligament (PCL) in total knee arthroplasty (TKA) may provide benefits in maintaining knee function and stability, it can also introduce potential complications, such as PCL impingement or rupture, as indicated in research such as the study conducted by Kwon and colleagues in 2014(8).

The objective of this study is to prospectively assess and compare the functional outcomes of Primary Total Knee Replacement in individuals where the Posterior Cruciate Ligament (PCL) was retained versus those where it was sacrificed. This evaluation will be conducted using the Knee Society Knee Scoring, Functional Knee Score, and WOMAC Questionnaire.

Materials and methods

The study spanned from June 2022 to August 2023, during which 24 knees were replaced in 22 patients. However, two patients who underwent total knee replacement were lost to follow-up— one patient succumbed to a medical (cardiac) cause, and another did not attend the scheduled follow-up. The remaining patients maintained regular follow-up and were included in the final study. The study ultimately focused on 19 patients.

In our hospital, total knee arthroplasty is performed for patients with osteoarthritis and rheumatoid arthritis, encompassing both varus and valgus knees. The inclusion criteria involve individuals aged over 50 years with Kellegran and Lawrence scores of Grade 3 and 4. Exclusion criteria comprise those under 50 years, minimal degenerative changes (KL I & II), poor skin conditions, post-traumatic arthritis, varicose veins, medical unfitness, and patients lacking necessary documents for the scheme. Retaining the posterior cruciate ligament (PCL) is contingent on factors such as its structural integrity, fixed flexion deformity of less than 150, varus less than 100, and valgus less than 100. Conversely, sacrificing the PCL is indicated by a fixed flexion deformity exceeding 150, varus or valgus surpassing 100, structurally contracted PCL, or technical inability to appropriately balance the PCL.

Before surgery, the patients' height and weight were recorded, and their Body Mass Index (BMI) was calculated and categorized according to WHO guidelines. The assessment included the utilization of the WOMAC Score and Functional Knee Score, both of which were used to evaluate patients before and after the surgery. Each knee score and functional score totaled 100 points, while the WOMAC Score had a maximum of 96 points (based on 24 questions).

Additionally, all patients undergoing knee replacement surgery underwent preoperative full-length radiographs from the hip to the ankle. A preoperative mechanical axis was drawn, and the degree of varus or valgus deformity was quantified. The severity of arthritis was assessed radiologically using the grading system advocated by Kellegren and Lawrence, which ranged from I to IV.

All cases underwent thorough investigations, and comorbid medical conditions were brought under control before surgery. A preoperative hemoglobin level of 12 gms% was set as the cutoff, and the absence of skin ailments and varicose veins was confirmed prior to surgery. The procedures for all 20 cases were performed by four different surgical teams at various times during the study period. Tourniquet control using a pneumatic tourniquet was employed for all cases, and anesthesia was administered either epidurally or spinally at the discretion of the anesthetist. A consistent approach involved an anterior midline incision, with retinacular exposure achieved through medial parapatellar arthrotomy. On-table ligament balancing and bone cuts were tailored to the severity of the disease. A bone defect exceeding 1 cm was observed in one case, and a bone graft from the distal femoral bone cut was utilized to fill the gap. The posterior cruciate ligament (PCL) was retained in five patients without preoperative flexion contracture and minimal deformities, while it was sacrificed in the remaining patients. PCL-retaining prostheses were applied to those with retained PCL. Uniform implants from the same manufacturer were used for all twenty cases, and bone cement was employed in each instance.

Postoperative follow-up occurred monthly for the initial three months. All patients underwent assessment for range of motion, pain relief, and scoring based on the Knee Society Knee Score, Knee Functional Score, and WOMAC questionnaire approximately three months after the surgery. Patient case records documented all follow-up data and scores. IBM SPSS Version 22.0 was used for data analysis. Continuous variables were expressed as mean ± SD, while categorical variables were presented as numbers and percentages. Chi-square test compared categorical variables. A p-value <0.05 indicated statistical significance.

Results

The study comprised 19 cases with regular follow-up, spanning an average follow-up period ranging from 3 to 18 months. Of these cases, 6 patients had their posterior cruciate ligament retained while undergoing total knee replacement with a cruciate retaining prosthesis, while it was sacrificed in the remaining cases. The study included 12 males and 7 females(Table 1), with males having a mean age of 62.66±7.31 years, a mean weight of

74.08±4.850 kg, and a mean height of 159.5±3.22 cm, and females having a mean age of 62.71±8.77 years, a mean weight of 73.14±6.12 kg, and a mean height of 153.14±3.39 cm. In our study, the left side knee was predominantly affected in approximately 11 cases(Table 2), and all patients exhibited varus deformity.

The average pain score, including stair climbing, was 43.4 out of 50 in the Posterior Cruciate Ligament (PCL) sacrificing group, while it was 38.4 in the Cruciate Retained group. In terms of stair climbing, the scores were 12.1 out of 15 and 9.5 in the PCL Sacrificing and Retaining groups, respectively, compared to the preoperative scores of 4.8 and 5.4. The mean range of movements showed significant improvement in both the Cruciate Sacrificing (CS) and Cruciate Retained (CR) groups, with postoperative scores reaching 20.8 (out of a maximum of 25) and 19.2, respectively, in the PCL sacrificing and retaining groups.

The average comprehensive knee score was 82.92 for patients who underwent Posterior Cruciate Sacrificing procedures and 76.3 for those who had Cruciate Retained procedures. This is in comparison to preoperative scores of 43.15 and 41.8, respectively(Table 3). Regarding the Functional Knee Score, it was 98.92 for the Cruciate Sacrificing group and 94.6 for the Cruciate Retained group, with preoperative scores of 40.15 and 35.6, respectively(Table 4). Importantly, the WOMAC Score showed significant improvement, decreasing from 67.23 to 24.84 in the Cruciate Sacrificing group and from 66.5 to 25.1 in the Cruciate Retained group(Table 5).

Discussion

Total knee replacement is a surgical procedure designed to replace the weight-bearing surfaces of the knee joint with artificial components, aiming to alleviate pain and improve mobility in individuals experiencing significant pain and disability. This procedure is frequently undertaken to address conditions such as osteoarthritis, rheumatoid arthritis, and psoriatic arthritis.

In the studied group, the mean age of patients who underwent total knee replacement for osteoarthritis was 58, which is relatively higher compared to Western populations. Interestingly, 50% of these patients had a body mass index (BMI) within the normal range (<25 kg/m2).

The early onset of osteoarthritis in individuals with a normal BMI in this population is attributed to cultural practices such as kneeling, squatting, and cross-legged sitting. At the initial presentation, 58% of patients had Grade IV osteoarthritis, indicating complete obliteration of the joint space.

Keeping the posterior cruciate ligament (PCL) intact during total knee arthroplasty (TKA) is intended to uphold posterior stability and potentially maintain the natural movement patterns of the knee joint. Research, such as the study conducted by Ritter et al. in 2001, has illustrated enhanced posterior stability and increased range of motion (ROM) in PCL-retaining TKAs compared to procedures where the PCL is sacrificed(9).Conversely, sacrificing the PCL might simplify surgical procedures and lower the risk of impingement, potentially leading to improved flexion stability, as suggested by investigations like that carried out by Whiteside et al. in 2000(10).

Retaining the posterior cruciate ligament (PCL) in total knee arthroplasty (TKA) theoretically minimizes disruption to the knee joint's blood supply, potentially reducing both intraoperative and postoperative bleeding. Conversely, sacrificing the PCL may entail more extensive soft tissue dissection and manipulation, heightening the risk of intraoperative bleeding. Several studies, including a meta-analysis by Zhang et al. (2016), have scrutinized the impact of PCL retention or sacrifice on blood loss in TKA, revealing slightly higher blood loss with PCL sacrificing(11). However, the clinical significance of this discrepancy varies based on patient factors and surgical techniques. Regarding surgical time, PCL retention may demand a more meticulous approach and additional steps for ligament preservation, possibly elongating the overall procedure. Conversely, sacrificing the PCL could streamline the surgery by obviating the need for intricate ligament preservation and fixation, potentially reducing surgical time. Studies contrasting surgical duration between PCL retaining and sacrificing techniques have yielded inconsistent findings. While some research indicates longer surgical times for PCL retention, others show no significant difference or even shorter durations compared to PCL sacrificing. For instance, Lutzner et al. (2015) observed that PCL retention did not significantly extend surgical time relative to sacrificing the ligament(12).

Upon analyzing the functional outcomes, it was observed that all patients in both groups experienced significant improvement in knee scores and functional knee scores. A comparison between the two groups revealed that in patients where the cruciate ligament was sacrificed, the average knee score was 85.8, and the Functional Knee Score was 99.6. In contrast, when the posterior cruciate ligament was retained, the knee score was 75.6, and the functional score was 91.6. Pain scores also demonstrated marked improvement in all patients, with an average of

42.6 in the cruciate sacrificing group compared to 37 in the cruciate retaining group. Statistical analysis indicated a significant difference (p-value) in favor of the cruciate sacrificing group for all pain score variables, suggesting better pain improvement in this group.Analyzing the total Knee Society Scores, the average Knee Society Score for the cruciate sacrificing group was 85.80, while for the cruciate retaining group, it was 75.60. Statistical analysis showed a significant difference in the p-value, favoring the Cruciate Sacrificing Prosthesis, indicating better functional outcomes.

The Functional Knee Society also demonstrated notable improvement in both groups, with a Functional Knee Score of 99.6 for the cruciate sacrificing group and 91.6 for the cruciate retaining group. Although there was no significant statistical difference in this aspect.WOMAC Scores also exhibited marked improvement, with a score of 24.6 in the cruciate sacrificing group and 27.4 in the cruciate retaining group. Statistical analysis indicated a highly significant difference in favor of the cruciate sacrificing prosthesis.

All patients exhibited notable improvement in their Knee Society Score, mainly driven by advancements in pain scores and stair climbing. The Functional Knee Score demonstrated excellent enhancement across the entire patient cohort. Additionally, the WOMAC Score showcased marked improvement, particularly in cases where the posterior cruciate ligament was sacrificed. The study revealed a substantial level of agreement among the Knee Society Score, Functional Knee Score, and WOMAC Score, highlighting the consistent positive outcomes across these assessment metrics.

A meta-analysis conducted by Seon et al. in 2012 compared clinical outcomes between PCL-retaining and PCL-sacrificing total knee arthroplasties (TKAs). Their findings suggested no significant difference in functional scores, such as the Knee Society Score (KSS) or the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC), between the two techniques(13).However, contrasting results have been reported in some studies. For instance, Song et al. (2014) found better clinical outcomes, including improved knee function and higher patient satisfaction, in PCL-retaining TKAs compared to sacrificing techniques(14).

Conclusion

In conclusion, the results demonstrated that both PCL retaining and sacrificing procedures led to significant improvements in knee scores, functional knee scores, and pain relief. However, the statistical analysis revealed a consistent trend favoring the PCL sacrificing group across various parameters, indicating superior outcomes in terms of pain relief and functional performance.

Patients in the PCL sacrificing group exhibited higher average knee scores, Functional Knee Scores, and lower pain scores compared to the PCL retaining group. The findings were consistent across multiple assessment tools, including the Knee Society Knee Score, Functional Knee Score, and WOMAC questionnaire. Notably, stair climbing and range of motion also showed favorable outcomes in the PCL sacrificing group. These results suggest that, in the context of Total Knee Arthroplasty, sacrificing the PCL may contribute to better functional outcomes and pain relief. Further research with larger cohorts and extended follow-up periods is recommended for comprehensive validation.

Declarations
Funding: None
Conflict of Interest: None declared
Ethical Approval: Not required

Table 1 - Gender

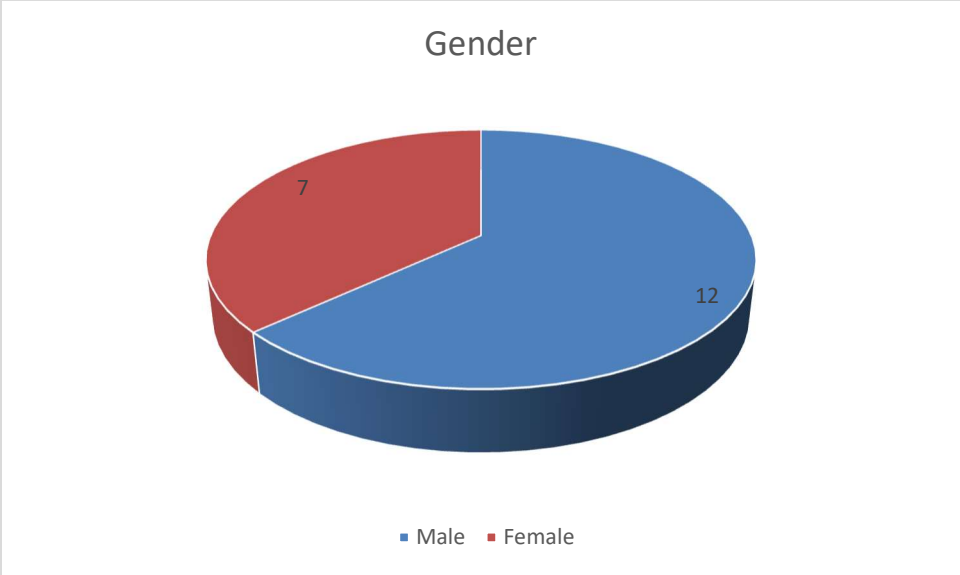


Table 2 – Side Affected

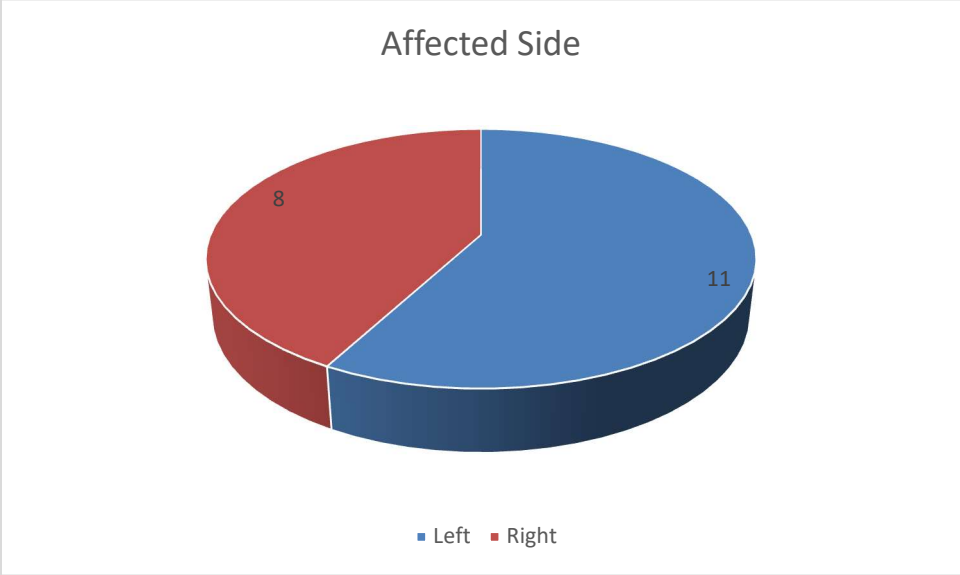


Table 3 – Comprehensive Knee Score

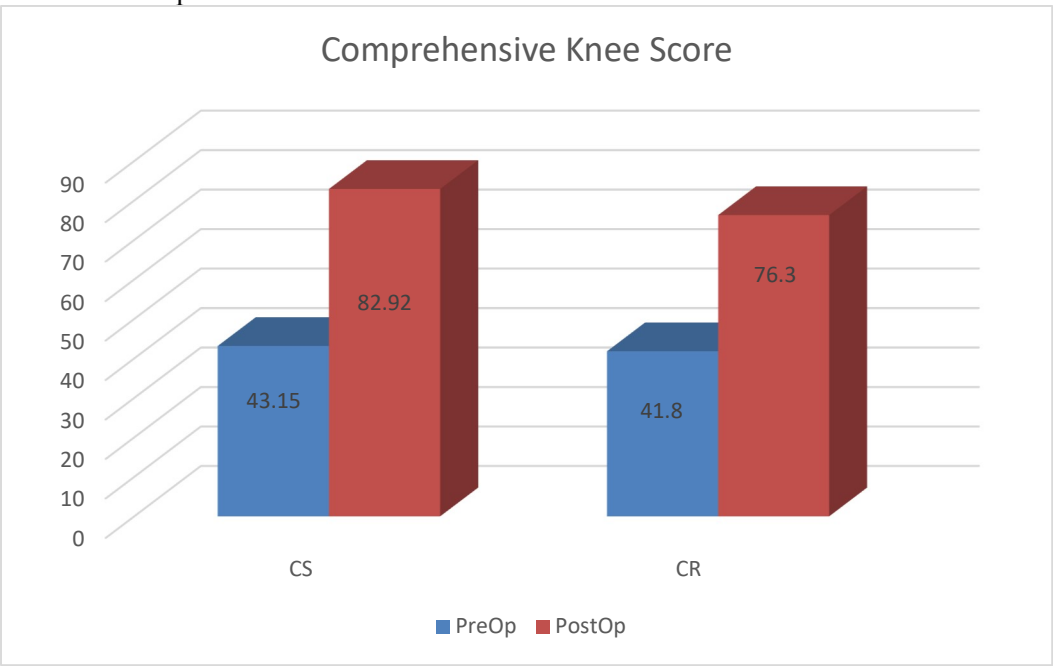


Table 4 – Functional Knee Score

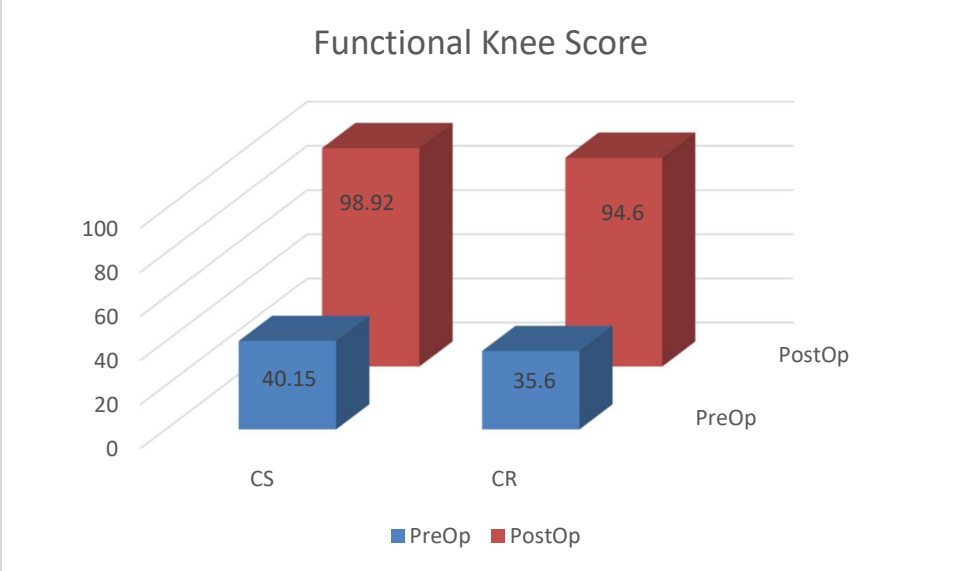
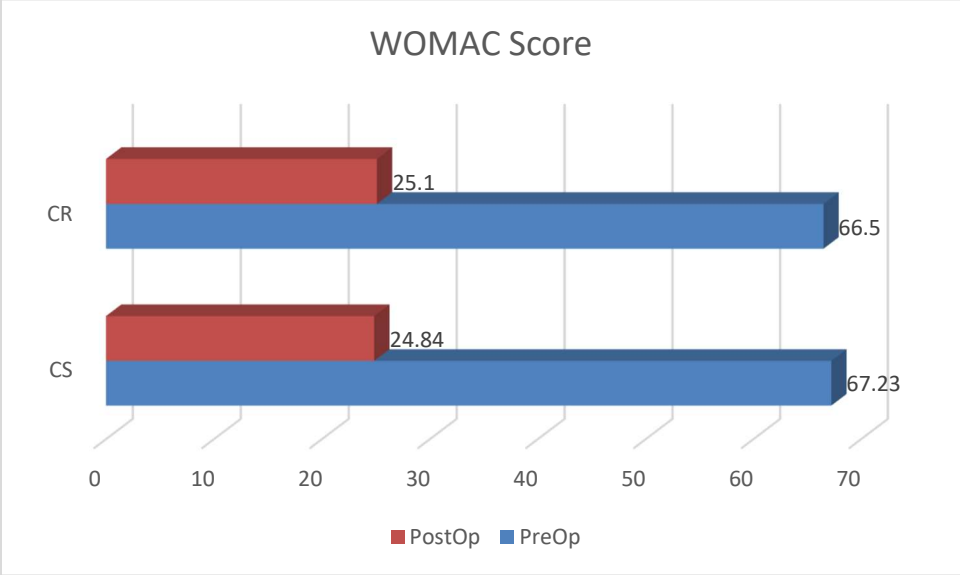


Table 5 – WOMAC Score



Master chart

S.NO	AGE	SEX	SIDE	PCL Retaining/ sacrificing	HT	WT	BMI	KL GRADING Pre op	PREOP KS Score	Pre op Functional knee score	Pre op Womac score	POST OP KS Score	Post op Functional knee score	Post op Womac score
1	71	M	R	sacrificed	164	78	29	4	43	40	66	94	100	24
2	54	M	L	sacrificed	158	66	26.4	4	44	34	64	85	100	25
3	76	F	L	sacrificed	154	72	30.4	3	42	42	68	84	100	22
4	69	M	L	sacrificed	159	80	31.6	4	35	44	66	90	96	24
5	55	F	R	Retained	150	64	28.4	3	40	30	65	80	94	26
6	60	F	L	sacrificed	154	78	32.9	3	42	43	70	84	100	27
7	73	M	R	Retained	162	74	28.2	4	47	40	65	94	92	24
8	67	M	L	sacrificed	160	67	26.2	4	45	44	69	79	100	26
9	59	M	R	Retained	153	70	29.9	4	36	30	66	25	98	28
10	70	M	R	Retained	165	78	28.7	4	44	36	68	82	96	24
11	51	F	R	sacrificed	151	66	28.9	3	46	38	66	85	92	26

12	57	M	L	sacrificed	156	68	27.9	4	44	26	70	95	100	23
13	62	F	L	sacrificed	160	82	32	3	46	31	64	69	100	28
14	60	F	R	sacrificed	154	78	32.9	4	38	40	63	84	98	24
15	58	M	L	Sacrificed	159	80	31.6	4	44	50	68	72	100	28
16	49	M	R	Retained	158	76	30.4	4	41	48	69	83	94	24
17	75	F	L	sacrificed	149	72	32.4	3	47	44	70	85	100	24
18	66	M	L	sacrificed	158	77	30.8	4	45	36	70	72	100	22
19	59	M	L	Retained	162	75	28.6	3	43	30	66	94	94	25

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