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Original research article

A study on comparison of bone loss at total knee replacement: Posterior stabilized versus cruciate retaining

[1]Dr. Vokkerla Kiran Kumar, [2]Dr. Bhanu Prabha T, [3]Dr. Gavaskar B

[1, 2, 3]Assistant Professor, Department of Orthopaedics, Government Medical College, Nizamabad, Telangana, India

Corresponding Author:
Dr. Vokkerla Kiran Kumar

Abstract

Background and Objectives: The posterior stabilised and cruciate maintaining designs of knee replacement are widely known. There are questions over how much additional bone is removed whenever a posterior stabilised knee replacement is inserted.

Methods: We examined the quantity of saw bone removed from the two kinds of prostheses produced by the two different manufacturers that are utilized at our institution (Genesis 2 and PFC). Prior to and during the surgery for the posterior stabilized prosthesis and the cruciate retaining prosthesis, the Sawbones were measured. In all of the configurations, the amount of bone loss was quantified. There were ten sawbones utilized for every one 4 categories.

Results: In comparison to the cruciate maintaining design, 5% greater bone was loss in the Genesis 2 posterior stabilized configuration (P<0.005). Comparing the cruciate retaining design to the PFC posterior stabilized design, 25% more bone was lost (<0.005). Additionally, 7% greater bone was lost when the PFC posterior stabilized model was used as opposed to the Genesis 2 posterior stabilised model (p<0.001).

Conclusion: Since a posterior stabilized knee requires much more bone to be extracted than an anterior stabilized knee, we suggest that cruciate retaining prostheses should be given attention in the absence of special criteria for posterior stabilization of the knee.

Keywords: Knee arthroplasty, posterior stabilized, cruciate retaining, bone loss

Introduction

Total knee replacements (TKR) can be divided into two main categories: posterior stabilised (PS) and cruciate retaining (CR). Studies have shown that there is minimal difference in the eventual functional outcome between the two [1, 2, 3]. Concerns have been raised about the PS knee replacement's femoral preparation process using less bone removal than the CR prosthesis. PS knees' more recent designs have made an effort to alleviate this problem [4, 5].

The goal of this study was to evaluate two regularly used prosthesis brands as well as to measure the quantity of bone loss from the femur in the two designs (PS versus CR).

Material and Methods

For the experiment, 25 femoral "sawbones" were employed from November 2021 to October 2022 and conducted at Department of Orthopaedics, Government Medical College, Nizamabad, Telangana, India.

Twelve were given to the PFC group and thirteen to the Genesis 2 group.

Sawbones were weighed using A&D EK series digital scales from Progen Scientific, India. The weight was recorded in grammes. A CR knee replacement followed. The Genesis 2 and PFC groups have correctly proportioned femurs. Using jigs with 5 degrees of valgus, one author cut the wood (RK). After garbage removal, the sawbones were weighed again.

The bones were reweighed after making further cuts for a posterior stabilised knee replacement with blocks.

The weight of the sawbone removed for a knee replacement that retains the cruciate is the difference between the first and second readings. The first and third readings differ because of the posterior stabilisation knee replacement's sawbone removal.

Data collection was done in Excel. The Wilcox Rank Test and Mann Whitney U test were used for statistical analysis because the data was not normally distributed.

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Results

Table 1: Contrasting the average quantity of bone removed from various knee replacement designs and models

	Cruciate Retaining (Mean weight in grams ± SD)	Posterior Stabilized (Mean weight in grams ± SD)	P value *
PFC			
Pre-operative	142.96 ± 3.91	142.67 ± 3.86	$p<0.005$
Post-operative	133.87 ± 3.20	130.26 ± 3.22	
Bone removed	10.80 ± 1.61	13.28 ± 1.62	
Genesis 2			
Pre-operative	142.30 ± 4.90	141.22 ± 4.83	$p<0.005$
Post- operative	131.60 ± 4.58	128.88 ± 4.50	
Bone removed	10.68 ± 0.85	12.36 ± 0.98	
P value **	P=0.317	$P<0.0001$	

p value measured by Wilcox Rank Test
** P value measured by Mann Whitney U test

Table 1 displays how much bone was removed for each group. PFC PS knee replacement required 25% more sawbone to be removed from the femur than cruciate maintaining knee replacement (13.28g vs 10.80g, $p<0.005$). Similar to the cruciate retaining knee replacement, 15% more saw bone was removed during the Genesis 2 PS procedure (mean 12.36g vs. 10.68g, $p<0.005$). Additionally, employing the PFC PS design, 7% more bone was lost in comparison to the Genesis 2 PS design (13.28g vs. 12.36g, $p<0.0001$). The quantity of bone removed by the PFC or Genesis 2 CR knees was not significantly different ($p<0.315$).

Discussion

Total knee replacement is an excellent therapy option for patients with severe knee arthritis. In this piece, we'll take a look at the two most common types of knee replacement surgery: the posterior stabilising and the cruciate retaining. Historically, both have been successful. Though originally developed to make the TKR more stable, the PS TKR is now commonly used in place of the TKR [7, 8].

The debate over whether the PS or CR design is better has yet to be resolved. The PS design is recommended for patients with no posterior cruciate ligament (PCL) and mild knee instability. Possibilities advantages include enhanced proprioception and simplified knee balancing. Comparative research on the two formats, however, yields mixed results. Between 2 and 5 years after treatment, Wang *et al*. compared the two groups' radiological changes and clinical outcomes (based on knee and functional scores). There was found to be little difference between the categories. The research team of Maruyama *et al*. looked at 25 individuals who had undergone bilateral knee replacements. One patient in each group underwent a CR knee replacement and the other a PS knee replacement. When comparing the knee scores of the two designs, there was no clear winner. Other studies have come to similar conclusions [8, 9].

Straw *et al*. conducted a study comparing the effects of PCL reinsertion, PCL removal, and PCL retention. Patients received either a CR TKR, a PS TKR, or a CR TKR with PCL resection based on a random allocation. They found no statistically significant difference between the three methods in terms of functional ratings or ROM (range of motion). Individuals who had been randomly assigned to retain the PCL but afterwards developed an excessively tight ligament underwent a procedure to release the ligament to an acceptable tension. This group significantly underperformed the rest [9].

In a study comparing the two designs, proprioception and balance were evaluated, but the researchers found no significant differences. Misra *et al*. compared the CR prosthesis to a healthy PCL and a PCL that had been sacrificed in a comparable study. As before, there was no observable change.

Gait analysis were employed by Andriacchi and Galante in one of the few studies that compared CR and PS knees. Walking and stair climbing abilities were significantly higher in the CR group. Abduction, adduction, and proximal and distal translation rotation increased in the posteriorly stabilised group, as did flexion and extension, although the difference was not statistically significant, according to the research by Ishii *et al*. Fascinatingly, there were no changes in gait during the swing period [9, 10].

Bone loss in five PS implant systems was investigated by Hass *et al*. They observed considerable heterogeneity in bone loss between implants and hypothesised that this would influence knee *in vivo* kinematics, raise the risk of intercondylar fracture, reduce bone remnants after revision, and shorten the lifespan of total knee arthroplasty. While our study did not explicitly compare CR prostheses to PS knees, it stands to reason that the larger amount of bone stock removed in CR knee arthroplasty could make it more difficult than it needs to be compared to PS knee arthroplasty [10].

Comparing the PS and CR knee replacement designs, we find that the former requires more bone removal. There are two other things to think about apart from the scope of this study. Unlike the CR design, the inset box of the PS design stops an osteotome or saw blade from entering the space between the prosthesis and bone interface. Therefore, more host bone is sacrificed while using PS prostheses. Second, in distal femoral periprosthetic fractures, the PS design eliminates nail passage [10, 11].

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Sawbones may come under fire for the study because they are being used as a bone substitute. However, without bone dust, gauging bone loss *in vivo* is next to impossible. Errors would also occur if blood, soft tissues, saline wash, etc. were used [11, 12]. This technique provides very precise estimations of the amount of material removed relative to the total sawbone weight. Sawbones, unlike real bone, have a consistent density throughout. Sawbone procedures are likely to be limited due to the cortical nature of the excess bone removed to make room for a PS knee. In conclusion, research has not demonstrated any benefit from increasing or decreasing bone removal during primary arthroplasty. In contrast, bone-preserving procedures are prefered, and orthopaedic surgeons just remove the damaged bone.

Conclusion

Despite its original design purpose of enhancing coronal plane stability, the PS TKR is now routinely used. When it comes to bone loss, a CR design during primary surgery on a basic knee may be better. However, if a PS design is required, it's important to put some effort to selecting a shape that resects as little bone as possible.

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Conflict of interest

None

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