Does a Total Knee Replacement (TKR) Improve Range of Motion (ROM) in Patients Over 80 Years of Age, as Compared to 50-70 Year Olds?

By

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Introduction:

The complexity of the knee joint has only begun to be acknowledged in the past 30 years; however, TKR's have been practiced for over 50 years. It is thought that Fergusson was the first to do a surgery similar to a TKR. It involved going into the joint capsule and placing materials such as skin, muscle, fat, and even a pigs bladder to try to 'cushion' the joint. Since then knee surgery has come a long way, from the types of material used to the size of incisions. (Cross) Presumably the reason for TKR's has never changed; to improve the life of the patient by decreasing pain and increasing mobility.

In the 1940's molds that were fitted with the bones in the joint were first thought of, however, the first models had reoccurring pain and loosening problems. Throughout the next decade the reoccurring models were hinge shape in design and did not compensate for the complexity of the knee joint, infection was also a very high probability with these surgeries. (Cross) In 1971, Gunston was the first to recognize that the knee doesn't rotate on a single axis, as the hinge models were currently replicated after, but is a roll and glide joint on multiple centers of rotation. His polycentric model had improved the movement allowed in a replacement, but was ultimately unsuccessful. Due to the same problems of loosening and pain, as with the previous models, had not been attended to. (Cross)

A kinematic conflict arose and still persists today when, even after Gunston's work, the Mayo Clinic in 1973 introduced a conforming and constrained TKR model. So the battle was between a 'rigid' but stable knee, hinge type model. Or the more Gunston idea of attempting to reproduce normal knee ROM with higher incidence of pain and replacement. In 1973, the next big leap was a total condylar model designed by Insall at the Hospital for Special Surgery, it did not try to resemble normal knee ROM, but did have the lowest mortality rate with 94 percent

surviving after 15 years. Later this model was altered by the same Hospital, by retaining the cruciate ligament to help keep knees ROM. This leads to another big argument in the TKR world of whether to preserve or discard knee ligaments in TKR's. There is no significant difference in studies thus far. There are multiple areas in the TKR world that have an insufficient amount of data. Especially in the long term affects of a TKR on an elderly patient and ROM gained, lost or maintained.

Common causes of a TKR are osteoarthritis, rheumatoid arthritis and post-traumatic arthritis. These are due to aging, genetics, and the natural wear and tear of a joint that is constantly being used. Symptoms that doctors look for in candidates for this surgery are severe pain, severe stiffness, chronic inflammation and swelling, bowing of the knee, and failure of these symptoms to improve with medications, injections, or therapy. Doctors tell patients to expect a significant decrease in pain from a TKR, but some possible complications of surgery are infection, blood clots, implants problems such as a severe decrease in ROM, continued pain, and possible neurovascular injury. (AAOS)

Total knee replacement surgery is the number one performed procedure in people over 65. When considering in 2010 thirteen percent of our U.S. population was over the age of 65 this is a topic prominent to many and will continue to be to more. (U.S. Census Bureau) The main reason most patients seek treatment, or their physicians suggest a TKR, is due to pain in the knee joint. I believe ROM should not be overlooked. The literature says over and over we need more data on the effects of TKR. The fact that younger and younger patients are having this surgery, will make ROM an even bigger issue. For the elderly the issue is not only pain, as most of the studies focus on. ROM is associated with mobility, mobility is associated with independence, and independence is a huge factor for this age group. Someone who has made it to 70 years old

without having to rely on too much outside help will not want to lose that independence because of this surgery.

Previous studies showed that at minimum an average person needs 93 degrees to get up from a chair, 90 degrees to go up and down stairs, 106 degrees to tie your shoe, and to lift an object requires 117 degrees of flexion.(Orthopod) ROM is usually measured with a goniometer, in both flexion and extension. Flexion is defined as the act of bending at a joint, so that the angle between the bones decreases. As you decrease the angle between these bones, that is increasing the ROM. Extension is opposite as it is defined as the angle between two bones increasing, so straightening the leg. (The American Heritage Dictionary) The average amount of therapy sessions prescribed/attended by the patients is 12 times, three times a week for four weeks.

My hope is the data will show a difference in ROM gained, lost, or maintained between the surgical (knee replaced) and non-surgical leg (did not get replaced), and the variance age plays in this surgical procedure. I believe the data will reveal that the very elderly's ROM does not benefit from this procedure. Especially according to Orthopods minimum ROM needed to do daily activities. I believe the ROM lost in the surgical knee will vary greatly with age, especially between the 50 and 80 age groups. I hope that this data will show, even through profitable, doctors should evaluate their geriatric patients very thoroughly before deciding there are not better options for the pain management of the knee. I want there to be more data showing either TKR's are benefiting patients of every age. Or the data will show there needs to be more money put into research to find a better TKR model or procedure to reduce pain and not lose mobility in the process.

Methods:

I went through Joplin's Freemen Hospital to collect my data. Specifically, I collected the data from their outpatient physical therapy documents on their computerized documentation system. I had to gain an IRB approval from Freeman to begin collecting the data. I met with the head of Freeman's outpatient therapy to discus aspects of my research and gain expert ideas. I also had to meet independently with Freeman's medical records and IT department. Freeman had recently switched their online documentation system. I was given a password to access the previous system to collect my data.

I gained data on patients that had a TKR from the dates of January 2011 to March of 2012. Freeman's medical records ran my patient list to meet the specifications of my research. The patient list consisted of patients between the ages of 50-89, at the time of their surgery. The list did not include patients who had prior TKR, or hip replacements. After gaining the list of patients I was able to look up their charts on the computerized documentation system and gather the data I needed. I only documented the ROM's taken in the active form, so that the patient was bending the knee themself while the therapist measured with the goniometer. I did not include ROM's taken in the passive form, where the therapist assists in the patient bending the leg then measures the ROM, as I thought this was not a true ROM reading. For each patient I documented their flexion and extension on both the surgical and non-surgical leg. I collected the flexion and extension ROM for the surgical leg on the last session attended. I only documented patients if they attended at least six therapy sessions. Along with being discharged by the therapist due to satisfaction with the ROM, as it had hit a plateau in it's ability to bend farther. As for the non-surgical leg, I took that ROM data at any point in the patient's therapy that the data was available. As it was not the leg being rehabilitated, so its ROM should be at a constant. I took the

surgical legs ROM at the last session recorded, as is probably the optimal ROM that patient will have gained from the surgery and rehabilitation.

When analyzing the data I broke the age groups into 50-59, 60-69, 70-79, and 80-89 year olds. I collected data on ten patients per age group, leaving me with a total of 40 patients in my data. I stuck to 10 patients per age group as that was the limiting number of 80 year olds I had in my data. The non-surgical leg was used as a control in this analysis. Since the patient had no previous surgery on the non-surgical leg, I assumed this is the natural ROM that patient would have before surgery. As pre-surgical ROM data on the surgical leg was not available to me. The data was analyzed between the differences in ROM of the surgical leg taken on the last therapy session against the non-surgical legs ROM, both the flexion and extension. The data was run to show if the patient gained, sustained, or lost ROM from the TKR compared to the control knee. The difference in ROM between each patients surgical and non-surgical leg were then averaged in the specific age groups, then those means were cross analyzed between the age groups to see how much age was a factor. I used a two tailed, one way ANOVA in Graph pad, and used a two way ANOVA in the psychology departments SPSS.

Results:

Table 1, shows the mean for the surgical and non-surgical leg, p value, standard deviation, and difference between the surgical and non-surgical leg means for all four age groups tested. The mean for the 50 year olds surgical leg was 119.1 degrees of flexion. The 50 year olds non-surgical mean was 127 degrees. The difference between the 50 year olds means was a loss of 7.9 degrees of flexion in the surgical knee compared to the non-surgical, or control legs mean. The mean for the 60 year olds surgical leg was 119.8 degrees of flexion. The 60 year olds non-surgical mean was 124.2 degrees. The difference between the 60 year olds means was a loss of

4.4 degrees of flexion in the surgical knees ROM compared to the non-surgical, or control legs mean. The mean for the 70 year olds surgical leg was 112.2 degrees of flexion. The 70 year olds non-surgical mean was 124.7 degrees. The difference between the 70 year olds means was a loss of 12.5 degrees of flexion in the surgical knees ROM compared to the non-surgical, or control legs mean. The mean for the 80 year olds surgical leg was 118.8 degrees of flexion. The 80 year olds non-surgical mean was 122.9 degrees. The difference between the 80 year olds means was a loss of 4.1 degrees of flexion in the surgical knees ROM compared to the non-surgical, or control legs mean.

Table 1: Mean, P Value, Standard Deviation, and Mean Differences for all Four Age Groups.

	50's	60's	70's	80's
Mean FS	119.1	119.8	112.2	118.8
Mean FNS	127	124.2	124.7	122.9
P Value	0.1065	0.2695	0.0476	0.1524
SD	13.93	11.825	17.24	8.293
Mean Diff	-7.9	-4.4	-12.5	-4.1

The only p value that tested significant was in the 70 year old age group, in the difference between the surgical and non-surgical mean ROM. The p value showed significance by being p=0.0476. All the other age groups p values were above the 0.05 mark, meaning not significant. The 80's age group had a p value of 0.1524, 60's age group p value equaled 0.2695, and the 50's age group was 0.1065. All of the previous p values mentioned were the within group statistics. The across group statistics all came out not significant, so with p values above 0.05, all of them were more than double that p value. Standard deviations for each age group reflected their mean differences. As you can see in Table 1, the 70's age group had the largest standard deviation and

largest mean difference. The 80's age group had the smallest standard deviation and smallest difference between the surgical and non-surgical legs ROM.

Figure 1 does a great job of showing the effect age has on the knees ROM, along with that it shows what ROM the TKR allows the patient to attain. The top line in the graph (red line), is the non-surgical ROM within the age groups. The only factor this line has is age, thus why it is the control group. I think it portrays how the knee's ROM gradually deteriorates with age. The bottom line (blue line) in Figure 1 shows the average mean within the age groups for the surgical leg. The bottom line is not a gradual one, more like a jagged line. Figure 1 shows the 60 year olds gaining the most ROM in their surgical leg, while the 70 year olds lost the most amount of ROM in their surgical leg. The graph also shows the 50 and 80 year olds got about the same ROM out of their surgical leg.

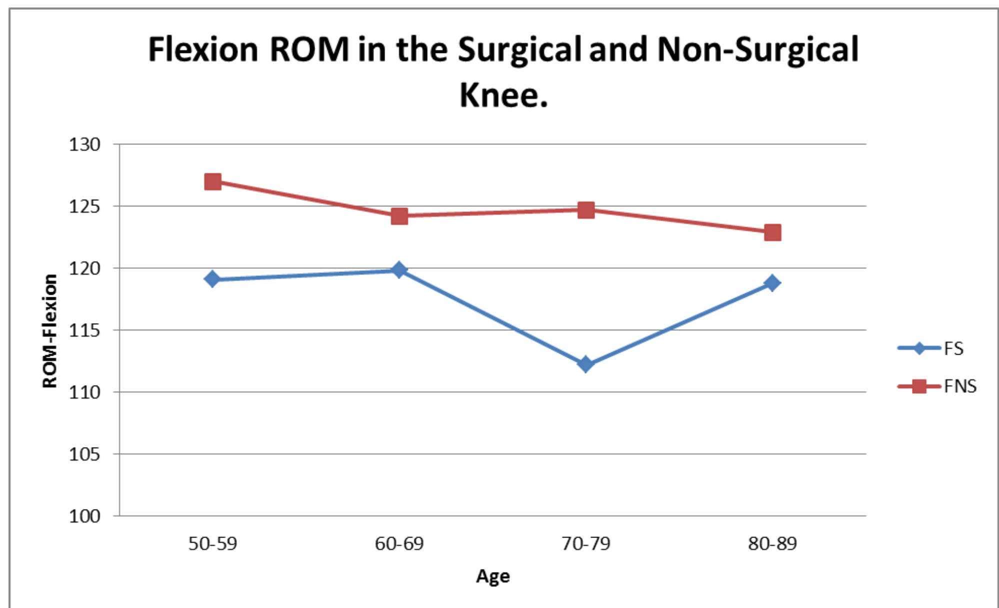

Figure 1. Top red line is the non-surgical leg mean for each age group. The bottom blue line is the surgical legs mean for each age group.

I like using Figure 2 to show the difference between the ROM of the control knee (non-surgical) and the TKR knee (surgical) ROM. On the graph you can see how close the 60's and 80's age group got to having the same ROM in both knees. The 50's age grop has a moderately greater ROM in the FNS (non-surgical/red bar), compared to the FS (surgical/blue bar) knee. And last the graph also shows the vast difference between the 70 year olds surgical and non surgical knees ROM.

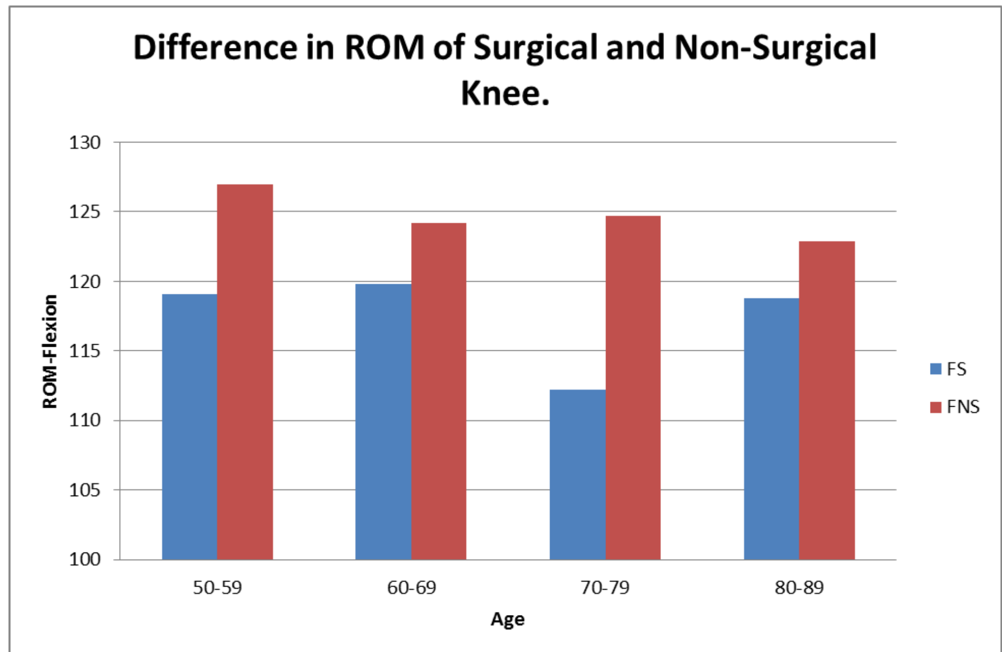

Figure 2. Red bars are the means for the non-surgical knee in each age group. The blue bars are the surgical knee's mean ROM in each age group.

Figure 3, I put in here to show how a TKR performs in allowing the patient to gain the minimum ROM needed to do basic activities. The top red line is the non-surgical knee, the middle blue line is the surgical knee, and the bottom green line is the minimum ROM needed to do some of the daily activities. All the dots correspond with the age group, except for the green line. The green line, from left to right is ordered as such. First dot, 93 degrees of flexion needed to stand from a chair.

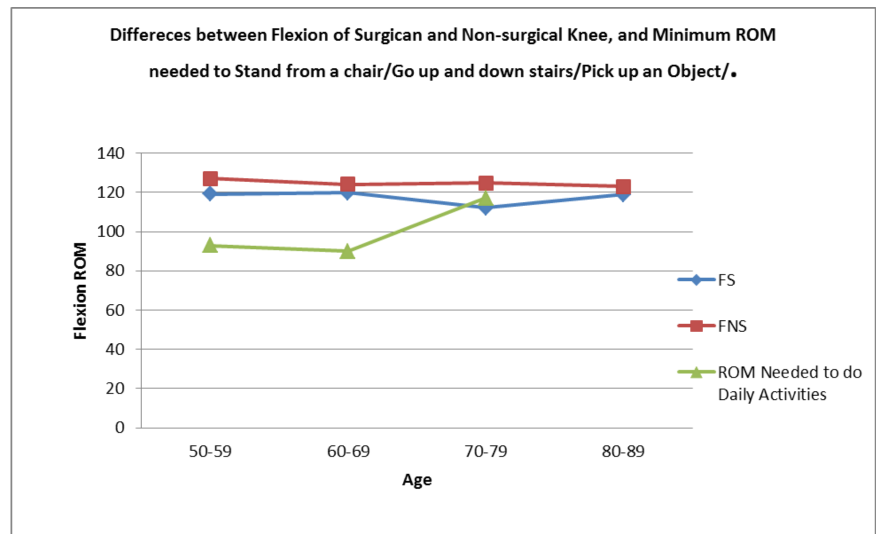

Figure 3.

Second dot, a minimum of 90 degrees are needed to go up and down stairs. Third dot, 117 degrees of flexion are needed to lift an object. And the fourth and final dot on the green line is showing that on average one needs 106 degrees to tie their shoe. I choose this style of graph as it shows that the non-surgical legs ROM in all the age groups are above these minimums, meaning that patient can bend that far in their non-surgical leg. However, if you look between the green and blue line, the graph shows that the 70 year olds surgical leg is below the lifting an object dot. Meaning that patient does not have the ROM they need to be able to lift an object in their surgical knee.

Discussion:

I would have preferred to have conducted this research on pre-surgical ROM and post-surgical ROM of the TKR leg. Not to compare the ROM of the surgical and non-surgical leg. However, the pre-surgical data was not available. I also would have preferred to have more people in each age group to heighten my statistical significance. However, due to my restriction to only accessing the old data base I was limited in numbers available that met my qualifications, especially in the 80 age group.

The fact that there was a significant difference between the surgical and non-surgical legs ROM is not surprising. The TKR will have limited ROM compared to the non-surgical leg that has not been operated on, even after therapy. The fact that the difference in ROM for the 50 and 80 year olds was the same is surprising, one would think the older you get the less ROM you can get out of the TKR. There are many possibilities for these results. First, we need to take into account deterioration of the non-surgical leg and that it too possible needs a TKR. Second possibility the patients are actually exercising when doing physical therapy. Third option is that

the TKR model needs to be given credit for allowing patients to gain acceptable ROM, no matter the age.

It is surprising that in the 80 year old age group there was not only no significant difference between their surgical and non-surgical knee, but that they had least amount of difference in ROM between their surgical and non-surgical knee, with their being a lack of 4.1 degrees in the surgical leg. I had to reject my hypothesis of their being a significant difference of ROM within the 80 year old age groups surgical and non-surgical knees, and to reject a difference compared to the other age groups, and accept the null. I was surprised there was an equal amount of males to females, as males die sooner than females, especially up in the 80's. I believe the main reason for the similarity of ROM in the knees is due to the patients' health. If a patient is still alive, qualifies for a surgery, and does not have to have a TKR until their 80's one can assume that their genetics and health habits are of at least some high standard. Leading to an ability to achieve a ROM in the surgical leg that is only about one degree less than that of people who are 11-39 years younger than them. I believe that statement is a testament to the ability of the TKR model and procedure.

There are numerous reasons why tests within the 70 year old age group was the only significant finding, with a p value of $p=0.04$. The 70 year olds had the biggest gap in their standard deviations and lacked an average of 12.5 degrees in the surgical leg compared to the non-surgical. I had to accept the null hypothesis that there was no significant difference between the 70 group and other age groups. This group was made up of more females than males, with their being 8 females and 2 males. Every other group was pretty evenly matched with about 5 males to 5 females. Perhaps with osteoporosis being a factor in females this accounted for a bigger difference in ROM. One huge factor is perhaps the 70 age group is not in the best

condition for the TKR, this age group has the highest mortality rate in general. Therefore, perhaps this is just a problem with the way 70 year old patients are evaluated for this surgery.

50 year olds are usually at a time in their life where they are trying to pay off mortgages, have high positions in their jobs and feel they don't have time to take off to do therapy. Therefore they do not rest the knee or work it out enough to get it's full ROM potential. Leaving us with the 50's having one of the bigger gaps between their surgical and non-surgical knees ROM. For the 60's perhaps perfect age to have a TKR. Unlike the 70's the 60 year olds can have an average of 15 more years left to get use out of their knee, while still having the energy to obtain the ROM through therapy.

If I were to do this study over again, or to continue it, I would start off with gathering a bigger sample size. My ideal sample size for this study would be at least 30 people per age group. I would have another factor of male versus female added. Thirdly I would not base this study on data collection through the computerized patient file system. Although time and amount of patients meeting the criteria would be under more pressure, the ideal condition in which to conduct this study is by collecting it straight from the patient. Via going into a therapy clinic of some sort that is willing to work with the collection process. Collection of data directly from the patient would allow for information such as ROM in the surgical leg before surgery, so as to see the ROM difference the TKR makes on the same leg. By collecting data through the computer I did not have access to the patients pre-surgical ROM in the surgical leg, therefore, I used the non-surgical leg as the optimal ROM that patient would have normally. Getting the data directly from the patient would provide knowledge of comorbidities, to perhaps correlate TKR progress with certain diseases. As some diseases affect healing more than others. I would also look at

correlating the outcomes to certain doctors, the TKR model used and cause of getting a TKR in the first place, for example genetic or trauma.

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