ORIGINAL ARTICLE

Cost Utility of Various Biologic Versus Endoprosthetic Reconstruction for Primary Bone Sarcoma of the Knee

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Background: Currently, the treatment of primary bone sarcoma has been developed to increase survival rate and enable patients to undergo limp sparing surgery. The cost-utility study of reconstructive surgery methods could also benefit developing treatment plans as well as national policies.

Materials and Methods: The present research was conducted among 27 patients with primary bone sarcoma of the knee undergoing limp sparing surgery by analyzing the cost-utility of various biologic versus endoprosthesis reconstruction. The result reported in the quality-adjusted-life years (QALY), cost per year of well-being (Cost/QALY), ratio of additional sanitary years (QALY gain), and creating alternatives to adjust costs to an acceptable range with one-way sensitivity analysis.

Results: The QALY of endoprosthesis was the highest at 5.316 years, while the lowest number was recycled bone autograft at 3.712 years. Compared with the Cost/QALY, the recycled bone autograft indicated the most breakeven method, while endoprosthesis showed the lowest. For analyzing by QALY gain, the additional investment totaled 171,314.27 THB.

Conclusion: Prosthesis as a good option, have side effects and the highest number of QALY but did not breakeven. However, reducing the cost by 27.004% was almost the same as the most breakeven method. For this method, an additional investment, equivalent to the minimum wage in Thai law averaging within 1 year, was not needed because this extra investment cost only about the minimum Thai civil servant salary for 1 year.

Keywords: Primary bone sarcoma of the knee; Bone reconstruction around the knee; Cost-utility analysis; Various biologic versus endoprosthesis reconstruction

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Musculoskeletal sarcomas are commonly found among patients aged less than 35 years old[1]. The symptoms tend to develop at extremity and one half of that appear at the knee[2]. In the last four decades, the treatment by limb salvage surgery compared with the amputation in term of survival rate after surgery are not significantly different[3]. The surgical procedures can be classified as various biological as osteoarticular allograft and recycled bone autograft, and endoprosthetic reconstruction.

Cost-utility analysis is an assessment of public health economics measuring costs in term of money and benefit as special clinical fees[4]. The term of various surgical reconstructions is important to select the most suitable treatment[4]. Wilson et al.[5] reported the cost-utility assessment among patients with primary bone sarcoma of the knee. The full osteoarticular allograft exhibited much more cost-benefits than endoprosthetic treatment. One-way sensitivity analysis revealed that endoprosthetic with 30% cost-discount would show more cost-benefits than osteoarticular allograft when the cost of endoprosthetic reconstruction was less than 51,900 USD. Albergo et al.[6] studied the surgical treatment of proximal tibia after cancer resection and found no difference in failure rate between osteoarticular allograft and endoprosthetics. Xu et al.[7] investigated surgical treatment of the distal femur after cancer resection. The first two years of endoprosthetic reconstruction with metal replacement showed better performance results.

Therefore, the significant findings of the present research will be used to support decision-making and promote the selection of the most appropriate

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treatment with high cost-utility in the Thai context.

Objective

The present study aimed to assess cost-utility of reconstructive surgical procedures with various biological reconstruction techniques, such as osteoarticular allograft and recycled bone autograft compared with endoprosthetic reconstruction among patients with cancer and primary bone sarcoma of the knee.

Materials and Methods

The present research constituted a retrospective analysis study targeting patients with cancer and primary bone sarcoma around the knee undergoing limb sparing surgery at the Orthopedic Department, Phramongkutklao Hospital between 2014 and 2018. Twenty-seven patients met the requirements.

Ethics approval

The present project, No. R187/62, was approved by Institutional Review Board of the Royal Thai Army Medical Department, No. IRBRTA 680/2563.

Inclusion criteria

Patients being treated at the Orthopedic Department, Phramongkutklao Hospital between 2014 and 2018 were screened. All participants diagnosed as primary bone sarcoma around the knee at the distal femur and/or proximal tibia and who underwent limb-sparing surgery were included. Exclusion criteria were patients having distant metastasis or recurrent lesion area when assessed using the EQ-5D Health questionnaire. The present project excluded those who could not be assessed by using the EQ-5D Health Questionnaire or did not voluntarily provide additional information in the case of incomplete information in the PMK Musculoskeletal Oncology Patient Database (PMK-MOPD).

Research method

1. Permission to access expenses information was requested including medical costs from medical records, hospital patient billing data and money that National Health Security Office (NHSO) reimbursed the hospital according to the Joint Disease Diagnosis Group (DRG) charges from the director of Phramongkutklao Hospital.

2. EQ-5D Health Questionnaires were used to collect assessment information from the database, PMK-MOPD and when any incomplete form was found, the researcher contacted the patient for more information with an understanding of informed consent regarding patient's rights.

3. Cost-utility of medical treatment was calculated using money currency in THB per quality adjusted life-year (QALY) accessed by life year-gained (LYG) with utility from EQ-5D Health Questionnaire assessment and literature review.

Outcome measurement

Cost-utility was compared and analyzed regarding various biological reconstruction surgery techniques such as osteoarticular allograft and recycled bone autograft versus endoprosthetic reconstruction surgery among patients with primary bone sarcoma around the knee. The study focused on the actual direct medical cost in the Thai context represented as QALY.

Definition

Model structure:

QALY obtained from the database, PMK-MOPD and literature review were used to create a Markov model. Cost per QALY was obtained by calculating direct medical cost (THB/QALY). QALY gain was calculated from the ratio of total cost difference between each pair of selected medical treatments. Altered cost and QALY (Cost/QALY) values were investigated considering factors such as total cost by various treatment procedures and cost-utility reflecting patients' conditions using one-way sensitivity analysis.

Model assumptions:

The model was based on assuming that each cycle of the model equaled one-year change, as cycle length, and that all patients will die at the age of 100 years. The mortality rate from all surgery treatments including primary surgery and revision surgery equaled zero and all patients were healthy before diagnosis. In this model, if any patient survived after diagnosis of primary bone sarcoma for 10 years, the patient would be considered disease-free and the mortality rate equaled that of the general population (LYG=10 years)[5].

Data collection

Cost: Total costs for social perspective include the following three categories but service provider perspective excluded category two and three as described below.

Direct medical cost:

The present research focused on the service

provider perspective and obtained the direct medical cost information from Phramongkutklao Hospital's database including the following:

- Hospital patient billing information
- Money that the NHSO reimbursed the hospital

according to the DRG charge. Direct medical cost was a standard cost without other disruptive factors such as economic status, traveling expenses for each area, and basic living cost. Moreover, these costs were measurable and could eliminate the problem of estimation error. Therefore, research results could be applied directly and used in policy specifying only the direct medical cost. The present research assumed the costs listed below.

- Cost of informal care for each patient is equal
- Cost of anesthetist procedures for each patient is equal
- Cost of bone replacement from donors are granted without compensation
- Cost of the sterilization process is assembly little
- Cost of bone do nor storage compared with cost of medical instruments and period of instrument use combined with number of benefits to the patient are approximated to cost from metal transplant's transportation
- Cost from cancer treatment in addition to the patient billing in the case of radiation was all equal and very few, so set as zero.

Direct non-health care cost:

The present research assumed that the cost of transportation, food, accommodation, service time lost, informal medical care, and patient care by curator for each patient were all equal.

Indirect cost:

The present research assigned that excused absence cost due to inability to perform usual activities of each patient was all equal.

Utility: From the literature review, no research demonstrated utility and QALY values of patients with primary sarcoma treatment by surgical tumor removal and using various procedures of reconstructive surgery. Therefore, the present research defined cost-utility from the database of patients at the Musculoskeletal Oncology, Orthopedic Department, Phramongkutklao Hospital PMK-MOPD. This database collected the information in form of EQ-5D Health questionnaires to measure utility according to the Health Technology Assessment Guide for Thailand[8] and complications from treating/repairing and number of surgeries. The present research assumed that each time of surgery, cost-utility value would reduce by 25% from average QALY based on the research of Losina et al[9]. Cost utility value of patients requiring amputation after treatment with limb-sparing surgery would be equal to 0.48 QALY as stated in Gundle et al[10]. Cost-utility value of any patient experiencing side effects involving non-operative complications would reduce 12.5% from QALY and cost-utility would reduce 3% QALY yearly since the surgery date as reported by Wilson et al[5].

Cost-utility assessment in the present research used the EQ-5D questionnaire, a tool used to assess indirect cost-utility comprising the measurement of five dimensions, for instance, mobility, self-care, usual activities, feeling of pain/discomfort, and anxiety/depression. Each dimension involves three levels, "I have no problem", "I have several problems", and "I have many problems". Volunteers participating in the present research would be requested to assess their level in each dimension. Zero score referred to death status, and one point referred healthy status. The values from the EQ-5D were analyzed by weighing the cost-utility calculated using time trade-off (TTO) according to reports from countries such as the U.K[11,12]. Results of the EQ-5D were displayed as five-digit numbers indicating health status and then transformed to cost-utility by an additional mathematic formula incorporating coefficient and constant values studied by the survey conducted in Thailand only[13].

Data analysis

General information was analyzed using descriptive statistics such as percentage, mean, minimum and maximum by the Stata/MP 17 (StataCorp LLC, College Station, TX, USA).

Cost-utility using utility (U) was multiplied by clinical parameter, in this case, the parameter was LYG, which equaled QALY.

$$QALY = U \times LYG$$

Then the cost utility from each alternative treatment was compared by calculating the cost for one QALY obtained from the ratio of Cost/QALY. The alternative treatment producing lower cost referred to more effectiveness in term of QALY.

QALY gain was calculated from the ratio of the difference between total cost and QALY compared with each pair of alternative treatments according to the following formula:

$$QALY\ gain = (CA - CB) / (QA - QB)$$

Where CA was the total cost when selecting treatment A,

CB was the total cost when selecting treatment B,

QA was the number of QALY when selecting treatment A,

QB was the number of QALY when selecting treatment B

One-way sensitivity analysis was the analysis by altering the value of each parameter under a specific range including discount rate for each percentage range showing the relationship between willingness to pay one QALY versus reduced costs.

Results

From the data collection within the specified time, 83 patients of primary bone sarcoma around the knee received surgical treatment, while 47 patients were selected for distant metastasis before operation. At their follow up after treatment, eight cases involved local recurrence. This group of patients was excluded from the project. Thiry-four subjects met the criteria but seven had incomplete EQ-5D data, so 27 patients participated in the present research project. Demographic data for each patient are shown in Table 1. Patients' age ranged from 9 to 64 years, with an average median age of 29.18 years. Most patient were male with 51.85%, for which the most common diagnosis was osteosarcoma at about 74.07% and other types included Ewing's sarcoma and malignant giant cell tumor (GCT) for 14.82% and 11.11%, respectively. Altogether, 59.25% of patients presented on the right side, which was more than patients presenting on the left side. The lesion areas were located on the distal femur in 77.78% and proximal tibia in 22.22%.

Complications resulting from treatment are summarized in Table 2. In the present research, the four major problems consisted of infection, system failure, recurrence, and leg length discrepancy. The greatest problems from infection and system failure involved reconstructive surgery with recycled bone autograft for three and two cases, respectively. However, other reconstruction procedures did not lead to system failure and only one case was infected. Although reconstructive surgery with recycled bone autograft indicated no recurrent case, other reconstruction techniques revealed one recurrent case for each technique. The last problem involved only one case of leg length discrepancy found from reconstructive surgery using osteoarticular allograft procedures. Problems from complications leading to revision surgery were mostly caused by reconstruction with recycled bone autograft in five cases with an average of 3.6 revision surgeries per case. In contrast to other techniques, the revision surgery cases comprised of only two cases with an average number of revision surgeries of 1.5 times per case. Notably, each technique led to a similar amputation side effect of one case per procedure.

Table 1. Demographic characteristics of patient

Data	Number (n=27)
Age (year); median (IQR)	29.18 (14.7 to 59.1)
Sex; n (%)	
Male	14 (51.85)
Female	13 (48.15)
Diagnosis; n (%)	
Osteosarcoma	20 (74.07)
Ewing sarcoma	4 (14.82)
Malignant GCT	3 (11.11)
Side; n (%)	
Right	16 (59.26)
Left	11 (40.74)
Location; n (%)	
Distal femur	21 (77.78)
Proximal tibia	6 (22.22)
Follow up time (days); median (IQR)	2,017 (637 to 4,186)

GCT=giant cell tumor; IQR=interquartile range

Based on cost-utility information from PMK-MOPD, endoprosthetic reconstruction with metal replacement equaled 0.5316 QALY and reconstructive surgery with various biological reconstructions equaled 0.4226 QALY, which could be divided in the osteoarticular allograft with a value of 0.4740 QALY and recycled bone autograft with a value of 0.3712 QALY as shown in Table 3.

Cost-utility analysis of each technique was calculated from the ratio of total costs for each surgery technique versus QALY (Table 4) using the coefficient of cost-utility obtained from collected data. The lowest cost-utility was recycled bone autograft procedure totaling 12,569.725 followed by using various biological reconstructions and osteoarticular allograft totaling 12,897.445 and 13,154.090, respectively. The highest cost-utility was endoprosthetic reconstruction totaling 60,467.772. Pairwise comparison of each reconstructive surgery procedure indicated the increment cost per one-year QALY (QALY gain) as shown in Table 5.

Based on the research data, altering the cost of endoprosthetic reconstruction would make change to the cost-utility in terms of one-year QALY. Because

Table 2. Complication of each reconstruction procedure

	Endoprosthetic reconstruction (n=9) n (%)	Osteoarticular allograft (n=9) n (%)	Recycled bone autograft (n=9) n (%)
Infection	1 (11.11)	1 (11.11)	3 (33.33)
System failure	0 (0.00)	0 (0.00)	2 (22.22)
Recurrent	1 (11.11)	1 (11.11)	0 (0.00)
Leg length discrepancy	0 (0.00)	1 (11.11)	0 (0.00)
Re-surgery			
Number of patients	2 (22.22)	2 (22.22)	5 (55.56)
Times/person (in re-surgery case)	1.5	1.5	3.6
Amputation rate	1 (11.11)	1 (11.11)	1 (11.11)

Table 3. Utility of each treatment methods

Parameter	Utility	References
Reconstruction methods		
Endoprosthetic Reconstruction	0.5316 QALY	PMK-MOPD
Osteoarticular Allograft	0.4740 QALY	PMK-MOPD
Recycled Bone Autograft	0.3712 QALY	PMK-MOPD
Biologic Reconstruction (allograft & recycled bone autograft)	0.4226 QALY	PMK-MOPD
Each re-surgery	↓25%	Losina et al.[9]
Amputation	0.4800 QALY	Gundle et al.[10]
Non-operative complications	↓12.5%	Wilson et al.[5]

QALY=quality-adjusted-life years; PMK-MOPD=PMK Musculoskeletal Oncology Patient Database

Table 4. Cost-utility analysis

Reconstruction methods	Cost (Baht)	QALY	Cost/QALY
Endoprosthetic reconstruction	321,446.677 (230,150.890 to 397,112.640)	5.316	60,467.772
Osteoarticular allograft	62,350.386 (32,453.000 to 112,130.250)	4.740	13,154.090
Recycled bone autograft	46,658.818 (22,028.750 to 99,146.900)	3.712	12,569.725
Biologic reconstruction (allograft & recycled bone autograft)	54,504.602 (22,028.750 to 112,130.250)	4.226	12,897.445

QALY=quality-adjusted-life years

Table 5. Cost for increased utility in 1 QALYs (QALY gain)

Comparison	QALY gain
Endoprosthetic reconstruction vs. Osteoarticular allograft	449,819.950
Endoprosthetic reconstruction vs. Recycled bone autograft	171,314.127
Osteoarticular allograft vs. Recycled bone autograft	15,264.171
Endoprosthetic reconstruction vs. Biologic reconstruction (allograft & recycled bone autograft)	244,900.986

QALY=quality-adjusted-life years

using metal involves a high price, lowering the cost of metal could improve QALY value. Therefore, alternative metal cost was analyzed using one-way sensitivity analysis producing cost-utility values as represented in Figure 1. Comparative analysis of endoprosthetic reconstruction versus the other reconstructive surgery methods to assess the most acceptable worthiness level in terms of one-year QALY are shown in Figure 2.

Discussion

The present research aimed to analyze benefits from various reconstructive surgery procedures after operating to remove bone tumors around the knee using cost-utility for each treatment procedure compared with QALY value. This value could directly reflect a patient's quality of life depending on many factors. One of the key factors impacting QALY value is treatment complications as shown in

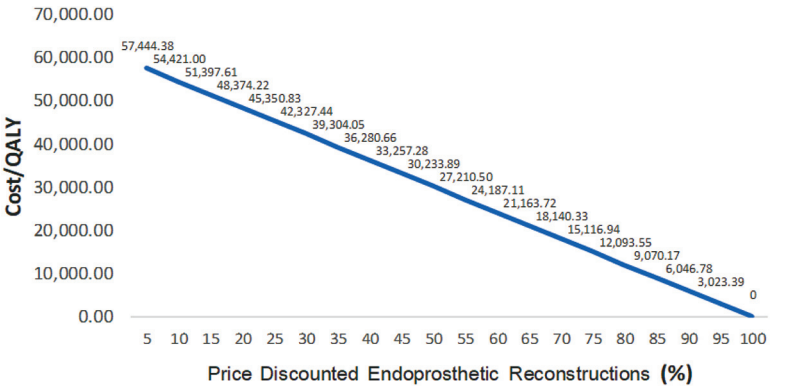

Figure 1. Sensitivity analyses of price discounted endoprosthetic reconstructions with cost-utility.

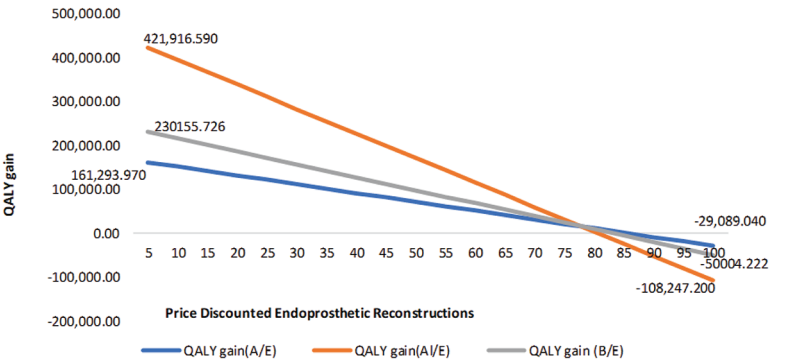

Figure 2. Sensitivity analyses of price discounted endoprosthetic reconstructions with cost for increased utility in 1 QALYs.

A: Autograft reconstruction, Al: Allograft reconstruction, B: Biologic reconstruction, E: Endoprosthesis reconstruction

Table 2. The present research revealed that patients receiving reconstructive surgery using recycled bone autograft reported the most complications, such as five out of nine cases stemming from infection and system failure. Complications from other surgery procedures such as reconstructive surgery using endoprosthetic reconstruction comprised two of nine cases. In one patient who experienced recurrence, it might not have been related to the reconstructive surgery and was caused by inadequate wide surgical margin, resistance to chemotherapy or disease's characteristics. All this information corresponded to the QALY value calculated from utility (U), as shown in Table 3, multiplied by LYG representing the clinical result. This research used a model with LYG value equal to 10 years and when any patient survived after a diagnosis of primary bone sarcoma for 10 years, that patient would be considered as having recovered from the disease and the death probability would be equal to that of the general population[5]. Patients with endoprosthetic reconstruction revealed the highest average QALY values of 5.316 years. The present result indicated that by this procedure, patient will survive and be healthy from the patient's perspective[4] including the ability to walk and perform usual activities without pain or depression for an average of 5.316 years. Therefore, from the present research, considering only the advantages of reconstruction surgery by endoprosthetic reconstruction, it could not be denied that endoprosthetic reconstruction procedure was the best method for treating primary bone sarcoma.

Nevertheless, based on country overview, policy formulation to determine the main treatment method, consistent with the reimbursement for patients' medical treatment bills, needs to compare the breakeven methods. This research compared values using the popular principle in public health economics, which is evaluating utility costs using the median value compared with each surgical treatment as the value of the cost of each alternative treatment divided by the QALY (Cost/QALY), as shown in Table 4. Recycled bone autograft, osteoarticular allograft, or even combined methods, could be

calculated as all of these used various biologic reconstructions consisting of similar values. However, the use of recycled bone autograft produced the lowest results meaning that it comprised the most cost-effective in terms of QALY, but with comparable results in this group. Therefore, it could be interpreted that the choice of methods in this group did not differ in terms of breakeven but should also use other information and the potential of each patient. For example, when the patient presents the characteristics of an osteolytic lesion, it would be unsuitable to use recycled bone autograft because the bone defect would cause the reconstructive surgery to be insufficiently strong. On the other hand, reconstructive surgery using the endoprosthesis constituted the highest cost when divided by the QALY, meaning that higher expenses resulted in lowering the breakeven point even though the data showed that it possessed the highest life years.

Health economics uses the comparison called the QALY gain, which constitutes the ratio of the total cost of each pair of alternative treatments, compared with those in Table 5. This indicates how much the patient will need to invest when treatment methods are adjusted to increase the number of life years. According to the data in the present research, when comparing between the use of endoprosthesis, which is the method presenting the fewest side effects from treatment, it exhibited the highest number of life years after treatment from the patient's perspective. Moreover, for the recycled bone autograft, namely, the most cost-effective alternative treatment, QALY gain was equal to 171,314.127 THB. The number of life-years for the patient could be increased by another one year from the life years that the patient should have after surgical reconstruction treatment and could be further strengthened using recycled bone autograft. Previously, the average life years were calculated at 3.712 to 4.712 years after having a surgical reconstruction. By changing the method of treatment to surgery using endoprosthesis instead, produced an additional investment of 171,314.127 THB. This cost is used as a comparison to show the additional investment cost by comparing it one-to-one. In the present study, four methods were compared indicating that the comparison partner requiring the most investment was a change in surgery by replacing the osteoarticular allograft using the endoprosthesis instead. Therefore, an additional 449,819.950 THB would be needed, followed by changing to surgery combining various biological reconstruction replacements to use the endoprosthesis, with an additional 244,900.986 THB. The least costly method, using the osteoarticular allograft instead of the recycled bone autograft required an additional investment of 15,264.171 THB.

It can be seen from the data in the present research that an advantageous alternative surgery method involving few side effects and providing longer life years is the use of endoprosthetic reconstruction although not a breakeven method. Changing the surgery to such alternative methods requires investment, but reducing the cost in the aforementioned method would be more advantageous and in an acceptable range to increase the number of life-years for the patients. The researcher then analyzed the one-way sensitivity of the price of endoprosthetic reconstruction that decreased with the cost per year of life years as shown in Figure 1 and 2. When patients added an additional quality of life by one year, they would be able to work, earn money, take care of their family, and not be a burden to society. By clearly illustrating the cost of additional investment, as in Table 6, choosing endoprosthesis as a substitute for additional life years by one year, instead of using the breakeven methods of various biologic reconstructions, decreased cost by 78.0671%. It costs 68,562.818 THB. Considering the use of various biologic reconstructions in each type, such as recycled bone autograft and osteoarticular allograft, the cost of surgery using the endoprosthesis did not reduce by much, that is to say, it decreased by 79.214% and 78.246%, respectively. When considering investing in using endoprosthesis to increase the number of life years by one, surgery using endoprosthesis instead would reduce cost 77.868% or cost 71,142.548 THB so it must involve investing equally at 15,264 THB.

If one patient were expected to have a better quality of life for one year due to improved surgical procedures, how could the patients benefit themselves, their family members, and society? Suppose that the patient is able to go to work and has an income equal to the minimum wage for one year, compared with the average minimum wage nationwide according to the announcement of the Ministry of Labor, enacted January 1, 2020, which is 321.09 THB daily per person, 365 days for a total value of 117,197.85 THB. By replicating the investment with surgery using the endoprosthesis would equal the income of the patients in one year of increased life quality. The endoprosthesis costs need to be reduced by 27.004% or cost 234,644.169 THB when using replacement surgery by the recycled bone autograft. It decreased 59.603% and 43.303% or cost

Table 6. Sensitivity analyses of price discounted endoprosthetic reconstructions with cost for increased utility in 1 QALYs in each situations

Situations	Cost (Baht)	QALY gain
Full-price endoprosthetic reconstruction		
Substitute osteoarticular allograft	Full-price	449,819.950
Substitute recycled bone autograft	Full-price	171,314.127
Substitute various biologic reconstruction	Full-price	244,900.986
Price discounted without QALY gain		
Substitute osteoarticular allograft	69,927.142 (↓78.246%)	0
Substitute recycled bone autograft	66,816.804 (↓79.214%)	0
Substitute various biologic reconstruction	68,562.818 (↓78.671%)	0
Price discounted for balance methods		
Substitute osteoarticular allograft	71,142.548 (↓77.868%)	15,264.171
Substitute recycled bone autograft	71,142.548 (↓77.868%)	15,264.171
Substitute various biologic reconstruction	71,142.548 (↓77.868%)	15,264.171
Price discounted as minimum wage rate		Minimum wage rate/year*
Substitute osteoarticular allograft	129,856.348 (↓59.603%)	
Substitute recycled bone autograft	234,644.169 (↓27.004%)	
Substitute various biologic reconstruction	182,250.258 (↓43.303%)	
Price discounted as government salary		Minimum government salary/year**
Substitute osteoarticular allograft	166,030.386 (↓48.349%)	
Substitute recycled bone autograft	335,378.818 (↓---%)	
Substitute various biologic reconstruction	250,704.602 (↓22.007%)	

QALY=quality-adjusted-life years

* Comparable Thai Ministry of Labor, Decree of the minimum wage rate No.10, December 6, 2019; Average 321.09 Baht/day/person: total value 117,197.85 Baht/year[14]

** Comparable Ministry of Finance, memorandum of the government permanent employee's wage adjusting, July 19, 2012; 15,000 Baht/month: total value 180,000 Baht/year[15]

129,856.348 and 182,250.258 THB, respectively for replacement surgery using recycled bone autograft and calculated by combining various biological reconstruction. However, when the patient is a civil servant earning a comparable minimum salary, the minimum salary level of a bachelor's degree announced by the Civil Service Commission starting January 1, 2012, monthly 15,000 THB each person, calculated yearly, the amount would total 180,000 THB. Then the simulated investment with surgery using endoprosthesis would be equal to the patient's income. In this case, reducing the cost of surgery using endoprosthesis would not be needed to replace surgery using recycled bone autograft, or when the cost of surgery could be reduced using only 22.007% of the endoprosthesis. It would cost 250,704.602 THB when replacing surgical methods using various biological reconstructions and decrease 48.349% or cost 166,030.386 THB when replacing surgery using osteoarticular allograft.

Limitation

Data collection in the present research was based on retrospective data. Thus, it could not control the standard of data collection. However, using an international score could increase interobservers reliability. Because the interobservers' reliability did differ much, the data can be considered dependable. Further research should implement a prospective data collection, and data from a multicenter would be more dependable.

Conclusion

Prosthesis as a beneficial option, involving few side effects and the highest number of QALY, but without reaching breakeven. However, reducing the cost by 27.004% would be worth it and almost the same as the most breakeven method. For this method, the additional investment would be equivalent to the minimum wage in Thai law averaged within one year, without the need to reduce the cost because this extra investment will cost only about the minimum of Thai civil servant salary for one year. The researchers agreed that it could be adapted to the national policy in determining standard surgical procedures for reimbursing each medical treatment coverage. This

includes the decision to choose treatment by doctors and patients to improve the quality of life of patients after receiving treatment for bone cancer in the knee area. It would directly affect the quality of life of the patient's family members and society at the national level.

What is already known on this topic?

This kind of research has been conducted in the context of the U.S., where prosthesis was reported as a good method, and a 30% cost-discount endoprosthesis would be a greater cost benefit than that of the most breakeven method.

How is the breakeven in terms of utilities, in the Thai context?

What does this study add?

The breakeven is similar. Therefore, it should be adapted to ensure the good utility of Thai patients.

Endoprosthesis is one good method to reduce costs by 27.004% and is almost the same as the most breakeven method with additional investment. It would be equivalent to the minimum wage in Thai law averaged within one year, and without the need to reduce the cost because this extra investment would total only about the minimum Thai civil servant salary for one year.

Conflicts of interest

The present research was run by protocols under consideration of the Institutional Review Board of the Royal Thai Army Medical Department either in written or verbal form. The authors received funding from the Mahavajiralongkorn Foundation, Phramongkutklao Hospital. Consequently, the authors do not declare any conflicts of interest.

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