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Psychosocial and Functional Outcomes in Long-Term Survivors of Osteosarcoma: A Comparison of Limb-Salvage Surgery and Amputation

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Abstract

Background—Traditionally, physicians have believed that limb-salvage surgery has functional and cosmetic advantages over amputation, yet the literature is equivocal. Therefore, we sought to compare the psychosocial and functional outcomes in osteosarcoma survivors after limb-salvage surgery and amputation. We hypothesized there to be neither psychosocial nor functional outcome differences between groups.

Procedure—Participants received treatment of extremity osteosarcoma, had received their cancer diagnosis at least 2 years prior, and were at least 16 years old. A comprehensive set of validated psychosocial and functional measures was used to assess outcome.

Results—Fifty-seven patients participated in this study (33 who underwent limb-salvage surgery and 24 who underwent amputation). Participants had gone 12–24 years since diagnosis and were 16–52 years old at study participation. We used multiple linear regression models to examine differences in quality of life, body image, self-esteem, and social support between the two groups and found no differences. Lower limb function was a significant predictor of quality of life ($p < 0.001$), whereas surgery type did not impact this relationship. Body image was rated significantly worse by those who underwent late amputation, amputation after failed limb salvage, than by those who did not.

Conclusions—Participants with more functional lower limbs had better quality of life than did those with less functional lower limbs regardless of whether they underwent amputation or limb-salvage surgery.

Keywords

Osteosarcoma; Quality of Life; Psychosocial Outcome; Functional Outcome; Survivorship

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INTRODUCTION

Osteosarcoma is the most common primary malignant bone tumor in children. Its incidence varies among age groups, but overall, about 400 new cases are diagnosed per year in the United States [1]. The long bones of the lower extremities are the most common sites of osteosarcoma. Treatment consists of chemotherapy and tumor resection, the latter of which necessitates amputation or a limb-sparing procedure, commonly referred to as limb-salvage. In the United States, limb-salvage surgery is the preferred surgical option when wide local excision of the tumor can be achieved.

Researchers have compared the functional outcomes of limb-salvage surgery and amputation using a variety of assessment tools and found varying results.[2] For example, several studies using the Musculoskeletal Tumor Society scoring system have demonstrated better lower limb function in patients who undergo limb-salvage surgery than in those who undergo amputation [3]. However, the Musculoskeletal Tumor Society instrument consists of subjective clinician ratings, raising validity questions and excluding patient-reported outcomes. Also, other researchers have not found differences in the functional outcomes of these two procedures. For example, Nagarajan and colleagues did not find any differences in functional outcome in 528 adults in the Childhood Cancer Survivor Study cohort using the Toronto Extremity Salvage Score (TESS) [4].

Researchers have explored the primary cosmetic and secondary psychological benefits of limb-salvage surgery. Quality-of-life variables studied include patient satisfaction with surgical outcome, psychological adjustment (e.g., mood, anxiety, sexuality, body image, self-esteem), academic achievement, employment status, and marital status. Study results have varied, and conclusions regarding the best surgical practice have been difficult to draw. Sugarbaker and colleagues performed one of the first published studies examining the impact of surgical type on quality of life in patients with extremity sarcoma and detected no differences [5]. Also, Postma et al. [6] found that patients who underwent amputation had fewer romantic relationships and were more embarrassed in social settings when compared with those who underwent limb-salvage surgery, but these differences have yet to be corroborated.

Greater understanding of the quality of life and functionality of the osteosarcoma survivor has the potential to impact treatment decision making and provision of follow-up services. Therefore, we performed the study described herein to compare the psychosocial and functional outcomes of limb-salvage surgery and amputation in osteosarcoma survivors. We hypothesized there to be neither psychosocial nor functional outcome differences between groups.

METHODS

Eligible study participants received treatment of extremity osteosarcoma at a single institution, had received a diagnosis of osteosarcoma at least 2 years prior, and were at least 16 years old at the time of study participation. Eligible study participants were enrolled between March 2007 and February 2008. Non-English-speaking patients were excluded. This study was approved by the Institutional Review Board of The University of Texas M. D. Anderson Cancer Center. Pre-notice letters that introduced the study and its purpose, the patient's eligibility to participate, and explanation of subsequent contact were mailed. Two weeks thereafter, questionnaires measuring the patient's current functional and emotional well-being were mailed to them. An accompanying consent statement was included, which notified the person completing the questionnaire that returning the questionnaire provided consent to use the resulting information for research study purposes. A small gift valued at

\$3 was included with each questionnaire as a token of appreciation for participating in the study.

If the completed questionnaire was not returned within 1 month of having been mailed, a reminder letter including a replacement questionnaire was mailed to the patient. One week after the reminder letter was mailed, the primary oncologist (who is also the senior author of this article) called those who had not responded. The primary reason for the call was to increase the perception of importance of the study and legitimize the request for participation. Emotional and functional outcomes were measured using the instruments described below.

Functional Assessment

Toronto Extremity Salvage Score (TESS) [7] is a self-administered questionnaire with 30 questions pertaining to the difficulty in performing daily activities over the prior week. Difficulty in task execution is rated on a five-point Likert-type scale ranging from “not at all difficult” to “impossible to do.” Scores range from 0 to 100. High scores indicate high level of function.

Quality of Life Assessment

The Quality of Life -- Cancer Specific Scale (QOL-CSS) [8] is a 41-item questionnaire that measures four domains of quality of life (physical, psychological, social, and spiritual well-being). Researchers have established the test/re-test reliability; internal consistency among test items and subscales; and content, predictive, and construct validity of this scale. The self-report measure is intended for use by long-term cancer survivors. Many of the items are questions about elements of positive adjustment rather than deficit-based questions. Test items are rated on a 10-point Likert-type scale. Several test items have reverse anchors. For example, if a subject circles “3” on such a test item, 10 minus 3 results in a score of 7. The reverse anchor items are 1–7, 9, 16–27, 29–34, and 38. High scores indicate good quality of life.

In addition, the Minneapolis-Manchester Quality of Life Instrument [9] includes a Romantic Relationships subscale. This subscale consists of two questions about romantic relationships that are normed for persons 13–20 years old and are in the process of being normed for persons 21–45 years old. Test items are rated on a five-point Likert-type scale, and good scores indicate good romantic relationships.

Body Image Assessment

Amputee Body Image Scale (ABIS) [10] consists of 20 items that assess perception and feeling about one’s body. For the present study, the word “amputation” was replaced with “affected limb.” Researchers have established the internal consistency of this scale, with a Cronbach’s alpha of 0.88. The validity of this scale is limited to logical content validity. Test items are rated on a scale of 1 (none of the time) to 5 (all of the time). Three of the questions (3, 12, and 16) are reverse-scored. Scores range from 0 to 100, with high scores indicating body-image concerns.

Self-Esteem Assessment

Index of Self-Esteem [11] is a 25-item self-report questionnaire designed to assess problems with self-esteem. This index has a mean Cronbach’s alpha of 0.93, a standard error of the mean of 3.70, and a 2-hr test/retest correlation of 0.92. Researchers have established the validity of this index with known scales for depression, happiness, and identity. Each test item is rated from 1 to 7, with low scores reflecting high self-esteem. A score of 30 or above indicates clinically low self-esteem.

Social Support Assessment

Sarason's Social Support Questionnaire -- Short Form [12] is a six-item abbreviated self-report measure derived from Sarason's 27-item Social Support Questionnaire [13]. Each item has two components: 1) the number of available others one can turn to in various times of need (number or perceived availability score) and 2) the individual's degree of satisfaction with available support (satisfaction score). The number or perceived availability score is a tally of the number of available others in the family, not in the family, and overall. For the satisfaction score, participants indicate how satisfied they are with the available support on a six-point Likert-type scale, ranging from "very dissatisfied" to "very satisfied." Studies have shown that social support moderates personal adjustment, social behavior, health maintenance, and recovery from illness [14–16]. Sarason's Social Support Questionnaire -- Short Form consists of a single factor, with mean factor loadings ranging from 0.76 to 0.82. The internal reliability of this questionnaire ranges from 0.90 to 0.93 for both the number and satisfaction score. Correlations of Sarason's Social Support Questionnaire -- Short Form with other personality and social competence variables are highly satisfactory from a psychometric viewpoint.

Statistics

Summary statistics were calculated for patient characteristics by patient group. Chi-square tests of independence were used to assess group differences in sex and race. Median tests were used to assess group differences in age at diagnosis, duration from diagnosis to study participation, and age at the time of study participation. Means, standard deviations, and confidence intervals were calculated for each functional and psychological outcome variable by patient group. Multiple linear regression models were used to examine differences in functional and psychological outcomes between the two patient groups after adjusting for duration from diagnosis to study participation.

RESULTS

One hundred persons were invited to participate in this study, and contact was confirmed with 63. Forty-five persons responded by mail. Eighteen persons were contacted by telephone: 13 contributed, 1 declined, and 4 did not contribute. It is unclear as whether or not the other non-contributors were aware of contact attempts due to obsolete telephone numbers, unanswered/unreturned telephone calls/messages, mailed packets returned by the postal service due to incorrect address, and unreturned mail. One responder had had Ewing's sarcoma rather than osteosarcoma, which was a registry error and the information was not included in the study. The participant response rate was 57.6% (57 of 99). The patients' ethnicities were white ($n = 41$), Hispanic ($n = 10$), black ($n = 3$), Asian ($n = 1$), American Indian or Alaska Native ($n = 1$), and other ($n = 1$).

Twenty of the patients (35%) were male. Though more women participated than men, the women were equally represented in the two treatment types, with 64% of those with amputation being female and 67% of participants with limb salvage being female ($p < 0.813$).

We grouped the 57 participants according to type of surgery. However, grouping them according to limb-salvage surgery versus amputation was more difficult than anticipated. Some participants acknowledged not knowing which procedure they underwent. Others left the related questions unanswered. Some of the patients described their procedures but did not select from the response options provided. The missing information led us to thoroughly review the patients' medical records to confirm and/or clarify the information requested in the questionnaire. One participant acknowledged having undergone an amputation when his

medical record indicated a limb-salvage procedure and a subsequent operation for a local recurrence. The participant's functional ability decreased after the second operation, which the patient referred to as an amputation. For the purposes of the study, we assigned this participant to the limb-salvage group because an amputation was not performed. Three participants did not acknowledge undergoing a limb-salvage procedure or amputation in the forced-choice questionnaire item but accurately described the operative procedure. All three of them underwent limb-salvage surgery (endoprosthetic, bone graft, and internal hemipelvectomy, respectively). Four participants misidentified the bone in which the tumor was located; we reconciled the data for all four patients with their medical records.

Seven of the participants underwent one or more limb-salvage procedures that were revised to an amputation. These amputations were performed 4–20 years prior to this study. We assigned all seven patients to the amputation group given the significant amount of and recent experience with amputation. We referred to these seven patients as having undergone late amputation.

We assigned 33 patients to the limb-salvage group and 24 to the amputation group. Of those in the amputation group, 23 had lower limb involvement, and 1 had upper limb involvement (shoulder disarticulation). Of those who underwent lower limb amputation, 13 of the procedures were transfemoral, 4 were below the knee, 4 were hip disarticulations, 1 was a hemipelvectomy, and 1 was a rotationplasty. We included the patient who received rotationplasty in the amputation group because that procedure converts an above-knee amputation into a functional below-knee amputation.

Of those in the limb-salvage group, 28 had lower limb involvement, and 5 had upper limb involvement (humerus). Six participants who underwent lower limb-salvage surgery received bone grafts, which were either autografts or allografts held in place with plates and screws. The affected bones in those who received bone grafts were the tibia, fibula, and femur in three, two, and one patient, respectively. One participant in the limb-salvage group had an internal hemipelvectomy. All of the others received an endoprosthetic implant (some of which were expandable) or a composite endoprosthetic allograft.

In both treatment groups, the femur was the most common site of involvement ($n = 33$) followed by the tibia ($n = 14$), humerus ($n = 6$), fibula ($n = 2$), patella ($n = 1$), and pelvis ($n = 1$).

The patients' median age at the time of study participation was 33.8 years (range, 16.1–52.0 years). Their median age at the time of diagnosis was 13.8 years (range, 3.3–28.2 years). The median duration from diagnosis to study participation was 18.6 years (range, 3.8–35.6 years). Chi-square tests of independence revealed no comparative group differences in sex or race. Median tests revealed no differences in age at diagnosis, duration from diagnosis to study participation, or age at the time of study participation (Table I).

In the amputation group, only one patient underwent an upper extremity amputation. Therefore, functional comparison of the two treatment groups was limited to those who had lower limb involvement. Lower limb functional outcomes in the two groups were comparable (Table II). The mean leg function score according to the TESS was 78.7 (standard deviation [SD], 14.0) in those who underwent amputation and 78.2 (SD, 17.5) in those who underwent limb-salvage surgery. After adjustment for the duration from diagnosis to study participation neither treatment was significantly associated with the leg function score ($p = 0.93$). The duration from diagnosis to study participation did not impact lower limb functional outcomes.

We used multiple linear regression models to examine differences in quality of life, body image, self-esteem, and social support between the two patient groups (Table II). We observed no differences in quality of life, self-esteem, or social support. We used the QOL-CSS, Total Scale Score, and Physical Well-Being, Psychological Well-Being, Social Concerns, and Spiritual Well-Being subscales of the QOL-CSS in this comparative analysis. The scores in the two groups were comparable (Tables I and II). We measured social support according to the total number of supportive others, number of supportive others in the family, number of supportive others not in the family, and satisfaction with support. We found no differences in any of the social support scores between the two treatment groups. Of interest, two respondents reported social support from pets and from God respectively. We measured quality of romantic relationships using two items and analyzed the results separately. We observed no differences in quality of romantic relationships between the two groups.

Body image was the only outcome measure that differed significantly between the amputation and limb-salvage groups (Table III). This difference was evident regardless of hip involvement (hemipelvectomy, internal hemipelvectomy, and hip disarticulation; $P = 0.046$), rotationplasty ($p = 0.023$), age at diagnosis ($p = 0.011$), duration from diagnosis to study participation ($p = 0.012$), and sex ($p = 0.011$). However, the difference was not statistically significant when the seven participants who underwent late amputation were omitted ($p = 0.194$). Therefore, the difference in body image scores between the amputees and limb-salvage surgery recipients was driven by the seven participants who underwent late amputation. The mean body image scores are listed in Table IV. A high score indicates body image concerns. Thus, those who underwent late amputation had more significant body image concerns than did the other 50 patients. One participant who underwent late amputation wrote the following comment on the body image questionnaire, "I don't like showing my affected limb (to where you can physically see the stump - I avoid at all times)." Apart from increasing body image concerns, those in our study who underwent late amputation did not impact the findings.

To explore the relationship between appearance and emotional adjustment, we analyzed relationships between the results of the ABIS and those of use of other measures of quality of life. Body image correlated with self-rating of physical function; physical, psychological, social, and total quality of life scores; and self-esteem. Each relationship was significant at a p -value of less than 0.001 with Spearman rank correlations. The spirituality subscale score on the quality of life measure and Sarason's Social Support scores did not correlate with body image. In our study sample, a patient's self-assessment of body image was associated with emotional well-being but not spiritual well-being or social support.

Illness burden is a term used to describe number of chronic conditions, their severity, and effect on functioning. The illness burden varies for osteosarcoma survivors. For example, a patient who undergoes a below-knee amputation may have less of an illness burden than does a person who undergoes a hip disarticulation [17]. However, the results of repeat analysis did not differ from the original findings following exclusion of patients with hip involvement, nor did omission of the patient who underwent rotationplasty.

In addition to the standardized assessment measures, we gave an open-ended questionnaire querying satisfaction with treatment decisions and outcomes to the patients (Table V). Those who underwent a transfemoral amputation expressed the most dissatisfaction (four negative, one ambivalent, and one positive). Of those who underwent late amputation, five expressed ambivalence, one described dissatisfaction, and one did not respond. Those who underwent below-knee amputation or limb-salvage surgery (endoprosthetics and bone grafts) gave

positive responses with the exception of one patient who expressed ambivalence with endoprosthetic limb salvage because of mobility limitations.

Age at the time of diagnosis varied from preschool to young adult years (range 3 to 28 years). Adolescence is a major developmental milestone, and the experience of osteosarcoma and adjustment to changes in physical appearance and function in adolescents may be vastly different from those in preschool- or school-age children [18]. In our sample, we grouped the patients by age (<13 years and ≥ 13 years) for the statistical model. We found that neither preadolescence nor postadolescence impacted the findings.

Additionally, we used sex as a variable in our study. Eiser and Grimer [19] also reported on the importance of sex on the comparisons between those with limb salvage surgery and amputation. In our sample, sex did not significantly impact the original findings.

Furthermore, we explored the relationship between physical function and emotional well-being in the sample as a whole. According to the QOL-CSS, lower limb function was a significant predictor of quality of life on all scales except the spirituality subscale (physical subscale, $p < 0.0001$; psychological subscale, $p < 0.0001$; social subscale, $p < 0.0001$; Total QOL-CSS scale, $p < 0.0001$). Lower limb function was also a significant predictor of both body image ($p < 0.0001$) and confidence in romantic relationships ($p < 0.043$). Social support and self-esteem were not related to lower limb function. Neither the duration from diagnosis to study participation nor the surgery type impacted these relationships ($p < 0.001$).

Upper limb function was not related to the total QOL-CSS score. However, only 6 of the 57 patients had upper limb involvement. In all six of these patients, the tumor was located in the humerus. One patient underwent amputation, and five underwent limb salvage. Given this small number of patients with upper limb involvement, we cannot make any generalizations about patients with upper limb involvement.

DISCUSSION

In our patient sample, better leg function was significantly related to better emotional functioning in long-term osteosarcoma survivors. Function rather than the procedure performed (amputation or limb-salvage surgery) determined psychosocial outcomes. A significant relationship between function and outcome was manifested despite our addition of variables to the model. Age at diagnosis, duration from diagnosis to study participation, age at time of study participation, sex, hip involvement, and rotationplasty did not significantly impact functional or emotional well-being or the relationship between function and emotional well-being.

The relationship between functional and emotional well-being in such patient populations has received minimal attention. O'Malley et al. [20] examined 115 pediatric cancer survivors and did not find a relationship between physical function and psychological adjustment following cancer. However, only 14% ($n = 16$) of the patients had bone cancer.

In half of the long-term osteosarcoma survivor studies that we reviewed for this study, the authors reported on functional [21,22] or psychosocial [6,18,23–26] outcomes. Of the remaining outcome studies reviewed, in which investigators assessed both functional and psychosocial outcomes [5,17,27–32], only one study compared a psychosocial variable with physical function. Novakovic et al. [30] reported on 89 Ewing sarcoma survivors and compared them with sibling controls. However, they did not group these patients based on amputation versus limb-salvage surgery. Six percent of the patients ($n = 5$) in Novakovic's study underwent amputation. Aspects of employment, marital status, fertility, and health

were more adversely affected in the patients than in their siblings. Specifically, Novakovic and colleagues compared function with marital status in the patients and found that marital status was not related to physical function.

In our study, physical function was associated with emotional well-being, outweighing the impact of other variables in the model. Investigators examining the functional and emotional outcome of rotationplasty have reported analogous findings. Those who undergo rotationplasty for osteosarcoma treatment have superior functional outcomes and equivalent emotional outcomes compared to those who have amputation and endoprosthetic replacement. For example, Hillman et al. [33] compared patients with bone cancer who underwent van Ness rotationplasty ($n = 33$) with those who underwent endoprosthetic replacement ($n = 34$). The patients had gone at least 2 years since their operations (median, 6 years). The results of rotationplasty were equal or superior to those of endoprosthetic replacement. Those who underwent rotationplasty had less pain, were less reliant on assistive devices, and had greater participation in hobbies, work, and other daily activities than did those who underwent endoprosthetic replacement. The relationship between physical function and emotional well-being was not a component of this study. In other countries, for example, Germany, rotationplasty is the preferred surgical option for bone cancer because of its functional outcome. Although the procedure was initially difficult to explain and destigmatize, the long-term functional benefits of rotationplasty have established this preference for it in Germany. Also, a Japanese report by Akahane and colleagues of a study at the Shinshu University School of Medicine and Nagano Children's Hospital published in 2007 [34] described their comparison of the functional benefits of rotationplasty with those of amputation and limb-salvage surgery in patients with osteosarcoma near the knee joint. Patients who had rotationplasty as compared to those who had amputation or endoprosthetic reconstruction, at least 1 year post-surgery, were rated as significantly more functional by a healthcare professional on the Musculoskeletal Tumor Society scoring system with equivalent quality of life.

We also observed a significant relationship between late amputation and body image concerns. Atherton and Robertson [23] found that body image and related beliefs were associated with distress and maladjustment in persons with amputation, rather than function or medical and treatment-related variables. These findings are consistent with those of research on cosmetic surgery. Adjustment to cosmetic surgical outcome is influenced by the patient's beliefs about the appearance change rather than the objective severity of the change [35]. Persons invested in their appearance as a standard of self-evaluation are likely to be disturbed if their appearance does not conform to their ideal.

Researchers have categorized late amputation after failed limb-salvage procedures as unique [28]. Such patients have endured the emotional process of giving up on limb preservation. Some patients who undergo late amputation reportedly believe that their surgeons are disappointed in the outcome and are reluctant to accept the need for amputation, which complicates treatment decision-making, physician-patient relationships, and emotional adjustment to amputation. Lane et al. [24] described a sample of 32 patients who underwent limb-salvage surgery, 9 (28%) of whom had compromised outcome with limb-salvage and 4 (13%) of whom eventually underwent amputation. The nine patients who had compromised outcome with limb-salvage described significant coping challenges, such as an "ever-present preoccupation" with the affected limb. The four patients who had late amputation expressed resentment toward others (including medical professionals and family members) for not accepting their need for amputation and delaying a good outcome. Moreover, those who underwent late amputation believed that earlier amputation would have given them a better quality of life. The seven patients in our study who underwent late amputation did not have

any functional differences from the other 50 patients but did have significantly more body image concerns.

In summary, our study has three primary findings: 1) function was associated with emotional well-being, 2) late amputation (all of which were transfemoral in this sample) was associated with body image concerns, and 3) patients who underwent transfemoral amputation (which included all of those who underwent late amputation) expressed ambivalence about or dissatisfaction with their treatment outcomes when asked an open-ended question (Table IV).

Anticipated physical function outcomes should be emphasized throughout treatment-related decision making for patients with osteosarcoma. Informing patients of long-term survivorship issues and projecting functional needs across their lifespans may inform and guide treatment. Most patients with osteosarcoma are teenagers or young adults at diagnosis and have limited experience in projecting their functional needs across their lifespans. Also, patients and their family members typically have no prior experience with osteosarcoma treatment options or outcomes and thus would benefit from guidance regarding anticipated functional outcomes across their lifespans. In addition to facilitating treatment-related decision making, providing information regarding outcome expectations (physical function, appearance, and medical follow-up) may result in the secondary benefit of preparing the patient for the treatment itself and in turn facilitating post treatment adjustment. Boyle et al. [36] found that patients who underwent amputation for cancer adjusted better than did those who underwent the procedure for a traumatic injury. Given what was known clinically about those in the sample, Boyle et al. hypothesized that preoperative preparation for amputation accounted for the adjustment difference. Lane et al. [24] described clinical indications that patients who participated in amputation-preparatory services adjusted more quickly to the loss of their limbs than did those who did not participate in such services. Once an operative plan has been established, preoperative preparation is recommended.

Post-surgical physical function assessments on a scheduled basis in patients who undergo limb-salvage surgery may minimize the negative impact when a failed limb-salvage needs to be revised to an amputation. Timely identification of poor physical function may lead to discussions of surgical revision for those with poor function, including rotationplasty and amputation. Self-reported and objective assessments of physical function provide different information, and the use of both would be ideal, as patients and surgeons rate mobility and satisfaction with treatment differently [29,37].

In summary, the role of function in treatment-related decision making for patients with osteosarcoma is an important determinant of treatment outcome. Discussion of information related to function early in the treatment process by members of the treatment team is recommended. Early preparation for limb-salvage surgery, rotationplasty, or amputation would allow patients to consider all treatment options, including those that may initially be more visibly distinct or stigmatizing but functionally promising.

With a 57.6% response rate, the generalizability of the sample to the whole population should be addressed. One person actively declined participation, and four persons passively declined participation subsequent to telephone contact. The remaining 37% of potential participants either passively declined or were never contacted. Given that telephone contact information was obsolete for 24% (13 of 55) of the persons who did not respond to the mailing, we expect that many were never contacted, and consequently, the response rate under rated. Across time, which was an average of 18.6 years post-diagnosis, contact between patients and treatment providers decreases and less is known about changes in the patient's life, including contact information and health status. The substantial number of

years post-diagnosis is a strength of the study, yet a contributing factor to the response rate. The sample consisted of 65% females, which does not mimic the gender distribution of osteosarcoma, generally believed to be 1.5 males to 1 female. The sample, however, is representative of the 99 eligible participants, which consisted of more females than males. In addition, the non-responders were equally female and male.

Given the lack of difference between treatment groups, amputation versus limb salvage, the question of a Type II error arises. Post-hoc power analyses were conducted. We estimated a clinically relevant effect size to be a 10% difference in the Quality of Life -- Cancer Specific Scale (QOL-CSS) Overall Score, and determined our sample size would have 80% power to detect this effect size. The high power relative to sample size is likely due to the number of participants in each treatment group (42% with amputation and 58% with limb salvage) and small standard deviations relative to the scores. Scores were on a 10 point scale and within group standard deviations ranged from 1.1 to 2.1.

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TABLE I

Patient Characteristics

Variable	Number of patients (%)		P
	Amputation (n = 24)	Limb salvage (n = 33)	
Sex			
Male	8 (33)	12 (36)	0.813
Female	16 (67)	21 (64)	
Race			
Hispanic	3 (13)	7 (21)	0.230
Other	1 (4)	5 (15)	
White	20 (83)	21 (64)	
Age (years)			
Median	37.2	31.2	0.085
Range	16.1–52.0	17.6–46.3	
Age at diagnosis (years)			
Median	12.9	14.2	0.672
Range	3.9–27.5	3.3–28.2	
Years from diagnosis to study participation			
Median	21.8	13.6	0.236
Range	5.0–35.6	3.8–29.6	
I find it easy to have an intimate relationship...			
Very true of me	11 (46)	17 (57)	0.463
Not very true of me	1 (4)	3 (10)	
Somewhat true of me	9 (38)	6 (20)	
Not at all true of me	2 (8)	1 (3)	
Not true or false	1 (4)	3 (10)	
I am confident when I am with people of the opposite sex...			
Very true of me	10 (42)	18 (55)	0.852
Not very true of me	2 (8)	3 (9)	
Somewhat true of me	9 (38)	8 (24)	
Not at all true of me	2 (8)	3 (9)	
Not true or false	1 (4)	1 (3)	

TABLE II

Assessment Scores (Mean & Standard Deviation) by Treatment Group

Variable	Amputation					Limb salvage				
	Obs	Mean	SD	95% CI LB	95% CI UB	Obs	Mean	SD	95% CI LB	95% CI UB
TESS legs	23	78.7	14.0	72.6	84.7	28	78.2	17.5	71.4	85.0
Physwb	24	7.6	1.6	6.9	8.2	33	7.9	1.7	7.3	8.5
Psychwb	24	6.3	1.7	5.6	7.0	33	6.3	1.4	5.8	6.8
Socwb	24	6.8	2.1	5.9	7.7	33	6.9	2.0	6.2	7.6
Spiritwb	24	6.6	1.8	5.9	7.4	32	6.5	2.1	5.7	7.3
QOL	24	6.7	1.3	6.1	7.3	33	6.7	1.2	6.3	7.2
ABIS	24	53.9	18.1	46.3	61.6	31	42.9	14.6	37.6	48.3
ISES	24	28.1	15.2	21.7	34.6	33	25.8	14.0	20.9	30.8
SSSQ-N	24	4.5	2.3	3.5	5.4	33	3.6	1.5	3.1	4.1
SSSQ-S	24	5.3	1.1	4.8	5.8	33	5.5	0.8	5.2	5.8

Obs, observation; CI, confidence interval; LB, lower confidence bound; UB, upper confidence bound; Physwb, physical well-being; Psychwb, psychological well-being; Socwb, social well-being; Spiritwb, spiritual well-being; QOL, quality of life total score; ISES, ; SSSQ-N, Sarason Social Support Questionnaire - Total Number of Supportive Others; SSSQ-S, Sarason Social Support Questionnaire Satisfaction Score.

TABLE III

Limb-Salvage versus Amputation Group Outcome Differences for Function (TESS), Quality of Life (QOL-CSS, Total and Subscale Scores), Body Image (ABIS), Self-Esteem (ISES), and Social Support (Number and Satisfaction Score)

Variable	P				
	Adjusted for duration from diagnosis to study participation	Adjusted for time excluding hip involvement (n = 6)	Adjusted for time excluding rotationplasty (n = 1)	Adjusted for time excluding late amputation (n = 7)	Adjusted for duration from diagnosis to study participation and age at diagnosis ($\leq >13$ yrs)
TESS legs	0.928	0.710	0.987	0.869	0.793
QOL physical	0.648	0.735	0.709	0.683	0.453
QOL Psychological	0.830	0.719	0.855	0.841	0.762
QOL social	0.716	0.921	0.654	0.917	0.519
QOL spiritual	0.980	0.925	0.900	0.887	0.961
QOL total	0.830	0.780	0.860	0.999	0.654
ABIS	0.012	0.046	0.023	0.194	0.011
ISES	0.509	0.963	0.570	0.651	0.579
SSSQ number	0.119	0.025	0.154	0.206	0.256
SSSQ satisfaction	0.555	0.768	0.494	0.433	0.681
					0.882
					0.657
					0.837
					0.725
					0.989
					0.838
					0.011
					0.514
					0.119
					0.540

QOL, quality of life; ISES, Impact on Self-Esteem Scale; SSSQ, Sarason Social Support Questionnaire.

TABLE IV

Summary Statistics of Body Image Total Score by Treatment

ABIS Total Score	Obs	Mean	SE	95% confidence interval
Amputation	17	48.8	4.1	40.2–57.5
Late amputation	7	66.3	6.0	51.7–80.9
Limb salvage	31	42.9	2.6	37.6–48.3

Obs, observations; SE, standard error.

TABLE V

Satisfaction with Treatment Decision and Outcome

Treatment group	If you have undergone a limb-salvage procedure, do you think that an amputation from the start of the bone cancer would have been a better choice? If you are an amputee, do you think that a limb-salvage procedure would have been a better treatment? Why?
Amputation	
Below Knee	Three blank.
Positive	Amputation has worked VERY well for me. I wouldn't have had it any other way.
Positive	I am an amputee and I have seen the limb salvage procedure often not work; hence, I think amputation is the better option and should also be the first option.
Transfemoral	Three blank.
Positive	I don't think I would have been happy with a limb-salvage because of reduced activity levels required.
Ambivalent	I would love to have my right leg. However, I have talked with people who have had limb salvage and limb salvage has challenges, too.
Negative	If limb salvage could have worked for me, I think it would have been better for me simply to have two legs. Life in general would have been easier as far as daily tasks.
Negative	I think limb salvage would've been better. I think the amputation had a lot to do with the burn I obtained. I think if I would not have had this burn, my knee would have a least been saved, making using a prosthetic easier.
Negative	It would have been wonderful to have been offered the option of a limb salvage. The thought of having two legs is amazing.
Late amputation	
Negative	I think that a limb salvage would have been better because you can't do many things that you would like to when you are an amputee.
Ambivalent	I am in a unique situation since I had both. I would rather have my leg, of course -- more specifically, my knee. But it's hard to judge if I'm indeed actually better off w/o my leg -- arthritis was already setting in, bone was fragile following limb salvage.
Ambivalent	That is a hard question. There is no easy answer. In some ways, yes, it would have been. I just can't answer that with a definitive answer. I do think that it needs to be looked at and studied, but for me I really am glad I had my leg for the time I did, but the pain that went along with it really shaped my world. The pain limited my ability to attend college, to have an active lifestyle and to do things a person should have been able to do in their twenties. I think adjusting to prosthesis would have been easier to 14 instead of 27. This is a question that could lead to a lengthy discussion.
Ambivalent	I struggled with a failed limb salvage for a long time before having an amputation. I do not think having an amputation as a first procedure was right for me. I had to be sure that there was no other option. Each patient is different in that manner.
Late amputation: hemipelvectomy	Blank.
Late amputation: shoulder disarticulation	
Ambivalent	Limb salvage would be better if all disease can be removed successfully; partial use of a limb is better than no limb.
Late amputation: rotationplasty	
Ambivalent	I believe the limb salvage procedure was a blessing. It let me have my leg 12 more years.
Hip disarticulation	Two blank
Positive	I am an amputee. I don't think limb salvage would have been better because of risk of not removing all cancer. Also, I have heard of people only being able to drag the salvaged limb, not use it.
Positive	I am an amputee and I believe that gave me my best chance for survival.
Limb salvage: endoprosthetic	Four blank.
Positive	No, I would have never wanted amputation. Limb salvage has been the better of the two choices.
Positive	No (meaning amputation would not have been a better choice).
Positive	No way -- because even though it hurts sometimes it works almost as good as it used to.
Positive	No. I'm glad that limb salvage was an option for me and they didn't just take my leg.

Treatment group	If you have undergone a limb-salvage procedure, do you think that an amputation from the start of the bone cancer would have been a better choice? If you are an amputee, do you think that a limb-salvage procedure would have been a better treatment? Why?
Positive	Limb salvage was the best thing to do.
Positive	No (meaning amputation would not have been a better choice).
Positive	No -- limb salvage was the best choice for me because of quality-of- life issues.
Positive	I went through limb salvage and could not imagine not having my own leg. So, I believe it was the better choice.
Positive	I am very happy to have my leg! I do live with pain and have a noticeable limp; amputation might have been easier.
Positive	I am very satisfied with the salvage. I go through my day like normal.
Positive	No. At 13, I could not see my life being complete without my leg. Amputation wasn't an option unless limb salvage didn't work.
Positive	No. Limb salvage has allowed me to live an almost normal life. Other than running or jumping I can do almost everything I did prior to the cancer and limb salvage.
Positive	No. I feel limb salvage was the best choice for me.
Positive	Even with the pain I am glad to have my leg and to be able to look and move somewhat normal.
Positive	No. I'm thankful for what I have. I'm grateful for the wonderful doctors who where able to save my arm and what mobility I have.
Positive	I am thankful the doctors chose to save my leg. If it can be saved, the limb salvage is better.
Positive	No (meaning amputation would not have been a better choice).
Positive	No, definitely not (meaning amputation would not have been a better choice).
Positive	You can save the limb.
Positive	I think it is always better to have your limb, if possible.
Positive	In my situation, limb salvage was the best choice.
Ambivalent	Hard to tell. I am very limited and sometimes think amputation would leave me with more mobility.
Limb salvage: bone graft	
Positive	No. I am grateful to have been able to keep my leg.
Positive	My surgery (bone graft limb salvage) worked wonderfully!
Positive	No (meaning amputation would not have been a better choice).
Positive	No (meaning amputation would not have been a better choice).
Positive	No (meaning amputation would not have been a better choice).
Internal hemipelvectomy	
	Blank.