Functional Evaluation Following Rotationplasty

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Abstract

Background: Rotationplasty is a procedure aiming that the patients function will approximate the function of subjects with below knee amputation with a fully functional knee joint.

Objective: This study was designed to evaluate the functional outcome of rotationplasty.

Patients and Methods: We used the musculoskeletal tumour society (MSTS) score including evaluation of pain, function, emotional acceptance, need of support, walking and gait components in 28 children who had rotationplasty operations after 12 months of wearing the prosthesis.

Results: This study revealed that these patients achieved a good MSTS score with an average of 24.6/30.

Conclusion: Rotationplasty is physically and psychologically a good procedure in children having malignant lower limb tumours.

Key Words: Malignant bone tumours – Lower limbs – Rotationplasty – MSTS score.

Introduction

FOR years, transfemoral amputation or a hip disarticulation were the usual treatments of tumours located around the knee and a transpelvic amputation, in more proximal lesions [1]. But the concept of limb salvage surgeries was originated with the start of modern chemotherapy [2].

The principal problem facing the surgeons in these young patients was the loss of the knee joint. Surgeons tried to avoid it via generating a knee arthrodesis. Even though this procedure is still quite valuable in many patients, but it has very major drawbacks, especially for tall patients or those interested in athletic activities. Moreover, this method is impractical in young children due to the essential removal of growth plates around the knee and the subsequent leg length discrepancy [3]. Although, the tumour replacement endoprosthesis is now quite prevalent; however it also has noteworthy restrictions" [3].

The modified rotationplasty technique appears to have the least problems associated with the above procedures [4].

This work was designed to evaluate the functional outcome of rotationplasty performed in children who had lower limb bone sarcomas, after 12 months of wearing the prosthesis. The evaluation was done by using the MSTS scoring system [5].

Patients and Methods

From 1998 till 2013, a retrospective and prospective study of rotationplasty operations was performed on 55 children at Kasr El-Aini Hospital, Faculty of Medicine, Cairo University and Children Cancer Hospital 57357.

Twenty seven patients were excluded from the study; 15 cases died due to secondary metastasis during the follow-up duration, 2 cases underwent amputation due to severe infection, 3 cases underwent disarticulation due to recurrence, 6 cases were missed during follow up and one case was > 18 years old. So, this study included only 28 patients who met the inclusion criteria. Twenty seven patients had osteosarcoma (25 of them had OSA of distal femur, one case had OSA of proximal tibia and one case after failed vascularized fibular graft), and one case of proximal femur Ewing’s sarcoma. The study was carried out on 50% male patients and 50% female patients; their age was ranging between 6 and 18 years. Six patients had pathological fractures while 22 patients had no pathological fractures. Rotationplasty type AI was done in 26 patients while 1 case underwent type AII rotationplasty and 1 case underwent rotationplasty type BII. All patients included in the study
were followed for a minimum of 12 months follow-up after prosthesis application as revealed in Fig. (1).

Functional assessment of the patients:

The necessity for a standardized system for functional assessment of numerous surgical alternatives after limb salvage and ablative procedures for musculoskeletal tumours was clearly identified during the first International Symposium on Limb Salvage (ISOLS) in 1981 [5].

The Musculo-Skeletal Tumour Society (MSTS) assumed for their joint studies a system of functional evaluation as shown in Table (1). The system assigns numerical values (0-5) for each of six categories: Pain, function, emotional acceptance, supports, walking and gait in the lower extremity. A numerical score and percent rating is calculated to allow for comparison of results [5]. Accordingly, in this study, we analyzed our patients of rotationplasty by the MSTS score after 12 months of wearing the prosthesis.

Statistical methods:

Data were coded and entered using the statistical package SPSS version 15. Data were summarized using mean and % change for the quantitative variables. Comparisons between groups (with sufficient number) were done using analysis of variance (ANOVA) and multiple comparisons (Post Hoc test) for the quantitative variables. p-values less than 0.05 were considered as statistically significant [6].

Table (1): MSTS scoring system [5].

<table>
<thead>
<tr>
<th>Score</th>
<th>Pain</th>
<th>Function</th>
<th>Emotional acceptance</th>
<th>Supports</th>
<th>Walking</th>
<th>Gait</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>None</td>
<td>No restriction</td>
<td>Enthused</td>
<td>None</td>
<td>Unlimited</td>
<td>Normal</td>
</tr>
<tr>
<td>3</td>
<td>Modest</td>
<td>Recreational restriction</td>
<td>Satisfied</td>
<td>Brace</td>
<td>Limited</td>
<td>Minor cosmetic</td>
</tr>
<tr>
<td>1</td>
<td>Moderate</td>
<td>Partial disability</td>
<td>Accepts</td>
<td>1-cane crutch</td>
<td>Inside only</td>
<td>Major cosmetic, minor handicap</td>
</tr>
<tr>
<td>0</td>
<td>Severe</td>
<td>Total disability</td>
<td>Dislikes</td>
<td>2-cane crutch</td>
<td>Unable unaided</td>
<td>Major handicap</td>
</tr>
</tbody>
</table>

Results

The present work was designed to assess the functional outcome of rotationplasty using the (MSTS) scoring system among twenty eight children after a minimum of 12 months of follow-up after prosthesis application as follow.

Analysis of pain component:

As demonstrated in Fig. (2), none of the patients included in our study complained of pain.

Analysis of function component:

As shown in Fig. (3), 53.57% of patients exhibited recreational restriction (grade 3) and 10.71% were not functionally restricted (grade 5). While, 35.71% of patients were in-between (grade 4). The average function score was 3.6 points.

Analysis of emotional acceptance component:

Our results revealed that 92.8% of patients were enthused (grade 5), only 1 case was satisfied (grade 3) and another case was intermediate (between grade 5 and grade 3) as shown in Fig. (4). The mean score of emotional acceptance was 4.9 points.

Analysis of Support component:

Our data in Fig. (5) revealed that all patients were in need of supportive prosthesis (grade 3).

Analysis of walking component:

As demonstrated in Fig. (6), 85.72% of patients had unlimited walking capability (grade 5), 7.14%
had limited walking ability and 7.14% were intermediate, between grade (4) and grade (2). Average walking score was 4.8 points.

In 75% of patients, the gait was oscillating between major cosmetic (grade 4) and minor cosmetic (grade 2), 17.9% of patients were in the (minor cosmetic grade) while 7.1% of patients; (2 cases) had normal gait (grade 5). The mean gait score was 3.3 points as demonstrated in Fig. (7).

**Analysis of total MSTS score:**

The MSTS scoring of our patients was ranging from (22 to 28 points) as provided in Fig. (8). The mean value was 24.6 points.
We compared our results with the results of the studies in the literatures which assessed the functional outcome of rotationplasty. There are various clinical studies which evaluated rotationplasty:

McClenaghan et al. [9] evaluated 18 patients managed with different operations (above-the-knee amputation, arthrodesis, and rotationplasty) for the treatment of malignant bone tumour of the knee region.

Catani et al. [10] analyzed the gait of ten children treated by the classical rotationplasty through kinetic, kinematic, and temporal-distance parameters in comparison with measurements of a normal population of ten healthy subjects.

Hanlon and Krajbicj, [11] followed-up 14 of skeletally immature patients with a Grade IIB osteosarcoma about the knee who were treated with a modified rotationplasty, for 4 to 10.5 years (mean follow-up: 8 years).

Hillmann et al. [12] evaluated 43 patients who had been managed with rotationplasty for the treatment of a femoral or tibial bone tumour, the mean age at the time of the procedure was 17.8 ± 10.2 years, and the mean duration of follow-up was 6.7 ± 4.9 years. Instrumented gait and electromyographic analyses were performed. The qualitative data were compared with the functional outcome, which was determined with the functional evaluation score of the MSTS.

Veenstra et al. [13] estimated the intermediate and long-term consequences on quality of life (QOL) following rotationplasty through a self-report questionnaire on 34 patients. All patients were older than 16 years and at least 1 year post surgery (mean 6.3 years). The response rate was 96%.

Rödl et al. [14] assessed the long-standing results in 22 patients with rotationplasty after resection of high-grade malignant bone tumours.

Wicart et al. [15] presented the results of rotationplasty in 4 boys undertaken after failure of massive knee endoprostheses implanted for malignant tumours at a mean age of 9.5 years for a stage-IIB malignant tumour of the distal femur.

Hopyan et al. [16] compared the relative physical quality of limb-sparing reconstruction, above-knee amputation, and rotationplasty in survivors of childhood and adolescent lower extremity bone sarcoma (minimum 5-year disease-free survivors).

Discussion

The past four decades have seen remarkable progress in treatment of pediatric cancers. Consequently, there are more and more adult childhood cancer survivors [7].

Various surgical techniques are available for patients with lower extremity bone tumours. The rotationplasty is an Ablative surgery that can be used for tumours of the distal femur or proximal tibia and consists of total resection of the tumour and the knee joint. For the reconstruction, the lower leg is 180 degrees revolved and attached to the residual femur resulting in an ankle joint functioning as knee joint [8]. The present work has been considered to evaluate the functional results of rotationplasty using the MSTS score in lower limb bone sarcomas in pediatric patients after at least 12 months of follow-up after wearing the prosthesis.
Aksnes et al. [17] assessed the long-term functional consequence in 118 patients treated for osteosarcoma or Ewing’s sarcoma in the extremities in at least of five years after treatment. A total of 67 patients (57%) primarily had limb-sparing surgery, but four had a secondary amputation.

Bekkering et al. [8] evaluated the functional capacity and the amount of physical activity by questionnaires and objective instruments in 82 patients aged 8-25 years with a follow-up of 1 to 5 years: Thirty-nine patients underwent limb-salvage surgery (24 allografts and 15 endoprosthesis) and forty-three underwent ablative surgery (27 amputations and 16 rotationplasty).

Cristiana et al. [18] delivered SF-36 questionnaires which were administered to 20 subjects, 12 men (60%) and 8 women (40%) aged between 17 and 38 years old with a mean follow-up of 17.2 years, range 6.7-22.4 years.

Analysis of the total MSTS score:

The MSTS scoring of our patients was ranging from (22 to 28 points) attaining a mean value of 24.6 points.

Consistent with our results, Hillmann et al. [12] reported that patients after rotationplasty achieved a total MSTS score of 24 points that was comparable with that of patients managed with prosthetic knee replacement.

Moreover, Wicart et al. [15] recorded excellent functional outcome of the results of rotationplasty with a mean score of 27.5/30 versus a score of 7.5/30 after endoprosthesis.

In addition, Aksnes et al. [17] reported that amputees had a significantly lower MSTS score than those with limb-sparing surgery.

Analysis of pain component:

Our results showed that none of patients involved in our study was complaining of pain. According to MSTS score, 100% of cases achieved 5 points in pain scale. Concomitant with our results, Wicart et al. [15] reported that the patients had no pain.

On the contrary, Rougraff et al. [19] reported that, after a rotationplasty, an unacceptable fit of the new exoprosthesis or early degenerative lesions of the ankle joint may occasionally cause pain. They reported that one female patient, who was very slim, continued to have problems related to the fit of the prosthesis. Seven years after the operation, she still had pain with weight-bearing activities.

Analysis of function component:

Functional capability and the degree of physical activity are important outcome measures in children and young adults after surgery for a malignant tumour of the lower limb. In our study, the average function score was 3.6 points, because 15 cases (53.57%) exhibited recreational restriction and 10 cases (35.71%) were capable of achieving their schoolwork and usual day to day activities but incapable of practicing the usual sports they used to perform such as swimming and football playing.

In support to our results, Hanlon and Krajbich, [11] assessed the patients using MSTS score and they found that all had good or excellent results. No patient thought that the reconstruction affected their ability to achieve recreational, sporting, or career objectives. The reconstruction is long-lasting and is not accompanied with an increase in late complications.

Moreover, Veenstra et al. [13] reported that, With respect to physical functioning, two-thirds of patients involved actively in sports.

In addition, Wicart et al. [15] reported that sporting activities such as swimming, jogging, martial arts or soccer, which had been impossible before rotationplasty, were achieved by all patients. The great improvement in function which was achieved with rotationplasty was associated with resolution of the psychological harms. The two youngest patients achieved a great progress regarding their schoolwork while the two oldest got suitable jobs and a marital partner or a stable relationship. The patients and their families confirmed that they would choose this treatment again if there was a need.

Furthermore, Hopyan et al. [16] found that the amount of time spent in the upright position as assessed with a remote activity monitor was maximum in patients who had undergone rotationplasty, although statistical assessment of this group was not feasible but how the level of physical activity between patients after ablative and limb-salvage surgery compare is indistinct, as the literature is infrequent.

On the other hand, Bekkering et al. [8] concluded that the results of ablative surgery has to be performed in children or adolescents with a malignant bone tumour around the knee, the functional outcome appears to be analogous to that of limb-salvage surgery.
Analysis of emotional acceptance component:

Although the psychological problems after rotationplasty are well documented, [20,21,22], interestingly, our results revealed that the mean score of emotional acceptance among our patients was 4.9 points as 26 cases (92.8%) were enthused especially when they remembered that they were prone to amputation and they believed that rotationplasty is a better alternative.

In agreement with our results, Rödl et al. [14] found no reduction in psychosocial adaptation and life satisfaction in patients after 10-year follow-up; it was about the same as in healthy persons. They therefore recommend rotationplasty as an alternative of amputation when conventional limb salvage is impossible.

Wicart et al. [15] reported that patients treated firstly with endoprosthesis had significant associated psychological problems whereas after rotationplasty there was a resolution of the psychological complications. They stated that, there was significant acceptance of rotationplasty in their patients which may be explained by the fact that they were aware that rotationplasty is a single definitive technique with a relatively low occurrence of complications and revision rate.

Moreover, they suggested that acceptance of this technique is a multifactorial; the gender of the patient is one factor, as their series included only boys.

However, Veenstra et al. [13] documented that Patients’ physical functioning was worse than that of healthy individuals but better relative to chronically ill patients. Levels of psychosocial functioning, general quality of life and social support were higher in comparison to those of healthy individuals. One-third to one-half of the patients described negative effects of the surgery on initiating social contacts, figures, and sexuality. Regarding the physical function, two-thirds of patients involved actively in sports. Patients reported wearing the prosthesis continuously and were, in general, satisfied with its fit.

Moreover, Hopyan et al. [16] reported that the psychosocial effect of limb-sparing reconstruction, AK amputation, and rotationplasty, was alike among all groups. These data may be beneficial in discussing reconstruction with patients and their families.

Remarkably, Cristiana et al. [18] informed that greater well-being was found in the Mental Component Summary scale of subjects aged more than 24 years, with a mean score of 54.2 (±4.8), compared with that of those aged up to 24 years, with a mean score of 48.0 (±6.6). Social and emotional difficulty in adolescence, which had been in part overwhelmed in adulthood, was revealed.

Analysis of Support, walking and gait components:

Our study revealed that all patients were in need of supportive brace (grade 3), the average walking score was 4.8 points and the gait score was 3.3 points among the patients.

In agreement with our results, Hillmann et al. [12] reported that patients had good restoration of gait after rotationplasty that was also verified by the symmetrical ranges of motion of the hip and knee joints and by the similar electromyographic activity patterns of the hip muscles demonstrating very good adaptation to the new function. Therefore, they supposed that this biological reconstruction technique is a good alternative for the treatment of bone tumours. Also they emphasized that enough muscles must be active by strengthening and stretching in order to regain control over the ankle joint (new knee). This may reveal an association between the number of excised quadriceps heads and the functional re-establishment.

Catani et al. [10] reported that, even though walking by patients managed with rotationplasty was to some extent irregular and slower than walking by a control group of normal patients, the rotationplasty group was well coordinated. Furthermore, they found that stride length, velocity, and cadence were significantly reduced in the rotationplasty group.

Moreover, on measuring the oxygen consumption, McClenaghan et al. [9] found that the patients who had been coped with rotationplasty walked faster and more professionally than those managed with AK amputation or arthrodesis.

Conclusions:

We can conclude from this study that: On the basis of MSTS score, rotationplasty is a procedure with a valuable outcome as all the patients included in the study reported no pain during the follow-up period, most of patients were emotionally enthused (92.8%) and most of patients (85.72%) showed unlimited walking activity. All patients who had rotationplasty were in need of support which might contribute to the resulted intermediate function and gait scale which attained 3.6 and 3.3 respectively. Collectively, patients included in our work achieved a good MSTS score of 24.6 (ranging from 22 to 28 points).
Recommendations:

We recommend further research to evaluate the functional outcome of rotationplasty by other tools, further studies to compare between rotationplasty and other ablative and limb salvage operations, further work to clarify the best type of rotationplasty technique and further research to discover any technical modifications in rotationplasty operations, allowing for better and better results.

References


ان اجراء الاستدارة الكاملة هو إجراء يهدف إلى أن تكون وظيفة المراضي مقارنة الى وظيفة المرضي الذين أجروا بتر تحت الركبة حيث يعمل مفصل الركبة بكامل وظيفته.

الهدف: لقد صممت هذه الدراسة لتقييم النتائج الوظيفية للاستدارة الكاملة.

المرضي والأساليب: لقد استخدمنا مقاييس جمعية الورم العضلي الهيكلي (ام اس تي اس) والذي يتضمن تقييم كل من الأم، الوظيفة، القبول الطبي، الحاجة إلى الدعم، المشي، وطريقة المشي في 28 طفلا قد أجريوا عمليات الاستدارة الكاملة بعد 21 شهرا من إحداثتهم للجهاز.

النتائج: وكشفت هذه الدراسة أنه عند تقييم هؤلاء المرضى باستخدام مقاييس جمعية الورم العضلي الهيكلي أن المرضى قد حققوا نقاطا جيدة بعشرسة 24 تقاسما 30 من إجمالي.

الخلاصة: إن اجراء الاستدارة الكاملة في الأطفال المصابون بأورام خبيثة في أطرافهم السفلية يعد أداة حيزة في تشخيص الجسدية والنفسية.

الكلمات النافذة: الأورام الخبيثة في العظام لا الأطراف السفلية - الاستدارة الكاملة - مقاييس جمعية الورم العضلي الهيكلي (ام اس تي اس).