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THE HISTORY OF BONE TUMOUR TREATMENT AND THE STATE OF THE ART IN VIENNA

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ABSTRACT

Purposes: Bone tumours have been a tragedy for the patient in any time period. In the majority of the cases it occurs in children or young adults. In the past the affected limbs could not be spared and the overall prognosis was poor.

Methods:Chemotherapy successfully introduced for the purpose of overcoming the poor overall prognosis (Rosen and Jaffe) and tumour prostheses were invented for the purpose of salvaging the affected limbs (Marcove, Scales, Campanacci, Sivas, Salzer).
According to the Vienna Tumour Registry in 1968, the first custom-made Vitallium prosthesis for the proximal femur was implanted in a parosteal osteosarcoma.

Results: In Vienna, as a result of the successful chemotherapy the surgical methods for bone tumours changed to limb sparing methods also . A modular ceramic prosthesis for the proximal humerus was introduced by Salzer. From 1975 -1982 16 custom-made endoprosthesis (1) for the knee region were implanted which were replaced by the KMFTR in 1982 (2, Kotz modular femur tibia reconstruction system) which was introduced at the "2nd ISOLS" to an international group of experts. The successful system was followed by the HMRS (Howmedica modular resection system) in 1988. At that time, especially in children, the rotation-plasty of Borgreve was adopted for tumours of the knee region (2). A scientific survey of 70 patients with rotation-plasty until 1991 showed excellent clinical and oncologic results. Later a similar approach was used in upper extremity tumours as "resection replantation" with surprisingly good results. Sophisticated technologies with growing mechanisms allowed the use of endoprostheses even in children (3) for the purpose of substitution since the mutilating rotation-plasty in 1996.

Conclusion: For almost 100 years efforts have been undertaken to improve the treatment of bone tumours. Surgery was aiming to keep the function of the limbs by tumour resection instead of amputation. Together with successful chemotherapy, which saves lives, an adequate surgery could stepwise salvage the function of the limb. Body integrity was the final aim for the diseased. Finally, by the effort of the International Societies like ISOLS and EMSOS the survival of malignant bone tumour patients improved from 20% to 80 % with good function quality by sophisticated operative techniques and improved tumour prostheses.

Keywords: Bone tumours, Limb salvage, adequate Chemotherapy, Tumor Prostheses

Bone tumours have been a tragedy for the patient in any time period. In the majority of cases it occurs in children or young adults. The affected limbs could not be spared in the past and the overall prognosis was poor (Fig 1).

Therefore there have been early attempts of limb salvation in bone tumours in the past. The "Umkippplastik" by Ferdinand Sauerbruch in Germany to preserve the lower part of the lower extremity as a femur stump in proximal femur tumours has been pub-

lished in 1922 [1]. The interscapulo-thoracic resection of the shoulder girdle from Tikhov (Tomsk, Russia) and also by Linberg (Smolensk, Russia, 2) were the first attempts to preserve the arm and the hand in tumours of the shoulder girdle published also in 1922 (Fig 2).

Fig. 1: Untreated Osteosarcoma in an eleven years old girl

Fig 2: Tikhof-Linberg resection (Vienna 1972)

Since, it took 20 years to use a metallic implant for leg preservation for the first time in bone tumours by Austin Moore and Harald Bohlmann in 1943 [3, Fig 3]. The diagnosis was a giant cell tumour of the proximal Femur and the surgery was performed with a proximal femur replacement from Vitallium. This proved to be successful for 2 years when the patient died due to a heart disease.

To overcome the poor overall prognosis of malignant bone tumours, chemotherapy with Doxorubycin in osteosarcoma was introduced in the United States which resulted in 40.2 % survival versus 12 % without chemotherapy [Cortes et al in 1974, 4]. At the same time Ralph Marcove in New York used femur and knee metallic prosthesis in osteosarcoma patients in 1974 [5]. Scales from Stanmore, London was using massive titanium endoprostheses in tumours in 1972 and he was also the first one to introduce a growing mechanism in extending prosthesis [6]. Mario Cam-

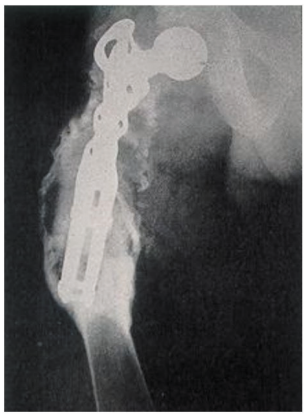


Fig: 3
The first metall hip joint
in a bone tumour
(New York 1943)

panacci in Bologna used prostheses after total resection of the distal femur or proximal tibia in sarcomas in 1979 [7]. Since 1977 67 tumorprosthesis were constructed by Konstatin Sivas and implanted by Nikolai Trapeznikov till 1983 [8, Fig.4] in the USSR.

The Vienna Tumor Registry - which has gathered clinical and histological cases with a total number of more than 10.000 during the last 44 years - was founded by Mechthild and Martin Salzer in 1962 and published for the first time in 1968 [9]. Martin Salzer, who was the first leading surgeon of the registry operated with "oncological radicality" [10] published in 1969. He graded the procedure "interlesional", "marginal" and "wide in healthy tissues". This staging system was followed by William Ennekings "Surgical Staging System of Musculoskeletal Sacroma" in 1980 [11]. A

Fig 4:
Custom-made tumour-
endoprothesis of the knee
from Titanium
(Trapeznikov, Russia 1977)

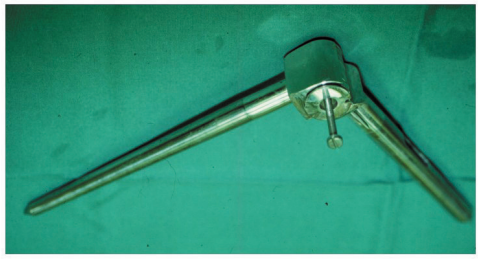
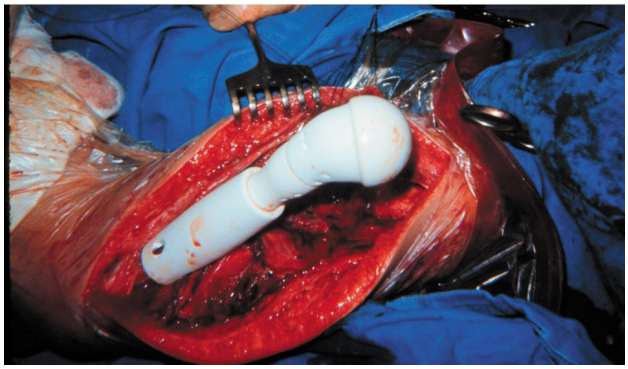


Fig. 5: The first distal femur acrylic prosthesis with a broken stem in Vienna 1964

distal femur acrylic prosthesis (Fig 6) was implanted in a giant cell tumour in 1964 in Vienna. The patient survived with this device for more than 40 years. In 1968 the first custom-made Vitallium prosthesis for the proximal femur was implanted in a patient with a parosteal osteosarcoma, who is still alive after 48 years without any revision.

Fig 6: First modular ceramic Humerus-endoprosthesis (Vienna 1874)



Since the use of high-dose Methotrexate, introduced by Isaac Djerassi [12] and used for bone tumours by Norman Jaffe [13] and put into a successful multidrug schedule by Gerald Rosen [14], the prognosis of osteosarcoma improved from 40% survival with Cortes´ schedule to 80%. The treatment of Ewing´s Tumours had a similar development with improvement from 10% to at least 60% [15]. Following these results for osteogenic sarcomas, the COSS protocols [16] and in Ewing´s tumours, the CESS protocols [17] were established in Austria and Germany. The author of this article was the surgical advisor in all COSS protocols for three decades, beginning in 1980.

Fig 7: Humerus-Howmedica modular replacement System (HHMRS)

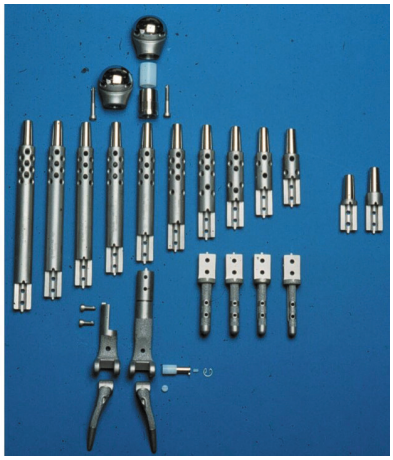
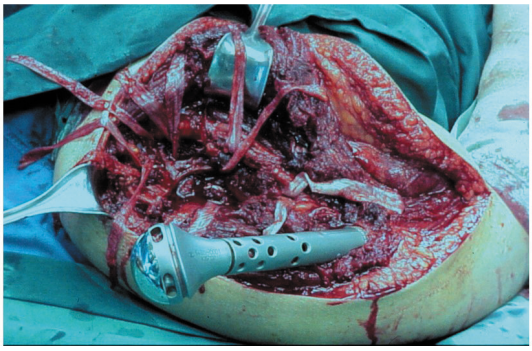
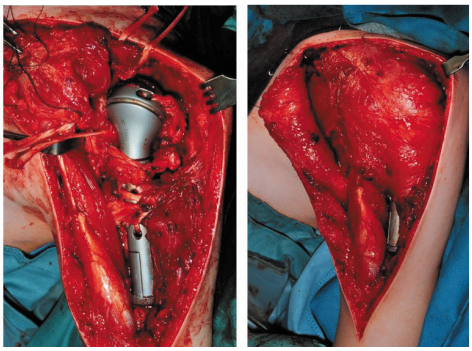


Fig 8: Fascia latae stripes for muscle fixation



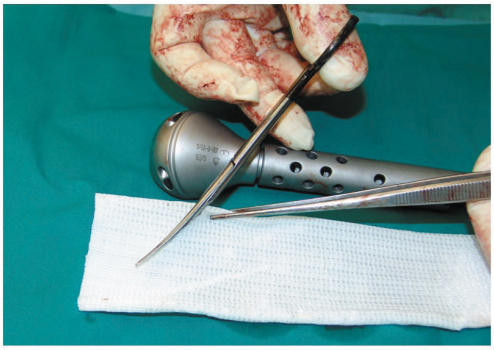
As a result of the successful chemotherapy the surgical methods for treating bone tumours changed to limb sparing methods also. The non-weight bearing upper extremity was the first aim for limb preservation. After Tikhof-Linbergs experiences in 1922, Ralph Marcove was the first to resect the proximal humerus and replace the defect with a nail. Fifty years after the publication of Linberg a modular ceramic prosthesis for the proximal humerus was introduced in the treatment of bone tumours by Martin Salzer [Fig: 6, 18]. In Vienna this three-part ceramic modular humerus prosthesis has been used successfully for 10 years. Afterwards, in 1989 it was replaced by the Humerus Howmedica Modular reconstruction system (HHMRS) from Vitallium which allowed to replace the elbow joint also. (Fig 7) Various fixations of the proximal

Fig 9: Pectoralis Transposition



humerus prosthesis were used (fascia latae stripes Fig 8, pectoralis major transposition Fig 9 and LARS augmentation Fig 10). In an experience with 120 cases in Vienna from 1989 to 2002 only five amputations were necessary (4.2 %) [19].

Fig 10: LARS Augmentation



The first custom-made endoprosthesis for the knee region was implanted in 1975. In the following 6 years Howmedica produced 16 custom-made prosthesis with varying design for no use of cement in the knee region [Fig 11, 20].

This was the exact situation when the 1st International Workshop for TUMOR PROSTHESES FOR BONE AND JOINT RECONSTRUCTION – DESIGN AND APPLICATION was held in Rochester, Minnesota by John C. Ivins, Edmund Y. Chao and Franklin H. Sim in 1981.

Fig 11: custom-made distal femur tumor prostheses (Howmedica°)

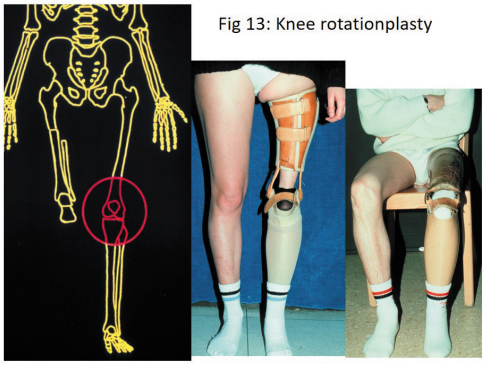
The positive experience with the report of these prostheses led to the development of a modular System for the lower extremity in adults and adolescent patients [Fig 12, 21], the KMFTR (Kotz modular femur tibia reconstruction system). At the "2nd International Workshop on Design and Application of Tumor Prostheses for Bone and Joint Reconstruction" this system was introduced to the small international group of expert surgeons, who were dealing with limb salvage methods

Fig 12: KMFTR System 1982 and improved HMRS 1988

for the treatment of bone tumours. The 3rd meeting organised by William J. Enneking in Orlando, Florida 1985 was the 1st Orthopaedic Symposium on Limb Salvage in Musculoskeletal Oncology, which led to the International Society on Limb Salvage (ISOLS).

The successful KMFTR system in Vienna and Bologna was followed by the HMRS (Howmedica modular resection system) in 1988. At that time, especially in children, the development of a different surgical procedure to preserve a healthy part of the limb

Fig 13: Knee rotationplasty



was first introduced in 1975 in Vienna for tumours of the lower extremity (Fig 13) and published in 1982 [22]. The rotation-plasty of Borgreve was adopted for tumours of the knee region. A scientific survey of 70 patients until 1991 showed excellent clinical and oncologic results [23]. Later a similar approach was used in upper extremity tumours (Fig 14) with this so-called "resection replantation" [24]. Never the less the

Fig 14: Resection-Replantation of the elbow

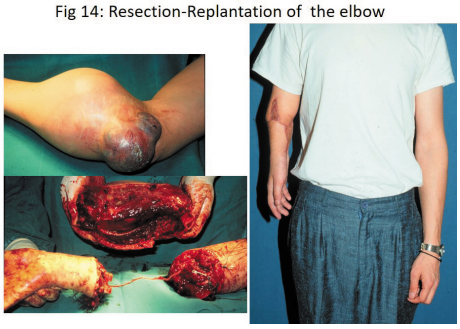
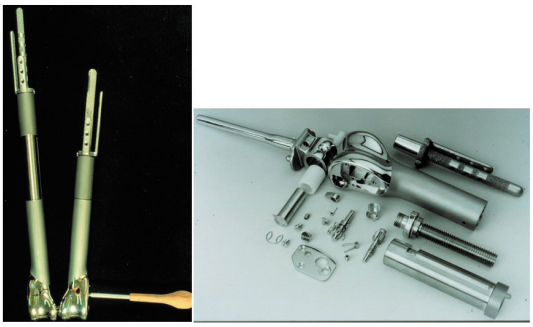


Fig 15: Growing prosthesis 1985 -2000 (60 patients)
manual and automatic



development of endoprosthesis abolished the wear of the plastic bushings, which lead to frequent revisions [25]. Sophisticated technologies with growing mechanisms (Fig 15) allowed the use of endoprostheses even in children [26]. With the experience with tumour prostheses of Martin Malawer from Philadelphia and Jeff Eckart from Los Angeles in the US, the European modular system, together with Mario Mercuri from Bologna, was combined in a global modular replacement system (GMRS), Fig 16. The axis was changed from a fixed hinge to a rotating hinge and the stem fixation was further improved after multiple experimental testing in the laboratory of the university clinic of orthopaedics at the Medical University of Vienna [27] Fig. 17. With these changes the results were better than those with other prostheses systems (28).

Fig 16: GLOBAL MODULAR (GMRS)
REPLACEMENT SYSTEM

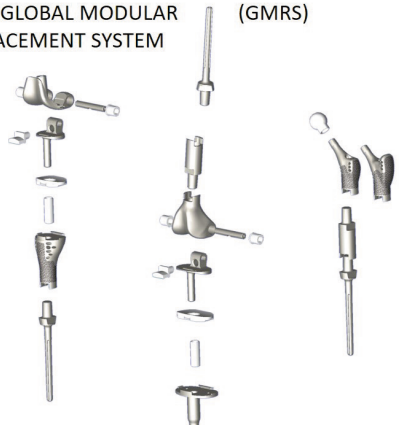
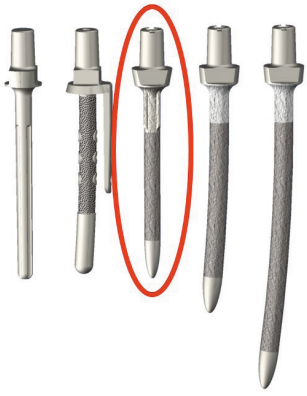
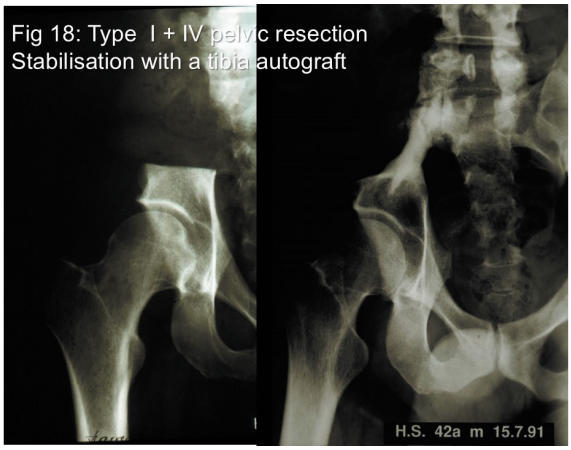


Fig 17: Stem fixation without cement (GMRS)



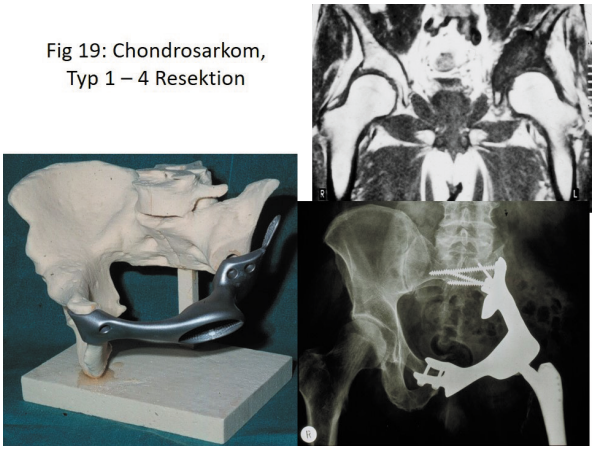
The pelvis and the spine were two other very important regions for bone tumour surgery where dramatic improvement could have been achieved by the end of the last century.

The limb salvage in periacetabular sarcoma [29] was not only a problem of resection in "wide margins" but also a challenge of stabilising the pelvic ring with a weight bearing extremity (Fig 18). The technical solutions varied between custom-made tumour prosthesis (Fig 19) and biologic reconstruction with autografts and allografts (Fig 20).



A special challenge were the primary bone tumours of the spine. With a special method invented by Katsuro Tomita from Kanazawa, Japan, and adopted in Vienna, "wide resection" of affected vertebral bodies of the thoracic and the lumbar spine could be performed [30] Fig 21.

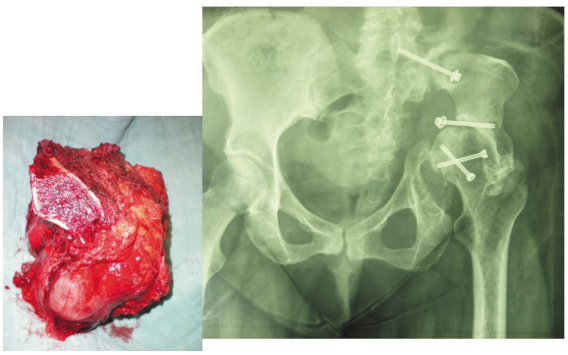
Fig 19: Chondrosarkom,
Typ 1 – 4 Resektion



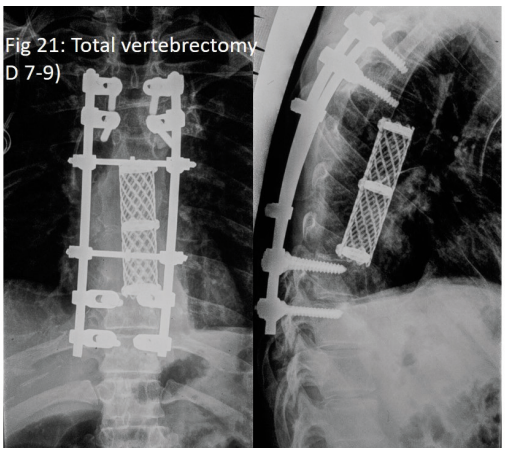
In desperate cases, experiences with 2 hemicorporectomies have been made in Vienna also. The first case was operated in 1974 (by MS), a chondrosarcoma of the pelvis in a 65 year old woman who died 48h after surgery due to an infection of the liquor, the second, a 65 year old male patient with chondrosarcoma

operated in 2004 (by RK) survived 14 days and died due to non-operative complications in intensive care [27] Fig 22.

Fig 20: Periacetabular Chondrosarcoma, biological reconstruction after inner hemipelvectomy



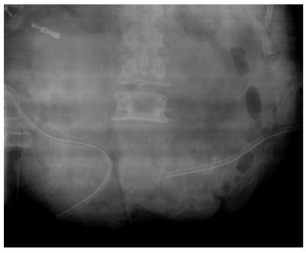
The improvement of chemotherapy in osteosarcoma and Ewing's tumours is documented in the COSS [31] and the CESS [32] protocols. While at the beginning of the successful chemotherapy era, dramatic improvements could be achieved when in the last



decades only small steps were made to improve the survival rate. Yet a reduction of side-effects could be observed. In addition, approaches to immunotherapy

Fig 22: 65 ys male with a chondrosarcoma

After amputation in the level lumbar 4/5



have been undertaken. Already in 1914 WB Coley [33] was using bacterial toxins in malignant inoperable tumours with some success. Later, human antibodies and dendritic cell therapy [34, 35] was developed to overcome chemotherapy resistance in recurrent tumours.

CONCLUSION

For almost 100 years efforts have been undertaken to improve the treatment of bone tumours. By classifying the different entities an adjusted treatment could be established according to the nature of the bone tumours. Surgery was aiming to keep the function of the limbs by tumour resection instead of amputation. Together with successful chemotherapy, which saves the lives, adequate surgery could stepwise salvage the function of the limb. Body integrity was the final aim for the diseased. Finally, by the effort of International Societies like ISOLS (International Society of Limb Salvage) and EMSOS (European musculoskeletal oncological Society) and cooperative studies, the survival rate from malignant bone tumours improved from 20% to 80% with improved life quality due to sophisticated operative techniques and improved tumour prostheses.

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Резиме

ИСТОРИЈА НА ТРЕТМАН НА КОСКЕНИОТ ТУМОР И ВРВНАТА ТЕХНОЛОГИЈА ВО ВИЕНА

Рајнер Коц

Wiener Privatklinik Betriebs-Ges.m.b.H. & Co.KG

Цели: Коскените тумори секогаш биле трагедија за пациентот. Во повеќето случаи тие се јавуваат кај деца или млади возрасни лица. Зафатените екстремитети не можеле да бидат поштедени во минатото и целокупната прогноза била лоша.

Методи: За да се надмине слабата целокупна прогноза, успешно беше воведена хемотерапија (Rosen and Jaffe), а за спасување на зафатените екстремитети се измислени и туморски протези (Marcove, Scales, Campanacci, Sivas, Salzer).

Во Виенскиот регистар на тумори во 1968 година првата специјално направена протеза на Vitalium за проксималната бутна коска беше вградена во паростелен остеосарком.

Резултати: Како резултат на успешната хемотерапија, хируршките методи за коскени тумори во Виена се променија во методи на штедење на екстремитетите. Модуларната керамичка протеза за проксималната надлактица беше воведена од Salzer. Од 1975 до 1982 година беа имплантирани 16 специјално изработени ендопротези (1) за регионот на коленото, кои беа заменети во 1982 година од KMFTR (2, Kotz modular femur tibia reconstruction system), кој беше претставен на „2 ISOLS“ на меѓународна група експерти. Успешниот систем беше следен во 1988 година од HMRS (Howmedica modular resection system). Во тоа време, особено кај децата, ротациската пластика на Borgreve беше усвоена за тумори на регионот на коленото (2). Научното истражување врз 70 пациенти со ротациска пластика до 1991 година покажа одлични клинички и онколошки резултати. Подоцна, сличен пристап се користеше кај туморите на горните екстремитети како „реплантација на ресекцијата“ со изненадувачки добри резултати.

Софистицираните технологии со растечки механизми уште од 1996 година овозможија употреба на ендопротезите дури и кај децата (3) за да се замени осакатената ротациска пластика.

Заклучок: Уште пред речиси 100 години вложени се напори за подобрување на третманот на коскените тумори. Хирургијата имаше цел да ја задржи функцијата на екстремитетите со ресекција на туморите наместо со ампутација. Заедно со успешната хемотерапија, која го спасува животот, соодветната операција може постепено да ја спаси функцијата на екстремитетот. Интегритетот на телото беше крајната цел за заболените. Конечно, со напорите на меѓународните друштва, какви што се ISOLS и EMSOS, опстанокот на пациентите со малигни тумори се подобри од 20 од 80% со добар квалитет на функцијата со софистицирани оперативни техники и подобрени туморски протези.

Клучни зборови: коскени тумори, спасување на екстремитетите, адекватна хемотерапија, туморски протези