Is Osseointegrated lower limb prosthesis better than conventional socket type prosthesis?

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There is no consensus regarding the global prevalence of amputations[1] but it has been estimated that that there were 1.6 million amputees in the United States in 2005 with a prevalence of 1 in 200 persons and with an alarming prediction of doubling of this figure by the year 2050.[2] Diabetics have the highest prevalence of lower limb amputations with a frequency of one amputation occurring every 30 seconds globally.[3] Currently lower limb amputees are mobilized and rehabilitated using conventional socket type prostheses.[4] These conventional socket type prostheses are associated with a complications rate in over 60%[5] amputees including stump ulcers and excessive sweating,[6] prosthesis fitting issues due to fluctuations in stump size,[7] residual limb fracture,[8] lack of confidence and problems in mobility.[9] To overcome these complications of socket prosthesis, osseointegrated prostheses have been designed.[10]

Keywords: Amputation, Osseointegration, Prosthesis

This article may be cited as: Shah FA, Muhammad E. Is Osseointegrated lower limb prosthesis better than conventional socket type prosthesis? J Pak Orthop Assoc 2022;34(3):

Osseointegrated lower limb prosthesis or bone anchored prosthesis involves a surgical technique of anchoring a metal implant directly into the residual bone of amputated limb on one side and connected to the external prosthesis with the help of a connector through a small stoma in the overlying skin of the stump on the other side.[4] The first osseointegrated femoral prosthesis was applied on 5th may 1990 in Sweden and since then many designs have been developed.[11] Currently there are six Osseointegrated prosthesis designs available in the market.[4] These are Osseointegrated Prostheses for the Rehabilitation of Amputees(OPRA) by Integrum, Integrated Leg Prosthesis(ILP) by Orthodynamics, Osseointegrated Prosthetic Limb (OPL) by Permedica, Percutaneous Osseointegrated Prosthesis(POP) by DJO Global, Compress Device by Zimmer Biomet and Intraosseous Transcutaneous Amputation Prosthesis(ITAP) by Stryker. Each prosthesis design has specific indications, merits and demerits.[4] The OPRA design is the oldest osseointegrated prosthesis design developed over three decades and had the longest follow up data of patients available.[12] The OPRA is made of Ttitanium and has three parts: the Fixture(stem),Abutment and Abutment screw(Fig. I).[13] The OPRA technique[9] is a two stage surgical technique of inserting OPRA into the amputated limb. In the first stage surgery the Fixture(80mm long) is inserted or screwed (Fig. II)[10] into the medullary cavity of the residual femur and the overlying wound and skin is closed. After wound healing the patient can utilize the conventional socket type prosthesis until second stage surgery which is performed six months later. In the second surgery the Abutment is inserted in the distal end of Fixture which is made protruded from skin through a small stoma. After two weeks the external limb prosthesis is attached with Abutment screw and rehabilitation is started.[13] The Osseointegrated Prosthetic Limb (OPL) [Fig. III][14] has evolved from Integrated Leg Prosthesis (ILP) The press-Fit stem of OPL is covered with a high porous metal for bone ingrowth and penetration.

The indications for osseointegrated prostheses are not yet clear.[4] They are more frequently applied in traumatic amputations and tumors. They are contraindicated in skeletally immature patients, elderly patients(> 70 years age), diabetes, peripheral vascular disease, pregnancy, chemotherapy, immunosuppressive drugs, psychiatric patients and patients with compliance issues.[15-17]Advantages of osseointegrated prosthesis include improved quality of life, increased range of motion of the hip joint, increased sitting comfort, osseoperception, improved walking ability and ability to wear and remove the prosthesis by the amputee himself.[18-23]

Osseointegrated lower limb prosthesis can be used in cases of short residual limb where application of conventional socket prosthesis is not possible.[24] The mean annual costs of socket type prosthesis and osseointegrated prosthesis are comparable with the latter visited less frequently to the prosthetist than the former resulting in significant reduction in post surgery costs of the osseointegrated prosthesis.[25] Haket[26] used IPL in 27 patients with transfemoral amputations and noted increase cortical thickness at two years follow up. Haket was of the opinion that the increased cortical thickness ensure survival of implants by avoiding fractures and loosening. Osseoperception occurred after osseointegration of the implant is completed and characterized by the feeling of the weight of the prosthesis by the patient resulting in activation of his residual muscles, improving balance accelerating the willingness to use muscles and ultimately improving his quality of life.[18,19,27,28]

Osseointegrated lower limb prosthesis has low risk of infection and implant removal as reported in the literature.Tillander[29] treated 39 patients with OPRA(screw type) and documented that only one patient had implant removal due to infection at five years follow up. Branemark [30] treated 51 patients with OPRA and the overall infection rate at 2 years follow up was 50% but only one patient had implant removal due to infection in his series.

Osseointegrated lower limb prosthesis is better than conventional socket type prosthesis. It is the future gold standard. It has improved the life style of thousands of amputees by enhancing their mobility and rehabilitation. These are effective implants with fewer complications and longer life span. We are confident that in near future the osseointegrated lower limb prosthesis will gain global acceptance particularly in underdeveloped countries where major limb trauma and war injuries are common and often lead to amputations due lack of limb salvage facilities. Meticulous surgical technique, access to these prosthesis, optimum physiotherapy services and local research is however mandatory for osseointegrated lower limb prosthesis to gain popularity in Pakistan.

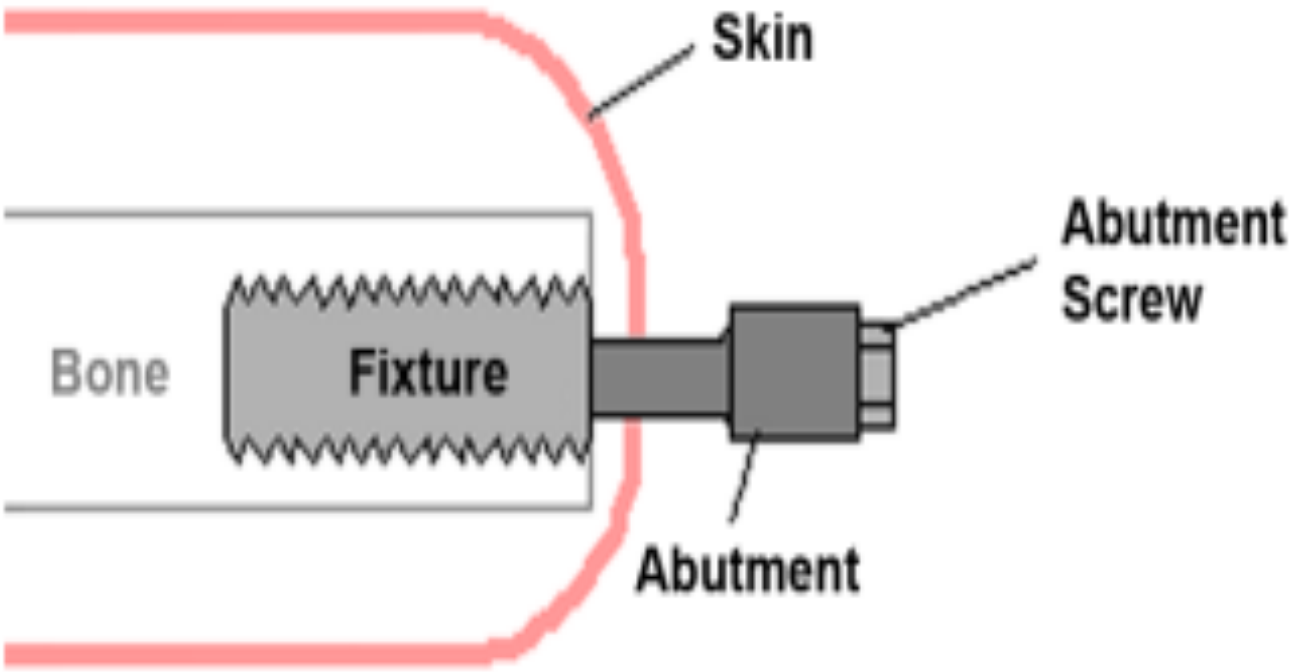

Fig. I: Components of OPRA[Adopted from Hagberg K, Branemark R. One hundred patients treated with osseointegrated transfemoral amputation prostheses--rehabilitation perspective. J Rehabil Res Dev. 2009; 46(3):331-344.][13]

Fig. II: Left: OPL (Osseointegrated Prosthetic Limb), **Right:** OPRA (Osseointegrated Prostheses for the Rehabilitation of Amputees) [Adopted from: Mirulla AI, Di Paolo S, Di Simone F, Ingrassia T, Nigrelli V, Zaffagnini S, *et al*. Biomechanical Analysis of Two Types of Osseointegrated Transfemoral Prosthesis. Applied Sciences. 2020; 10(22):8263. https://doi.org/10.3390/app10228263][10]

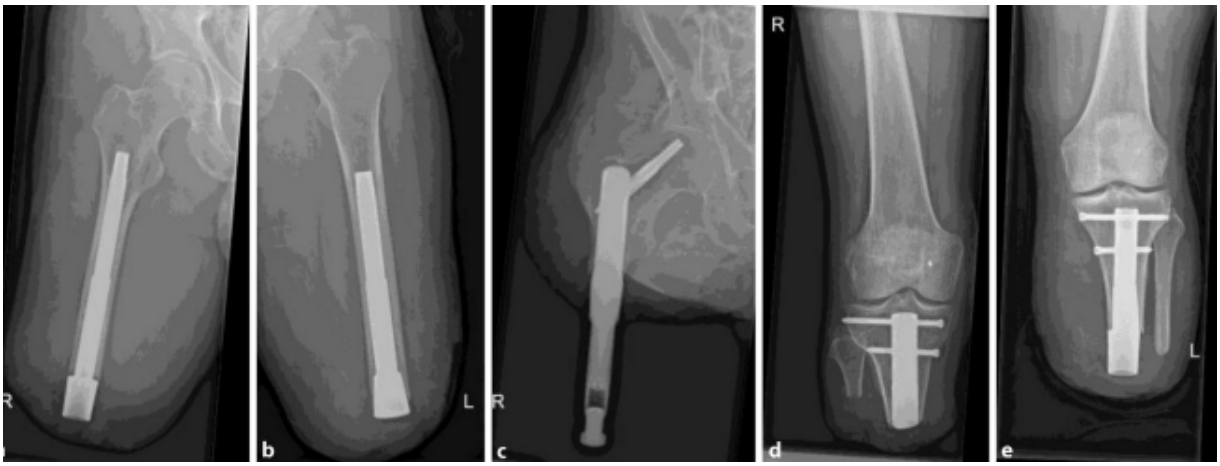

Fig. III (a): OPL type A with extra-medullary head. b) OPL type B with intra medullary head. d) & e) Custom made tibial implants with 3D mesh coating [Adopted from Frolke JP, Leijendekkers RA, van de Meent H. Osseointegrated prosthesis for patients with an amputation: Multidisciplinary team approach in the Netherlands. Unfallchirurg. 2017;120(4):293-299.][14]

Conflict of Interest: None

Grants/Funding: None

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