

SOCKET'S FAILURE OF PARTIAL FOOT PROSTHESIS TYPE CHOPART

Assist. Lecturer Abdul Munium Razoki Majeed Algbory.
Assist. Lecturer Mahasin Jaassam Mohammad
Assist. Lecturer Jwain Waddh Mohammad

*Institute of Medical Technology (Baghdad)
Foundation of Technical Education*

ABSTRACT

The research was achieved in the center of prosthesis manufacturing (Sadr Al- Qanat Factory for Prosthesis and Orthoses), and Baghdad Factory/Ministry of Health and Prosthesis and Orthoses workshop (Belong to Technical Medical Institute). The research made a study on a sample of (60) handicapped in the kind of partial foot amputation for the foot kind (Chopart). The material used in manufacturing the socket was plastic or leather or the two materials together. It was found that the maximum percentage of failure was (55%) for the socket made from plastic and the cause of failure was fracture where as the minimum percentage was (15%) for the socket that made from leather and the cause of failure was fracture. Either for the height of the socket It was found that the maximum percentage was (50%) for the socket of height with knee level and the cause of failure was fracture, where as the minimum percentage was (15%) for the socket of 1/3 distance between the knee and ankle joint and the cause of failure was fracture also. Either for the motion of ankle joint it was found that the maximum percentage was (60%) for the socket of no motion and the cause of failure was fracture where as the minimum value was (15%) for the socket of no motion but the cause of failure was the shape change of the socket.

Key word: Socket, Prosthesis. Partial foot, Chopart, Gait analysis, Stance Phase

فشل الوقب للطرف الاصطناعي للبتر الجزئي للقدم نوع چوبارت

م.م. عبدالمنعم رزوقي مجيد الجبوري م.م. محاسن جسام محمد م.م. جوان واضح محمد

المعهد الطبي التقني (بغداد) / هيئة التعليم التقني

الخلاصة

اجري البحث في مركز صدر القناة ومصنع بغداد للاطراف الاصطناعية والمساند العائدين الى وزارة الصحة وقسم التأهيل الطبي في المعهد الطبي التقني- بغداد، تمت الدراسة على عينة من (60) معاق لديهم بتر جزئي في القدم نوع (Chopart)، المواد المستخدمة في تصنيع الوقب كانت البلاستيك او الجلد او المادتين معا. بعد جمع البيانات وجد ان اعلى نسبة مئوية كانت (55%) لوقب مصنع من البلاستيك وكان سبب الفشل هو الكسر في حين كانت ادنى نسبة مئوية هي (15%) لوقب مصنع من الجلد وكان سبب الفشل ايضا الكسر اما بالنسبة لارتفاع الوقب فقد كانت اعلى نسبة هي (50%) لوقب ذو ارتفاع عند مستوى الركبة

وكان سبب الفشل هو الكسر وادنى نسبة كانت (15%) لوقب ذو ارتفاع 3/1 المسافة بين مفصل الكاحل ومفصل الركبة وكان سبب الفشل هو الكسر ايضا . اما بالنسبة لنوع مفصل الكاحل فقد كانت اعلى نسبة هي (60%) لوقب ذو مفصل الكاحل الثابت وكان سبب افشل هو الكسر وادنى نسبة كانت (15%) لوقب ذو مفصل الكاحل الثابت وكان سبب الفشل هو التغير في شكل الوقب.

INTRODUCTION

Partial foot amputation (PFA) describe the loss of part of either the fore- or hind foot (Murdoch,1967) and is typically the result of vascular insufficiency secondary to diabetes (Higgs, 2001). However, trauma, frostbite, and congenital anomalies are examples of the many other causes of amputation reported in the literature (Macfarlane,1997 and Bo, 1977). The motion of the foot is mainly governed by two joints, the ankle joint and subtalar joint (Ibrahim, 2000 and Make, 2001), the ankle joint is the joint between the tals and the tibia, while the subtalar joint is between the talus and calcaneus (L.I.C., 1987). To research the problem facing the amputees how had a partial foot amputation and identified the variable that lead to change the socket of partial foot prosthesis type chopart and determined the type of material appropriate to the each case of partial foot amputation as well as determine the height of the socket depending on the movement of the ankle joint and the appropriate period to use the prosthesis. The partial foot amputation was more complex amputation (Tang, 2004) it contains multiple levels, (amputation of phalanges, amputation of distal part of metatarsal, amputation of proximal part of metatarsal some time named Lisfrance, amputation include the talus and calcinuas bone (heel bone) named Chopart amputation which is widely amputation of the foot include the ankle joint and Pragrooph amputation it likes the symes amputation (Mann, 1988). After amputation the movement applied at ankle joint either, severely limited (stiff), mild range of motion (specific movement) or normal (Lavery, 1995).

Philosophically , the verdict on the order of the party's situation of artificial limb through the foot, it gives an idea of quarterly to the length of any stump loss ratio of total of the remaining of the foot (Kulkarni etal, 1995). There is no doubt that is the loss have an impact on the ankle joint (Hirsch etal, 1996). The forces acting on the partial prosthesis which transmitted from the stump to the prosthesis or from the ground reaction are analyzed from the viewpoint of biomechanics (Boyd etal 1999).

Partial foot stumps will still have the fatty tissue that is covering the normal heel. The majority of the patients weight should be transmitted this naturally adopted area. The stumps will mostly have many bony prominences (e.g. lateral process of calaneal tubersoty) with thin skin cover that must not be exposed to high pressure otherwise callosities may develop (Wilson, 2005).

The suture is in many cases adherent to the underlying bone and therefore also very sensitive to pressure or "rubbing" action (Macfarlane, 1997).

The mid-foot amputation will further have more complication with in inversion position the distal/anterior part of the stump.

The chopart type of partial foot amputation is the most common types of the stump and it has many problems during manufacturing of prosthesis also it has a biomechanical problems because of including the ankle joint. The important factors which must be study to determine the type of the partial foot socket are; the motion of the ankle joint, the type of material used to manufacturing the socket and the of height of the socket (Boyd etal, 1999).

The objective of this research is to study the relationship between ankle joint motion and the height of the partial foot prosthesis socket and the material that used in

manufacturing the socket with failure causes that included (the fracture of the socket, the change of the shape of the socket and enlargement of the socket).

MATERIALS AND METHOD

The studying samples included (60) handicaps with partial foot amputation type (chopart). Three factors were studied including the following:

1- The height of the socket

- Full length that mean with the level of knee joint (L.I.C., 1987).
- 2/3 the distance between the mechanical ankles joint axis and mechanical knee joint Wilson, 2005).
- 1/3 from distance between the mechanical ankle joint and the mechanical knee joint Mann et al, 1988).

2- Ankle joint movement

- fixed joint mean the ankle joint movement was zero (Bo, 1977).
- mild range of motion (specific movement) Kulkarni et al, 1995).
- Normal movement of ankle joint (Mueller et al, 1997).

3- Material of the socket

- Plastic
- Plastic and leather
- leather

A questionnaire papers containing many questions (see appendix 1) about the factors above were distributed to the patients and then the answers were recorded in three tables. Appendix (2) represents the entire figure related to this research.

The proportion of failure of the socket is calculated by the following formula:

Proportion of failure = No. of failed socket due to one cause of failure / Total No. of Sockets. * 100 %

RESULTS AND DISCUSSION

The results of this research represent the relationship between the proportion of failure of the socket according to material of the socket, height of the socket, and the nature of the motion (ankle joint) with failure causes which are represented by enlargement of the socket, fracture of the socket and change of the shape socket and the recorded data are represented in tables (1), (2) and (3) respectively.

Figures (1 & 2) represent the magnitude and the distribution of proportion of failure according to the materials of the socket due to different causes (enlargement of the socket, fracture of the socket and change of the shape of the socket).

It is clear from these figures that the maximum value of the failure proportion for the socket made from plastic (Polypropylene) was 55 % due to fracture of the socket. While the lowest value was 15 % for the socket made from leather material due to fracture of the socket. This is because that plastic is a stiff material and the coefficient of its flexibility is low, where as the leather is a soft matter and has a good ductility and elasticity in comparison with plastic material.

Also it is noticed that the socket that was made from plastic (polypropylene) was recorded proportion of failure about (20%) and (25%) consequently because of the enlargement of the size and the changing of the socket shape, where as the socket that was made from the leather gives a higher proportion to the failing because of the enlargement the socket and the size changing was about (50%) and (35%)

consequently and this is because of the flexibility and softness of the leather that getting the changing in the dimensions and the shape more than in the plastic (polypropylene) that was stiff ,either the proportion of the socket that is made from leather and plastic together its proportion because the large in socket and the changing in the size was (35%)and (25%) consequently either the failing because the recorded is a proportion about (40%) fracture this is because the socket has a meditative properties between the leather and plastic (polypropylene) .

Figures (3 & 4) represent the distribution of failure causes in form of ratios and in form 3-Dim. magnitudes respectively according to the height of the socket. It is illustrated from these figures that the failure was because of the fracture recorded high proportion a bout (50%) for the socket with the level of knee joint while a less proportion was about (15%) for the socket has a height (1/3) distance between the knee joint and ankle joint for the same reason of failure this is because the moment that was generated for the socket with a knee joint level is larger than the moment that is generated to the another socket. The socket that has the height (1/3) distance between the knee joint and ankle joint recorded a failure proportion because of enlargement the socket and the change shape of the socket reached to (45%) and (40%) consequently where as the socket with the knee level recorded a failure proportion reached to 30% and 20%, this is because of effect of force distribution through the walk dynamically has big affect if the socket is short and a little affect if the socket is long.

The socket that has a height a bout (2/3) for the distance between the knee joint and ankle joint recorded a meditative proportion reached to (35%) and (35%) and (30%) consequently and this returns to the plastic matter is sever or stiff compared with the socket made from leather that considers a soft matter (Bo, 1977).

Figures (5 & 6) show relationship between the magnitude and distribution of failure proportion, type of motion of ankle joint and causes of failure of socket.

It is clear from these figures that a high proportion for the failure would be observed, it was because the fracture, it reached about (60%) for the socket, it was found a joint with fixed motion was a proximity to ankle joint of specific motion and ankle joint of normal motion proportion (40%), (45%) consequently this is because the force concentration in the first type that will make a large moment generating it will make breaking, where as the two another types that have moved joint and limited will make a dispersing the force and exchange it and with that generated moment will be less. While the minimum proportion of failure it was (15%) for the socket of fixed ankle joint and the causing of the failure was the changing in the shape and this is because that.

CONCOLUSIONS

1. The maximum value of failure proportion was (55%) for plastic due to the fracture of the socket, while the minimum value was (15%) for leather material.
2. Prostheses made from plastic material their height was assumed to be 2/3 distance between the knee joint and ankle joint or at the knee level.
3. Prostheses that made from leather material only and from leather and plastic material together their height was assumed to be 1/3 or 2/3 distance between the knee joint and ankle joint.
4. Maximum value of failure proportion was (60%) due to no motion, while the minimum value was (20%) due to normal motion.

REFERENCES

Bo Klasson and E. Kraus, " Biomechanics of the Normal and Deformed Foot", The deformed Foot and Orthopadic Foot Wear Report of the ISPO Workshop in Stockholm , Vol. 2 , pp55-6, March, (1977) .

Boyd LA, Rao SS, Bumfield JM, Mulroy SJ, Perry J., "Forefoot rocker mechanisms in individuals with partial foot amputation", Paper presented at Gait and Clinical Movement Analysis. Dallas, TX, March 10-13, (1999).

Higgs, D. Sanders P., "Design of a Below the Knee Prosthetic Socket" ,University of Texas at San Antonio, (2001).

Hirsch G , Margaret E., D. Duncan, David J. Sanderson, Lan D., Michael R.M., "Chopart prosthesis and semi rigid foot Orthosis in traumatic forefoot amputation ; Comparative gait analysis" , Am, phys MedRehabil (1996);75:283-291.

Ibrahim, Ahmed Aladdin, "Development, and Testing of Symes Prosthesis with Enhanced Structural Strength", PhD. Dissertation, Mechanical Department, University of Technology, Iraq, (2000).

Kulkarni J, Curran B , Ebdon . Parry M, "Total contact silicon partial foot prosthesis for partial foot amputation", Foot (1995);5:32-35.

Lavery LA, Lavery Dc , Quebedeas –Farnham TL, "Increased foot pressure after great toe amputation in diabetes", Diabetes Care (1995);18:1460-1462.

L.I.C. Orthopedic, "Education for Orthopedic Technician", Prosthesis for lower limb, Part 1, Sweden, (1987).

Macfarlane PA , Nielsen DH , Shurr DG and Meier K, "Perception of Walking Difficulty by Below –Knee Amputee Using a Conventional Foot Versus the Flex – Foot", Prosthet Orthot Journal Vol.27,No 3, pp 114- 119, (1997).

Mak F.M., Ming Z., David A. B., "Review of Prosthetic Socket Biomechanics", Jockey Club Rehabilitation Engineering center, The Hong Kong Polytechnic University, Hong Kong., Journal of Rehabilitation and Development, Vol. 38 , No2, March/April, (2001).

Mann RA, Poppen NK, O' Konski M., "Amputation of the great toe, A clinical and biomechanical study" , Clin Orthop (1988); 192-205.

Mueller MU, Salsich GB, Strube MJ, Allen BT., "Therapeutic footwear can reduce planter pressure in patients with diabetes and transmetatarsal amputation", Diabetes Care (1997);78:952-956.

Murdoch, G ., "Level of Amputation and Limiting Factors", Annals Journal of the Royal College of Surgeons of England Vol.40 ,Apr.1967, PP: 204- 216, (1967) .

Tang SFT, Chen CPC, Chen MJL, Chen WP, Leong CP, Chu NK, "Transmetatarsal amputation prosthesis with carbon- fiber plate : Enhanced gait function", Am. J phys. Med Rehabil (2004) ;83:124-130.

Wetz HH, Bellmann D, M'Barek BA, "Erfahrungen mit dem Silikon-Soft-Socket im Unterschenkel-Kurzprothesenbau (experiences with the silicone soft socket in below-knee prosthetics)", Med Orthop Tech 112, 256-263, (1992)..

Wilson EJ. Dillon MP., "Restoring center pressure excursion using toe off orthosis in single partial foot amputee", Paper presented at international society of Prosthesis and Orthosis, Australian National Member Society, Carlton Crest Hotel, Sydney, Australia, November 2-5, 2005. DC. Conferences, Nsw, 2005; 31-32.

Table (1): Relationship between the materials of the socket and the causes of failure which included the enlargement of socket, fracture of socket and change the shape of socket.

Causes of failure of socket	Materials of the socket					
	plastic	Proportion of Failure %	Plastic and leather	Proportion of Failure %	leather	Proportion of Failure %
Enlargement of socket	4	20	5	25	7	35
Fracture of socket	11	55	7	35	3	15
Change the shape of socket	5	25	8	40	10	50
Total	20	100	20	100	20	100

Table (2): Relationship between the height of the socket and the causes of failure which included the enlargement of socket, fracture of socket and change the shape of socket.

Causes of failure of socket	Height of the socket					
	With knee level	Proportion of Failure %	2/3distance between knee & ankle joint	Proportion of Failure %	1/3distance between knee & ankle joint	Proportion of Failure %
Enlargement of socket	6	30	7	35	8	40
Fracture of socket	10	50	7	35	3	15
Change the shape of socket	4	20	6	30	9	45
Total	20	100	20	100	20	100

Table (3): Relationship between the motion of the ankle joint and the causes of failure which included the enlargement of socket, fracture of socket and change the shape of socket.

Causes of failure of socket	Type the Motion of Ankle joint					
	Normal Motion	Proportion of Failure %	Specific Motion	Proportion of Failure %	No Motion	Proportion of Failure %
Enlargement of socket	4	20	7	35	5	25
Fracture of socket	9	45	8	40	12	60
Change the shape of socket	7	35	5	25	3	15
Total	20	100	20	100	20	100

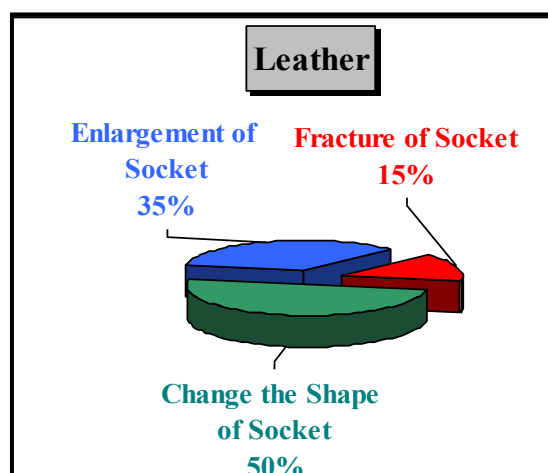
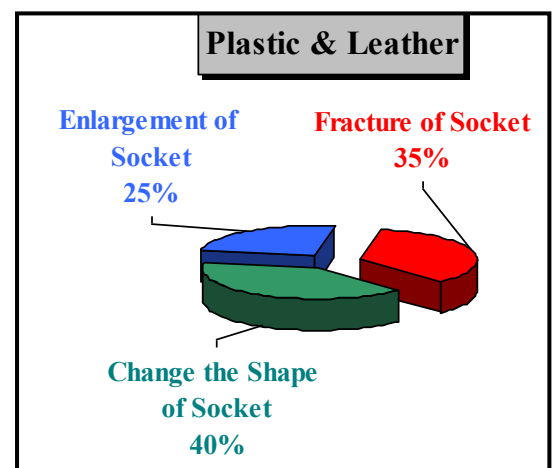
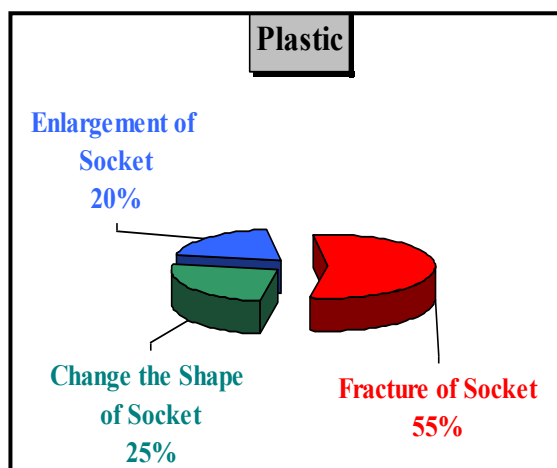


Figure (1): Proportion of failure distribution according to materials of the socket.

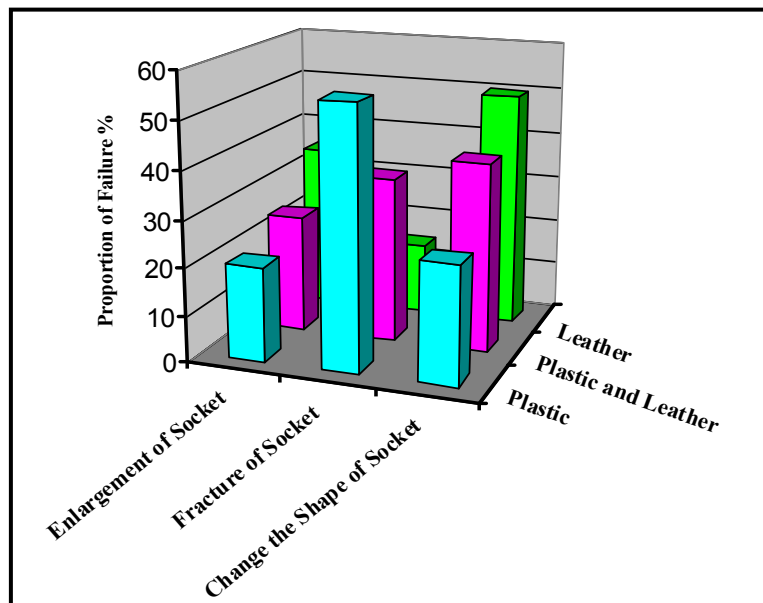


Figure (2): 3-Dim. relationship between proportion of failure, materials of the socket and causes of failure.

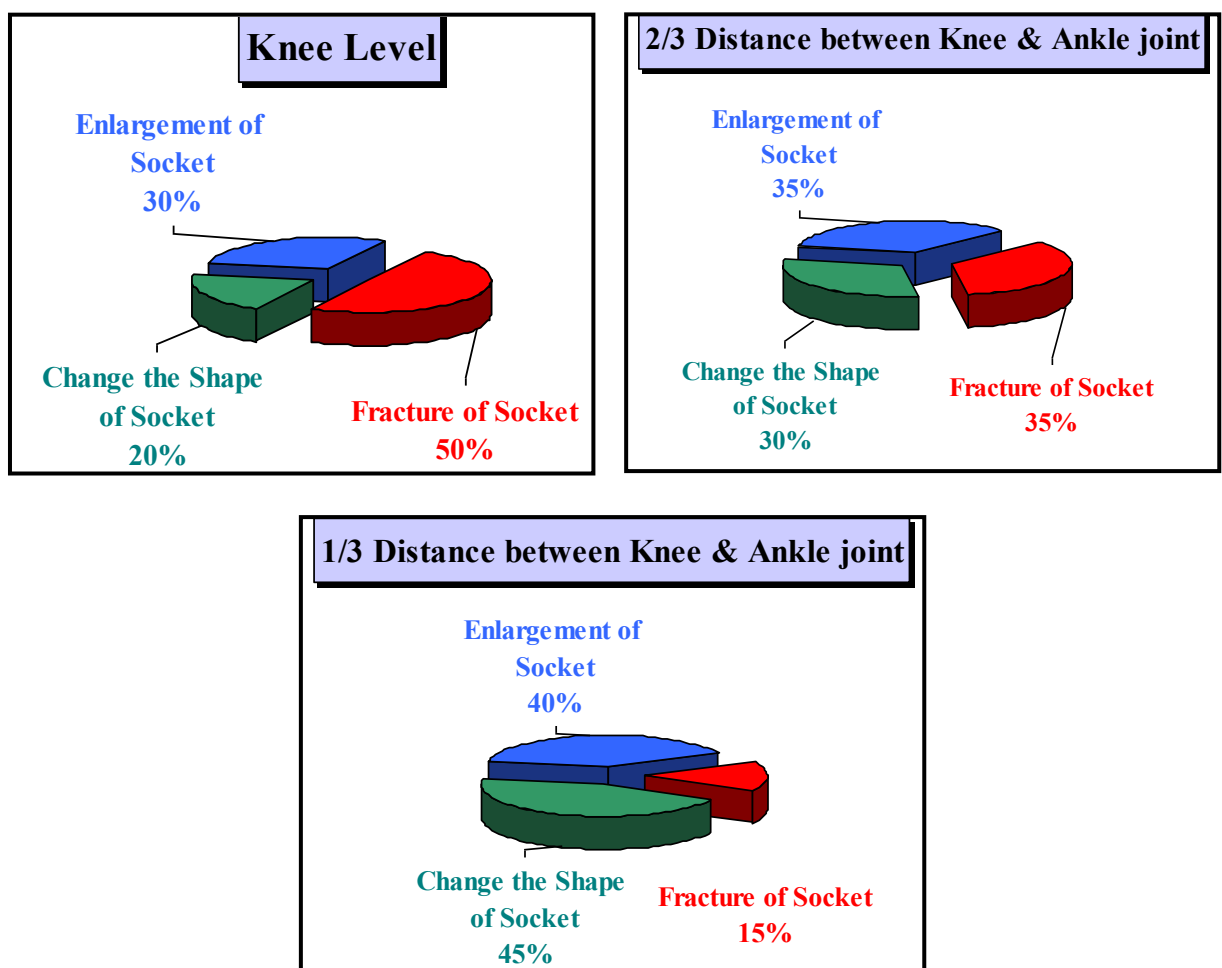


Figure (3): Proportion of failure distribution according to height of the socket.

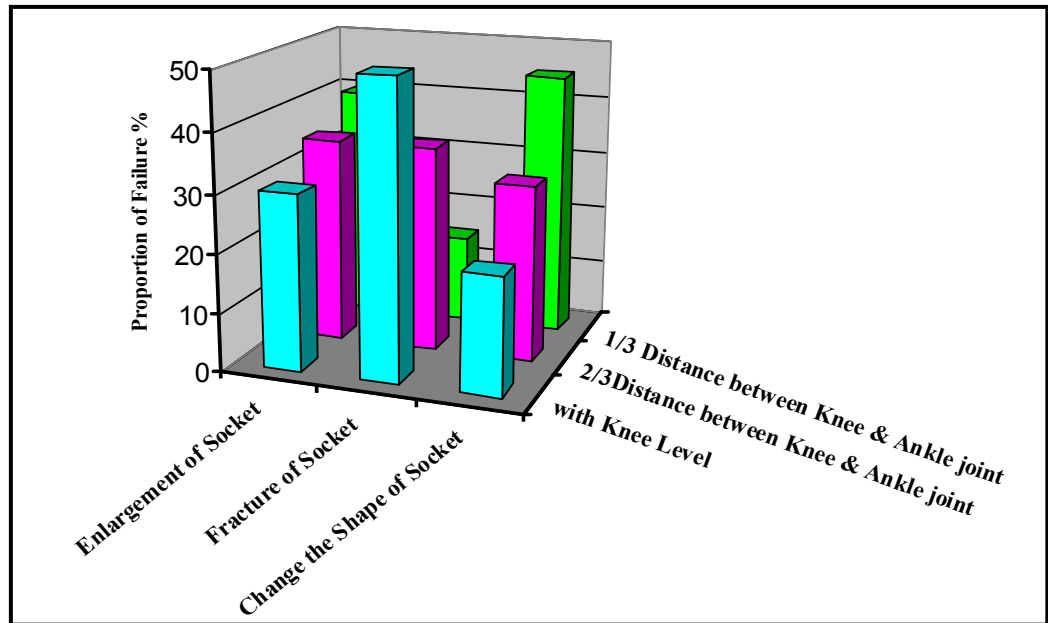


Figure (4): 3-Dim. relationship between proportion of failure, height of the socket and causes of failure.

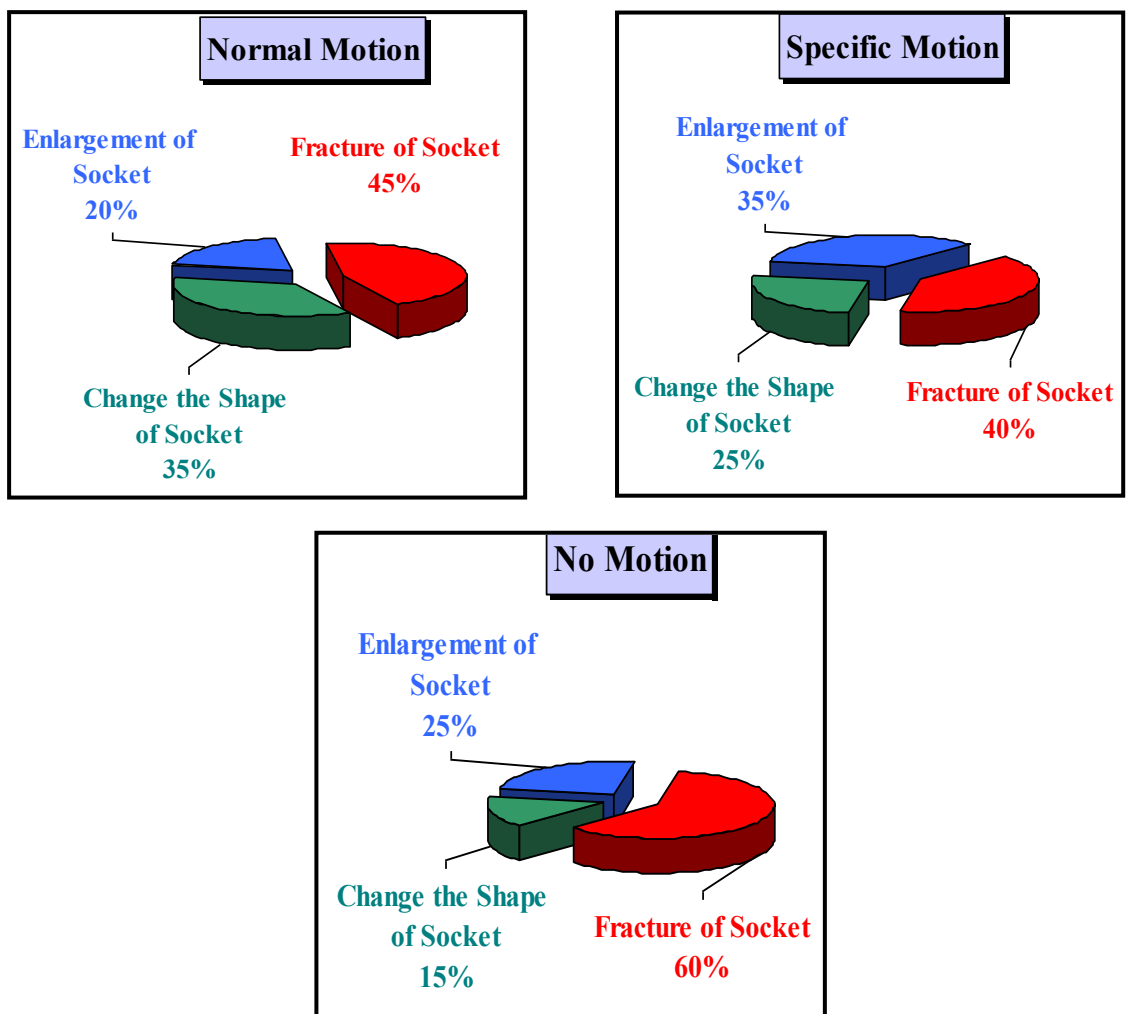


Figure (5): Proportion of failure distribution according to motion type of the ankle joint.

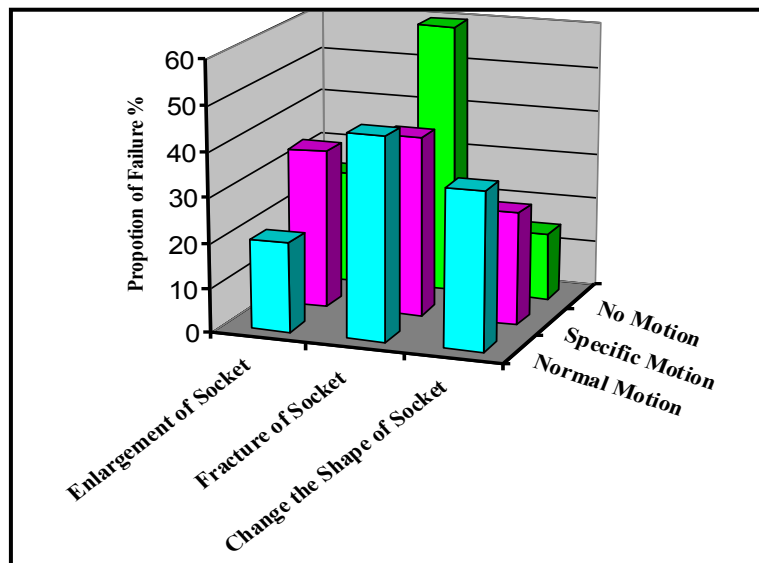


Figure (6): 3-Dim. relationship between proportion of failure, motion type of the ankle joint and causes of failure.

APPENDIX NO.1

Interview Form

- 1- Gender.....
- 2- Age.....
- 3- Cause of amputation.....
- 4- Side foot amputee (right)..... ()
- 5- Side foot amputee (Left)..... ()
- 6- Reason of failure of the prosthetic socket:
 - A. Enlargement of socket.....
 - B. Fracture of socket.....
 - C. Change the shape of socket.....
- 7- Type of motion of ankle motion:
 - A. Normal motion of the ankle joint.....
 - B. Specific motion of the ankle joint
 - C. No motion (Natural) of the ankle joint
- 8- Type of material that the socket made for you is:
 - A. Plastic.
 - B. Plastic and leather.
 - C. Leather
- 9- Height of the socket

- A. With knee level.....
- B. $\frac{2}{3}$ distance between knee & ankle joint.....
- C. ()
- D. $\frac{1}{3}$ distance between knee & ankle joint.....
- E. ()

APPENDIX NO.2

Figures related to the Research

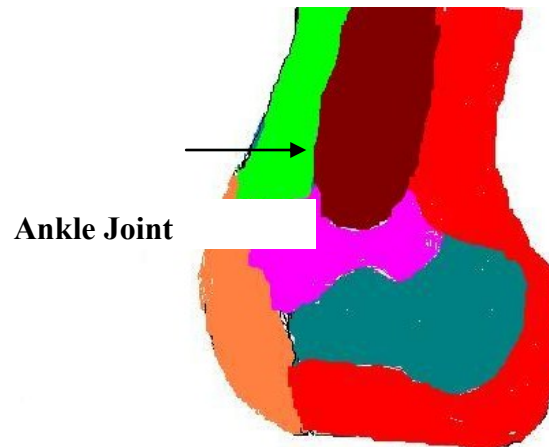
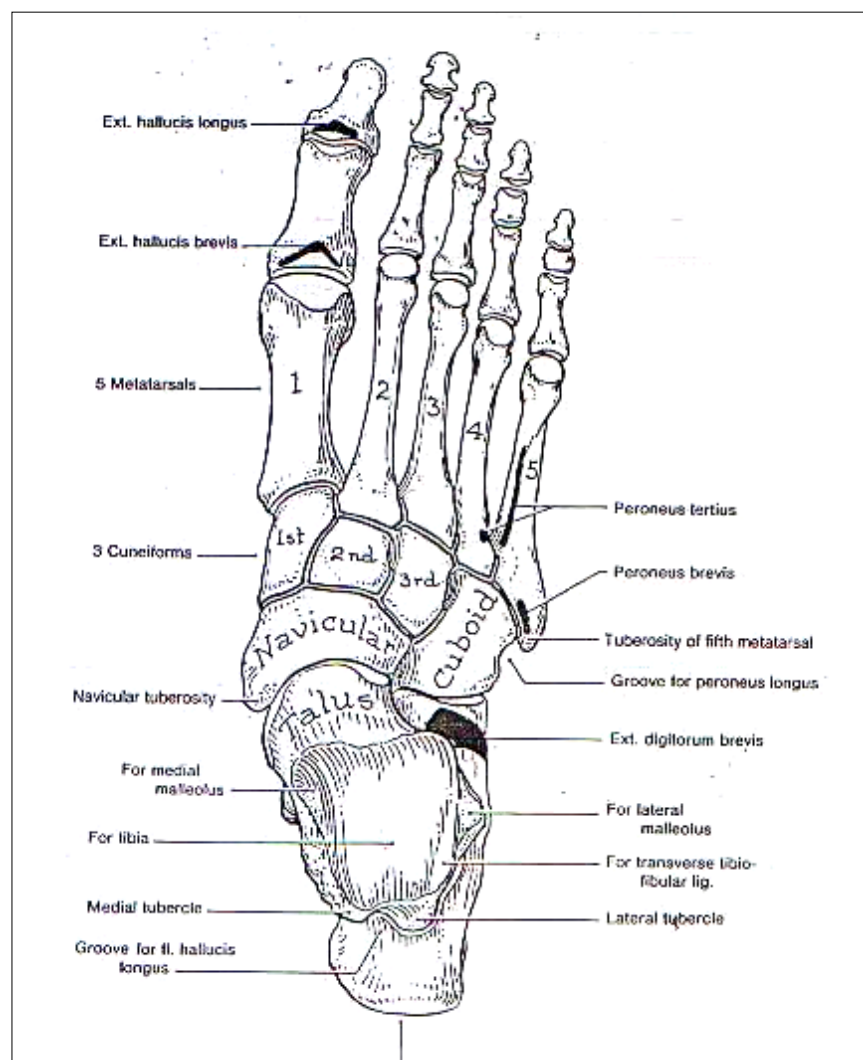


Figure (7): Partial foot amputation type Chopart & the Ankle Joint



Figure(8): Thebans and joint of the foot



**Figure (9): Sample of partial foot Prosthesis
with Knee axis height.**



**Figure (10): Sample of partial foot Prosthesis with
 $\frac{2}{3}$ height between Knee joint axis & Ankle joint**



**Figure (11): Sample of partial foot Prosthesis with
 $\frac{1}{3}$ height between Knee joint axis & Ankle joint**