

EVALUATION OF ABS HOLLOW & SOLID PATTERN FOR THE
PRODUCTION OF LONG STEM HEMI

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ABSTRACT

Orthopedic implants can be defined as medical devices used to replace or provide fixation of bone or to replace articulating surfaces of a joint. Many trauma cases require almost immediate/short lead time surgery. Thus rapid response from the manufacturer is very crucial. The manufacture of surgical implant often requires the use of machining process. Current trend shows that preform either from casting or forging is preferred to reduce machining cost and time. It is expected that by employing rapid manufacture using rapid prototyping and investment casting process could expedite the manufacturer to surgery time. This objective of this project was to evaluate the effect of dewaxing time on collapsibility characteristic of solid and hollow constructed rapid prototyped Long Stem Hemi (LSH) ABS pattern. Wax pattern casting is used as reference for this ABS pattern process. FDM2000 machine was used to build the ABS patterns. Acrylonitrile Butadiene Styrene (ABS) P400 was used for pattern material in this study. Only shell investment casting mould is involved in this study. Output responses investigated were collapsibility, expansion defects. ABS Hollow and Solid mould are prepared and they are subjected to dewaxing time. The ABS Hollow and Solid shell are compared based on the dewaxing process results, ceramic shell defects, FESEM analysis etc. The best pattern material is chosen based on the results and compared with the reference process.

ABSTRAK

Implan ortopedik boleh ditakrifkan sebagai alat perubatan yang digunakan untuk menggantikan atau menyediakan penetapan tulang atau untuk menggantikan atau mengartikulasikan permukaan sendi. Kebanyakan kes trauma memerlukan pembedahan hampir serta-merta. Oleh itu maklum balas dari pembuatan adalah sangat penting. Pembuatan implan pembedahan sering memerlukan penggunaan proses pemesinan. Trend semasa bagi proses pembuatan menunjukkan proses penuangan atau penempaan adalah pilihan untuk mengurangkan kos pemesinan dan masa. Adalah dijangkakan dengan menggunakan pembuatan pesat, prototaip pantas dan proses tuangan pelaburan, kini ia dapat mempercepatkan proses pengilangan dan masa pembedahan. Projek ini telah dilaksanakan untuk menilai kesan masa dewaxing pada ciri keruntuhan pepejal dan berongga pesat prototaip corak Long Stem Hemi (LSH) ke atas ABS. Mesin FDM2000 telah digunakan untuk pembuatan corak ABS. Acrylonitrile Butadiene Styrene (ABS) P400 akan digunakan untuk bahan corak dan bahan mentah dalam kajian ini. Hanya pelaburan pemutus acuan kelompang terlibat dalam kajian ini. Hasil pengeluaran yang disiasat adalah kecacatan keruntuhan struktur akibat pengembangan, lilin telah digunakan sebagai rujukan untuk proses ini. Acuan ABS berongga dan pepejal disediakan dan ia tertakluk kepada masa penyahlilinan. Perbandingan diantara kelompang ABS berongga dan pepejal telah dilakukan. Berdasarkan keputusan proses penyahlilinan, kecacatan kelompang seramik, analisa FESEM dan lain-lain bahan pembuatan corak terbaik telah dipilih.

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LIST OF SYMBOLS

2D	-	Two dimensional
3D	-	Three dimensional
A	-	Ampere
ABS	-	Acrylonitrile Butadiene Styrene
C	-	Celsius
CAD	-	Computer Aided Design
CS	-	Ceramic shell
F	-	Fahrenheit
FDM	-	Fused Deposition Modeling
In	-	Inch
kg	-	Kilogram
QS	-	Quick Slice
RP	-	Rapid Prototyping
mm	-	Mili meter
Cu cm	-	Cubic centimeter
gms	-	Grams
M	-	Meter
i.e.	-	In Example

CHAPTER 1

INTRODUCTION

1.1 Background

Orthopedic implants can be defined as medical devices used to replace or provide fixation of bone or to replace articulating surfaces of a joint. In simpler words, orthopedic implants are used to replace damaged or troubled joints. The implant surgeries are performed only by highly specialized and trained surgeons. The surgical procedures for each implant involve removal of the damaged joint and an artificial prosthesis replacement.

Orthopedic implants are mainly made from stainless steel and titanium alloys for strength and lined with plastic to act as artificial cartilage. Few are cemented into place and others are pressed to fit so that your bone can grow into the implant for strength.

Stainless steel is a very strong alloy, and is most often used in implants that are intended to help repair fractures, such as bone plates, bone screws, pins, and rods. Stainless steel is made mostly of iron, with other metals such as chromium or molybdenum added to make it more resistant to corrosion. There are many different types of stainless steel.

The stainless steels used in orthopedic implants are designed to resist the normal chemicals found in the human body[1].

Investment casting (IC) is a key technique among a range of modern metal casting techniques that is capable of providing an economical means of mass producing shaped metal parts containing complex features (e.g. thin walls, undercut contours and inaccessible spaces) which can be difficult or impossible to create using other fabrication methods [2]. Despite the wide range of applications in many industries, the standard (conventional) IC process practiced in modern foundries has its drawbacks. High tooling costs and lengthy lead times are associated with the fabrication of metal moulds required for producing the sacrificial wax patterns used in IC. The high tooling costs involved in conventional IC result in cost justification problems when small numbers of castings are required[2, 3].

Rapid prototyping (RP) techniques are fast becoming standard tools in the product design and manufacturing industry. With the capability of rapidly fabricating 3-D physical objects, RP has become an indispensable tool employed for shortening new product design and development time cycles [3]. RP techniques are limited neither by the geometry nor by the complexity of the parts to be fabricated. In addition, RP techniques involve no tooling or fixtures; result in resulting in simpler set-up, lower overhead cost and shorter production lead times compared to other fabrication methods. With RP, parts that were previously impossible or extremely costly and time-consuming to fabricate can be built with ease [3].

Fused deposition modeling (FDM) is one of the RP processes that forms three-dimensional objects from CAD generated solid or surface models. FDM builds part of any geometry by sequential deposition of material on a layer by layer basis. The process uses heated thermoplastic filaments which are extruded from the tip of nozzle in a prescribed manner in a semi molten state and solidify at chamber temperature[4, 5].

1.2 Problem Statement

Many trauma cases require almost immediate/short lead time surgery. Thus rapid respond from the manufacture is very crucial. The manufacture of surgical implant often requires the use of machining process. It can either be machined from metal block or preform produced from investment casting or forging processes. Current trend shows that preform either from casting or forging is preferred to reduce machining cost and time. It is expected that by employing rapid manufacture using rapid prototyping and investment casting process could expedite the manufacturer to surgery time.

1.3 Objective

The objective is defined below :

- To evaluate the effect of dewaxing time on collapsibility characteristic of solid and hollow constructed rapid prototyped Long Stem Hemi (LSH) ABS pattern.

1.4 Scopes

The scopes of works for this project are as follows:

- FDM2000 machine was used to build the ABS patterns.
- Acrylonitrile Butadiene Styrene (ABS) P400 will be used for pattern material in this study.
- Only shell investment casting mould is involved in this study.
- Output responses investigated were collapsibility, expansion defects and surface roughness of cast products.

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