NOVEL EDM SCREW THREADING TECHNIQUE USING THREADED CAVITY ELECTRODE

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This report submitted in accordance with the requirement of the UniversitiTeknikal Malaysia Melaka (UTeM) for the Bachelor Degree of Manufacturing Engineering (Manufacturing Process) (Hons.)

by

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APPROVAL

This report is submitted to the Faculty of Manufacturing Engineering of UTeM as a partial fulfillment of the requirements for the degree of Bachelor of Manufacturing Engineering (Manufacturing Process) (Hons.). The member of the supervisory is as follows:

....

Dr Raja Izamshah Bin Raja Abdullah

Project Supervisor

ABSTRACT

The complicated geometrical design and tight tolerance of orthopedic screw such as titanium alloys were fabricated using single-point threading and thread whirling technique. However, there are few problem encounters with these techniques such as rapid tool wear, limited design flexibility, low accuracy and high capital cost. The suitable candidate to overcome this problem is using Electrical Discharge Machining (EDM) process in which the material is removed by spark erosion. Since there is no physical contact between tool electrode and workpiece, the tool wear rate is low and the material hardness is not dependent. In addition, the main advantages of using EDM technique are the accuracy and fine surface integrity which is suitable for medical application. However, to ensure the success of EDM as an alternative manufacturing technique for orthopedic screw required a scientific investigation especially on the effect of EDM machining parameter. This study aims to investigate the effect of EDM machining parameter namely current, pulse on time and pulse off time on machining performances. A statistical response surface methodology are use to evaluate the effect of the machining parameter on the machining performances namely surface roughness, machining time and electrode wear. Lastly, the optimal machining condition base on the multi-objective performance criteria will be proposed.

ABSTRAK

Reka bentuk geometri yang rumit dan ketepatan yang tinggi skru ortopedik seperti aloi titanium telah direka menggunakan satu titik ulir dan teknik “*thread whirling*”. Walau bagaimanapun, terdapat beberapa masalah yang timbul dengan mengunakan teknik-teknik ini, seperti kehausan mata alat, reka bentuk terhad, ketepatan yang rendah dan kos modal yang tinggi. Calon yang sesuai untuk mengatasi masalah ini adalah dengan menggunakan “Electrical Discharge Machining (EDM) proses di mana bahan kerja dia hakis melalui teknik percikan api. Kerana tidak ada hubungan fizikal antara elektrod alat dan bahan kerja, kadar kehausan mata alat adalah rendah dan kekerasan bahan tidak bergantung. Di samping itu, kelebihan utama menggunakan teknik EDM adalah ketepatan dan integriti permukaan halus yang sesuai untuk aplikasi perubatan. Walau bagaimanapun, untuk memastikan kejayaan EDM sebagai teknik pembuatan alternatif untuk skru ortopedik memerlukan penyiasatan saintifik terutamanya mengenai kesan parameter pemesinan. Kajian ini bertujuan untuk mengkaji kesan parameter pemesinan EDM iaitu arus elektrik, “*pulse on time*” dan “*pulse off time*” di persembahan pemesinan. “*Response surface methodology*” digunakan untuk menilai kesan parameter pemesinan pada persembahan pemesinan iaitu kekasaran permukaan, masa pemesinan dan kadar kehausan mata alat. Akhir sekali, keadaan pemesinan asas optimum pada kriteria prestasi pelbagai objektif akan dicadangkan

DEDICATION

Dedicate to my beloved parents Hassan Bin Salleh and Hasnah Binti Hamid.
Dedicated to my beloved brothers,
Dedicated to all my family and my friends.

Thank you for your support and encouragement.
You all are everything for me.
May Allah bless all of us. InsyaAllah.

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TABLE OF CONTENT

APPENDICES

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS, SYMBOLS AND NOMENCLATURE

CNC	-	Computer Numerical Control
EDM	-	Electric Discharge Machine
MRR	-	Material Removal Rate
EWR	-	Electrode Wear Rate
SR	-	Surface Roughness
TWR	-	Tool Wear Rate
CAD	-	Computer Aided Design
CAM	-	Computer Aided Manufacturing
%	-	Percentages
kHz	-	Kilohertz
A	-	Ampere
µs	-	Micro Second
mm	-	Milimeter
V	-	Voltage

CHAPTER 1

INTRODUCTION

1.1 Background

Orthopedic medical is one of path in medical. Orthopedic is related with bone and joint human body anatomy. Orthopedic pain mostly causes by accident or injury on work, sport and others. Treatment on orthopedic pain taken by doctor is applying the implant device between the fracture bone and orthopedic disease area. Medical device is one of important requirement in orthopedic surgery. The device needs to fulfill the criteria state on medical standard. In the criteria, material selected is important. Recent trends in the medical industry increase the use of titanium alloys because of its outstanding mechanical properties such as lightweight material with greater strength and thougness, and non-corrosive.

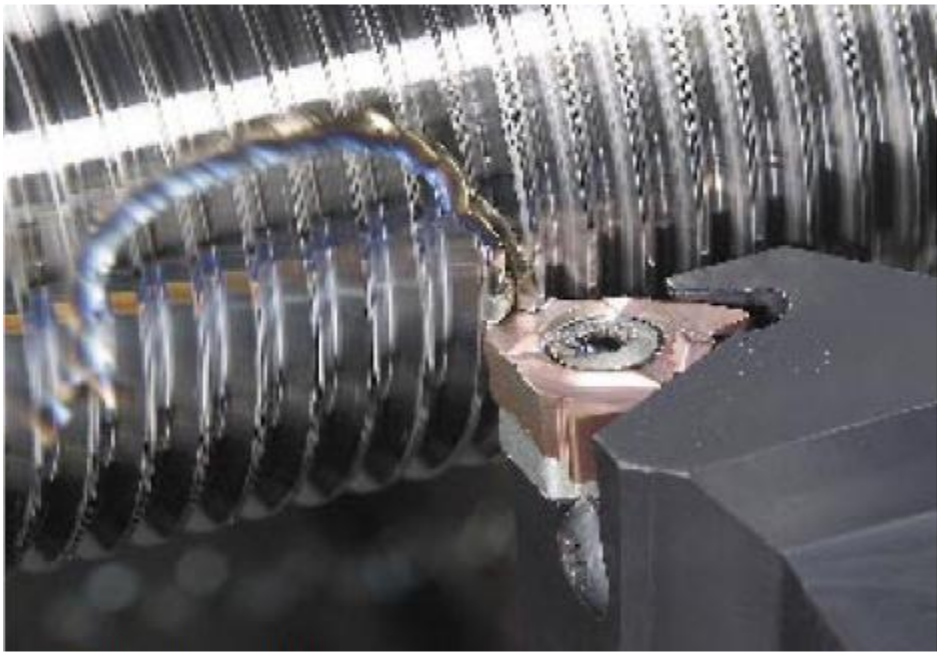
The complicated geometrical design and tight tolerance of orthopedic screw such as titanium alloys were fabricated using single-point threading and thread whirling technique. However, there are few problem encounters with these techniques such as rapid tool wear, limited design flexibility, low accuracy and high capital cost. The suitable candidate to overcome this problem is using (EDM) process in which the material is removed by spark erosion. Since there is no physical contact between tool electrode and workpiece, the tool wear rate is low and the material hardness is not dependent. In addition, the main advantages of using EDM technique are the accuracy and fine surface integrity which is suitable for medical application.

1.2 Current Method Produced Screw Thread

There are many methods of generating thread including subtractive methods, deformative methods and additive method. However for complicated geometrical design and tight tolerance of orthopedic screw, the thread can only be produced by method thread turning, thread rolling and thread whirling. The method chosen for any one application is chosen based on constraint- time, cost and degree of precision.[1]

1.2.1 Thread Turning

Thread turning is the oldest and the most widely used threading operations. It is a process for producing external or internal threads that usually using a single point tool. The disavantages of this method are the tool wear and costs to fabricate orthopedic screw are high.



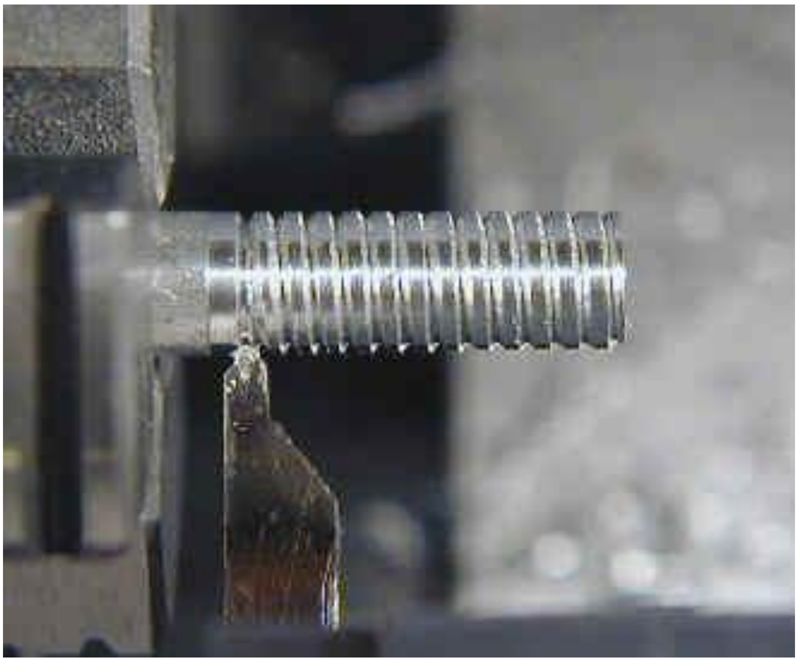


Figure1.1: Thread Turning

1.2.2 Thread Rolling

Thread rolling is a cold forming process for producing threads on a cylindrical or conical blank. It is similar to internal roll form tapping. The tool or die displaces or extrudes the metal from the part surface to form the thread. Thread rolling machines are designed with two flat die rollers in a side-by-side position. The threads on the blank, which is inserted between the rollers, are usually completed after eight revolutions. However this method is having limitation about highly rate of tool wear.

Figure 1.2: Thread rolling

1.2.3 Thread Whirling

Thread whirling is a process used for internal and external threads. Whirling removes material in a manner similar to thread milling. The process uses a special head supporting the threading tool. The whirling head is mounted in machine spindles that rotates eccentrically at high speed around the slowly rotating workpiece, or perform a planetary rotation along a stationary workpiece. The cutter uses insert arranged along the inside or the outside circumference of a ring for external and internal thread, respectively. The most critical issues are about the cost for fabricating orthopedic screw.

Figure1.3: Thread whirling

1.3 Problem Happen Making Titanium Screw

Table 1.1: Qualitative comparison between screw threading fabrication methods.

	Turning	Rolling	Whirling	EDM
Tool Wear	High	High	Medium	Low
Accuracy	Medium	Low	High	High
Time	Medium	Medium	High	Low
Cost	High	Low	High	Low
Shape Hard Material	Medium	Low	High	High

Table 1.1 shows the comparison between screws threading technique which depicted EDM is the most suitable as compared to other technique. Based on this justification, EDM are chosen as an alternative screw fabrication method.

1.4 Objective of Research

Both the difficulties and disadvantages for fabricating titanium screw were causing to initiate this project:

1. To determine the capability of EDM Die Sinking on screw threading fabrication using threaded cavity electrode.
2. To investigate EDM machining parameter namely current, pulse on time and pulse off time on machining performances (surface roughness, electrode wear and machining time).
3. To propose an optimal machining condition based on multi-objective performance criteria.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction to Electrical Discharge Machining (EDM)

Electrical Discharge Machining (EDM) is the process of machining electrically conductive materials by using precisely controlled sparks that occur between an electrode and a workpiece in the presence of a dielectric fluid. The electrode may be considered the cutting tool. EDM is one type of advance machining that can be milled, drilling grinding and other machining operation. The commonly operation of this machine are to producing mould and die component. Die-sinking or also known as RAM type EDM machine require the electrode to be machined in the exact opposite shape as the one in the workpiece. EDM differs from most chip-making machining operations in that the electrode does not make physical contact with the workpiece for material removal. Since the electrode does not contact the workpiece, EDM has no tool force. The electrode must always be spaced away from the workpiece by the distance for sparking, known as the sparking gap. [2]

2.2 EDM Machining System

Its three major assemblies are the machine tool, power supply and dielectric unit. The assemblies are dependent upon one another to such an extent that the EDM system will not function unless all assemblies are operating properly.

The power supply must provide each individual spark to the sparking gap for material removal. It must also monitor the electrical conditions at the sparking gap and direct the machine servo in advancing, retracting or maintaining the position of the electrode, in reference to the workpiece. The dielectric unit must provide the dielectric fluid to the machine for submersing the workpiece. In addition, the dielectric unit must send fluid to the sparking gap for cooling purpose and to remove the EDM chip. The dielectric unit includes a filtration system for cleaning the dielectric fluid. [2]

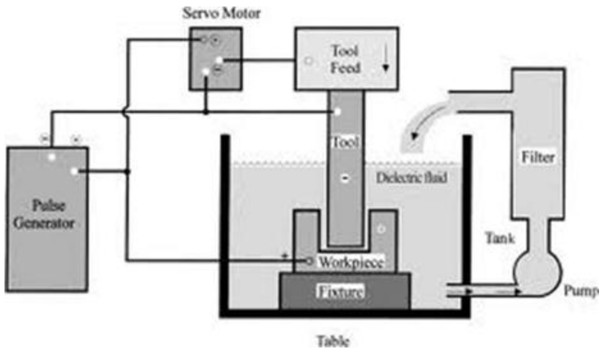


Figure 2.1 Basic EDM die sinker component

2.3 Process Parameter

The process parameters that affected the properties of EDM parts need to be identified in the first step of the experiment [3]. The parameters are listed as below:

2.3.1 Discharge Voltage

Discharge voltage in EDM is related to the spark gap and breakdown strength of the dielectric. The preset voltage determines the width of the spark gap between the leading edge of the electrode and workpiece. Higher voltage settings increase the gap, which improves the flushing conditions and helps to stabilize the cut. MRR, tool wear rate (TWR) and surface roughness increases, by increasing open circuit voltage.