醫療植入物功能性測試與實務操作

醫材概念介紹

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2024/09/09

MEDICAL DEVICES
THROUGHOUT LIFE

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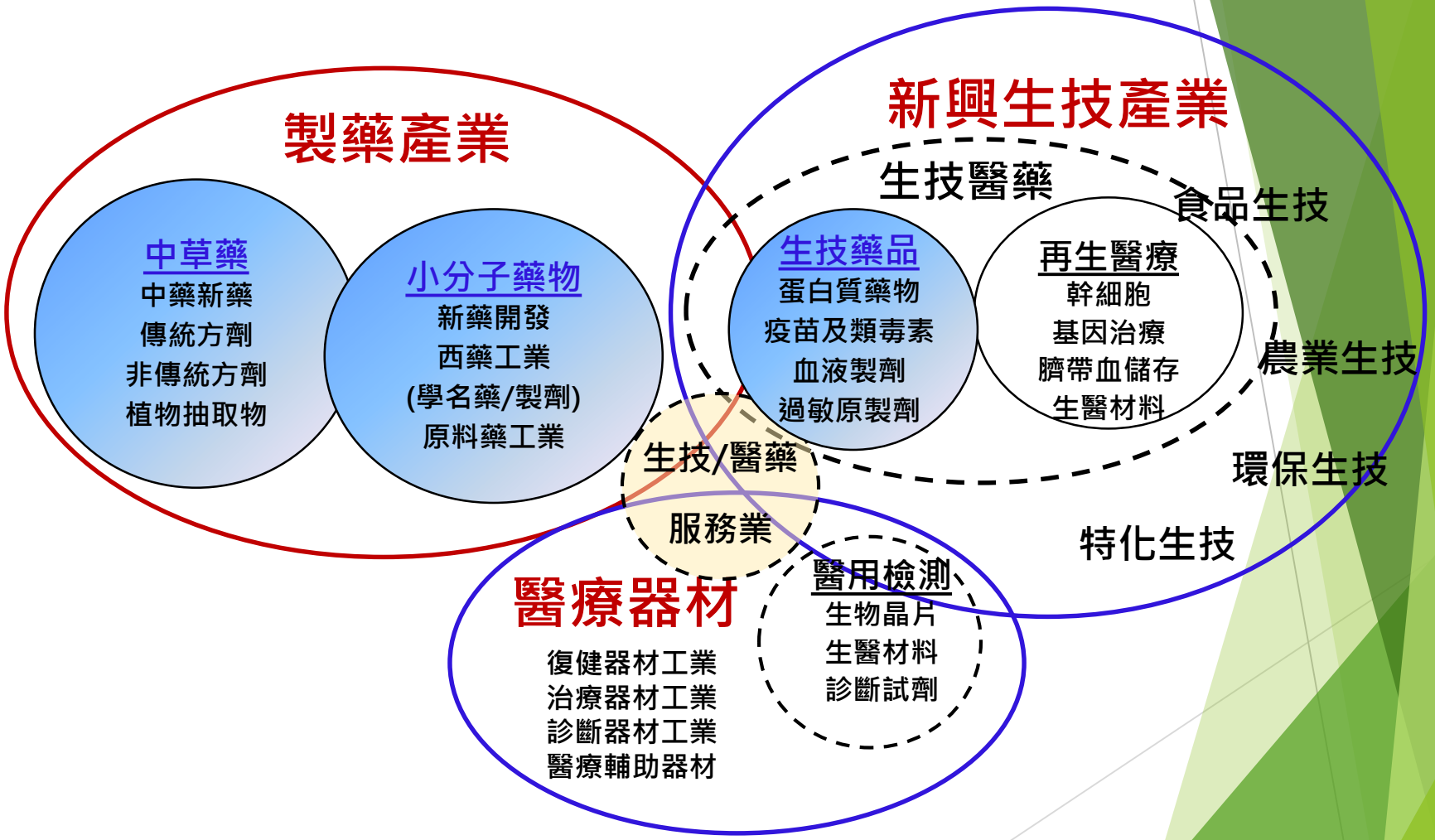
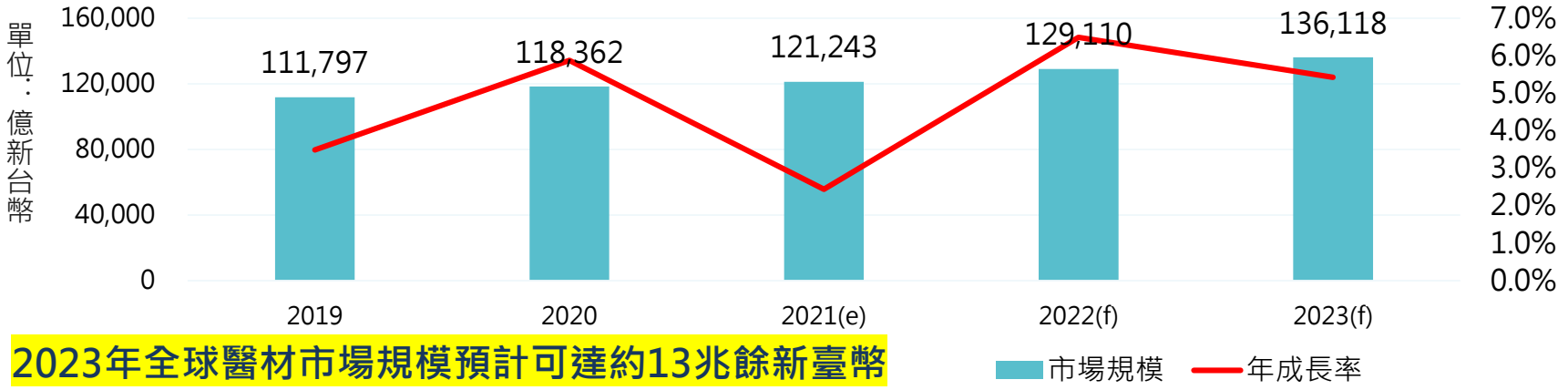
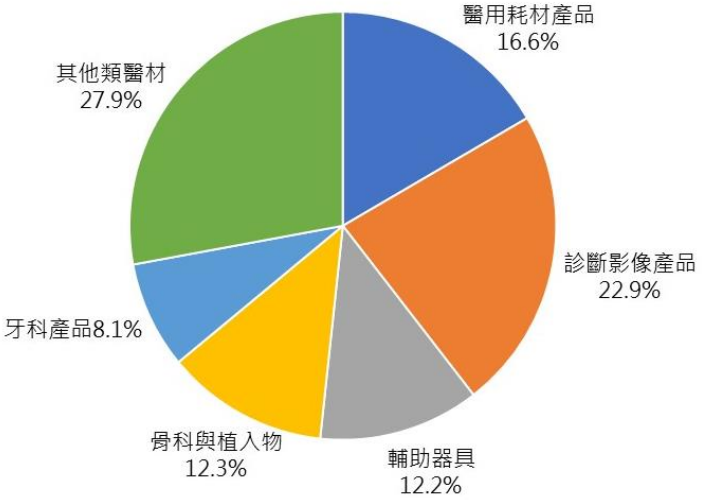
生技產業範疇

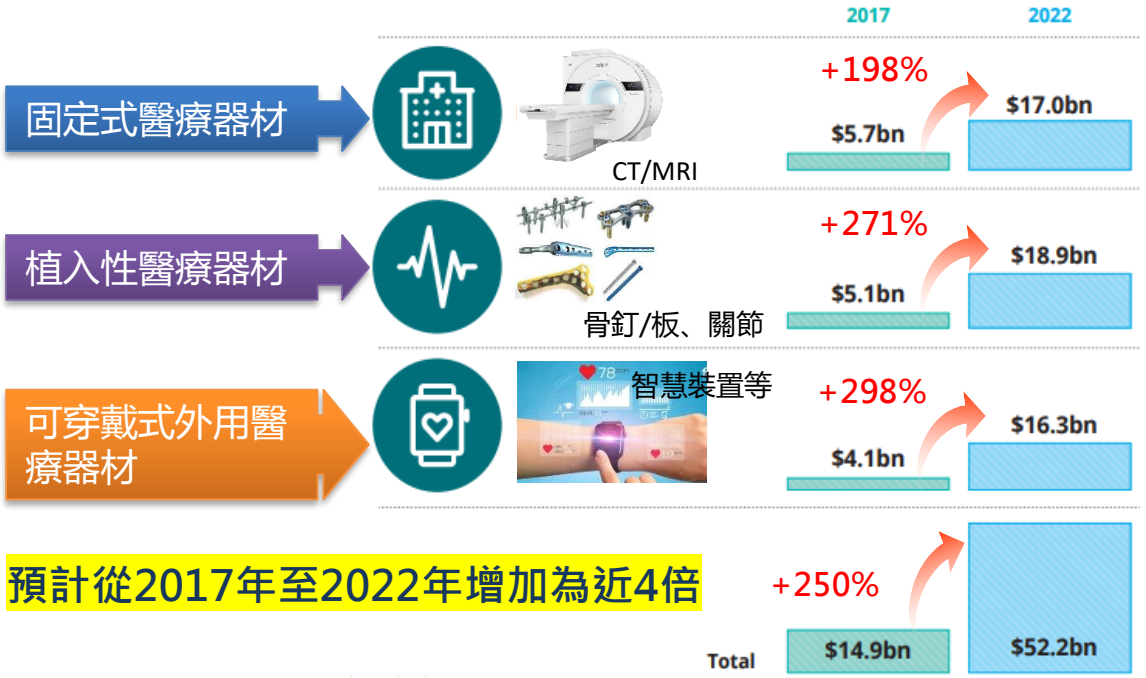

製藥產業
中草藥
中藥新藥
傳統方劑
非傳統方劑
植物抽取物
小分子藥物
新藥開發
西藥工業
(學名藥/製劑)
原料藥工業
新興生技產業
生技醫藥
生技藥品
蛋白質藥物
疫苗及類毒素
血液製劑
過敏原製劑
再生醫療
幹細胞
基因治療
臍帶血儲存
生醫材料
食品生技
農業生技
環保生技
特化生技
生技/醫藥
服務業
醫療器材
復健器材工業
治療器材工業
診斷器材工業
醫療輔助器材
醫用檢測
生物晶片
生醫材料
診斷試劑

全球醫療器材市場產業概況



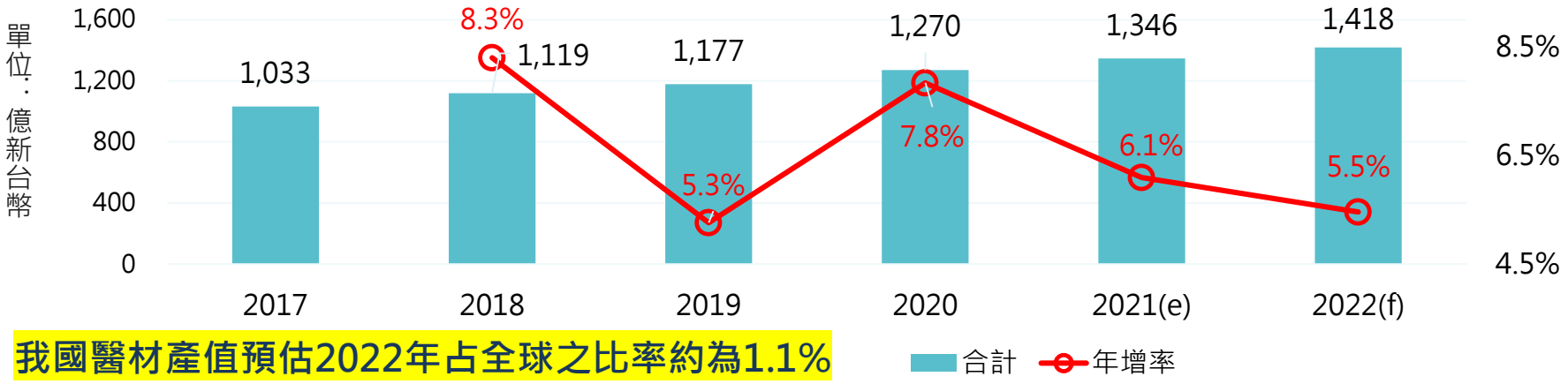
2023年全球醫材市場規模預計可達約13兆餘新臺幣





資料來源：BMI Research(2021/04)；工研院產科國際所(2021/05)

台灣醫療器材產業現況



我國醫材產值預估2022年占全球之比率約為1.1%

年度	年度通過張數	未註銷總張數	國產總張數	輸入總張數
2010	3,920	30,140	5,905	24,235
2011	4,047	33,865	6,857	27,008
2012	3,592	32,821	7,057	25,764
2013	3,827	35,705	8,079	27,626
2014	3,605	37,967	8,952	29,015
2015	3,743	40,579	9,678	30,901
2016	3,818	43,328	10,329	32,999
2017	3,940	46,797	11,203	35,594
2018	3,985	45,890	11,172	34,718
2019	3,770	45,839	11,332	34,507

2010年到2019年，10年間產值和發放許可證張數皆成長為近2倍

醫療器材定義

藥事法第13條(102年5月8日修正)

- 本法所稱醫療器材，係用於**斷、治療、減輕、直接預防人類疾病、調節生育，或足以影響人類身體結構及機能，且非以藥理、免疫或代謝方法作用於人體**，以達成其主要功能之**儀器、器械、用具、物質、軟體、體外試劑及其相關物品。**
- 前項醫療器材，中央衛生主管機關應視實際需要，就其範圍、種類、管理及其他應管理事項，訂定**醫療器材管理辦法**規範之。

醫療法第8條

- 本法所稱人體試驗，係指醫療機構依醫學理論於人體施行**新醫療技術、新藥品、新醫療器材及學名藥生體可用率、生體相等性**之試驗研究。

人體試驗管理辦法第2條

- 新藥品、**新醫療器材**於辦理查驗登記前，或醫療機構將新醫療技術，列入常規醫療處置項目前，應施行人體試驗研究（以下稱人體試驗）。

法源依據

- 依據「醫療器材管理法」第3條第2項規定。

第三條	1	本法所稱醫療器材，指儀器、器械、用具、物質、軟體、體外診 斷試劑及其相關物品，其設計及使用係以藥理、免疫、代謝或化學以外之方法作用於人體，而達成下列主要功能之一者： 一、診斷、治療、緩解或直接預防人類疾病。 二、調節或改善人體結構及機能。 三、調節生育。
	2	**前項醫療器材之分類、風險分級、品項、判定原則及其他相關事項之辦法，由中央主管機關定之。**
	3	第一項第二款屬非侵入性、無危害人體健康之虞及使用時毋需醫事人員協助之輔具，得報請中央主管機關核准，免列為前項醫療器材之品項。
	4	前項輔具係指協助身心障礙者改善或維護身體功能、構造，促進活動及參與，或便利其照顧者照顧之裝置、設備、儀器及軟體等產品。

- **110年4月26日公告訂定「醫療器材分類分級管理辦法」，全文共7條。**

醫療器材分類品項

醫療器材管理辦法第3條

- 醫療器材依據功能、用途、使用方法及工作原理，分17類

一、臨床化學及臨床毒理學。
二、血液學及病理學。
三、免疫學及微生物學。
四、麻醉學。
五、心臟血管醫學。
六、牙科學。
七、耳鼻喉科學。
八、胃腸病科學及泌尿科學。
九、一般及整形外科手術。
十、一般醫院及個人使用裝置。
十一、神經科學。
十二、婦產科學。
十三、眼科學。
十四、骨科學。
十五、物理醫學科學。
十六、放射學科學。
十七、其他經中央衛生主管機關認定者。

- 前項醫療器材之分類分級品項如附件一。

醫療器材分類分級/風險

	台灣	美國	歐盟 (GHTF)	中國
範圍	試劑+儀器	試劑+儀器	試劑+儀器	試劑+儀器
分類	Class1 低 Class2 ↓ Class3 高	Class1 低 Class2(510k) ↓ Class3 高	List A 高 List B ↑ Self-test other 低	Class1 低 Class2 ↓ Class3 高
主管	TFDA	FDA	CA	SFDA
審查	TFDA(ITIR)	FDA Accerdited person	Notified body	C1市級 C2省級 C3國家級 境外 國家級
發證	TFDA	FDA	Notified body	C1市級 C2省級 C3國家級 境外 國家級

台灣醫療器材分類分級

醫療器材管理辦法第2條 醫療器材字號：衛部醫器製壹字第005

- 醫療器材依據風險程度，分成下列等級：
  - 第一等級：低風險性。
  - 第二等級：中風險性。
  - 第三等級：高風險性。

Class I	・如手動聽診器、醫用口罩、紗布、一般手術手動器械、彈性繃帶、壓舌板、機械式輪椅、矯正鏡片
Class II	・如衛生套、衛生棉條、輸液幫浦、靜電器(電位治療器)、動力式輪椅、軟式隱形眼鏡及其保存用產品、注射針筒/針頭、血糖機、血壓計、電子體溫計、磁振診斷裝置、外科及皮膚科用雷射儀、電子聽診器
Class III	・如心臟瓣膜置換物、人工水晶體、眼科用準分子雷射系統、冠狀動脈支架、心律調節器、人工牙根、玻尿酸植入物

醫療器材內容與查詢

西藥、醫療器材、化粧品許可證查詢

詳細處方成分 | 藥物外觀 | 仿單/外盒資料 | 授權使用 | 健保藥價查詢 | 離 開

許可證詳細內容

＊＊＊ 衛部醫器輸壹字第016710號 ＊＊＊

註銷狀態		註銷日期	
註銷理由		製造許可登錄編號	
有效日期	110/06/28	發證日期	105/06/28
許可證種類	醫　器		
舊證字號		醫療器材級數	第一等級
通關簽審文件編號	DHA09401671001		
中文品名	"貝格" 法西歐手術導板 (未滅菌)		
英文品名	"Bego" VarseoWax Surgical Guide (Non-Sterile)		
效能	限醫療器材管理辦法「牙齒骨內植入物附件(F.3980)」第一等級鑑別範圍。		
醫器規格	空白		
劑型		包裝	
標籤、仿單及包裝加註			
醫器主類別一	F牙科裝置	醫器次類別一	F3980牙齒骨內植
醫器主類別二		醫器次類別二	
醫器主類別三		醫器次類別三	
主成分略述			
限制項目	02輸　入		
申請商名稱	620118G125 新丞貿易有限公司		
申請商地址	台北市中正區南昌路1段157號3樓		

主製造廠

製造廠名稱	M471287000 BEGO Bremer Goldschlagerei-Wilh. Herbst GmbH & Co. KG		
製造廠廠址	Wilhelm-Herbst-Str. 1, 28359 Bremen, Germany		
製造廠公司地址			
製造廠國別	GERMANY	製程	

醫療器材分類品項

(共有 1739 筆資料,共分 174 頁,目前在第 1 頁)

序號	分類分級代碼▼	中文名稱▼	英文名稱▼	等級▼
1	A.0001	苯環利定試驗系統	Phencyclidine test system	2
2	A.0002	臨床化學離子分析儀	Clinical chemistry electrolyte system	1
3	A.1020	酸性磷酸酶(總量或前列腺的)試驗系統	Acid phosphatase (total or prostatic) test system	2
4	A.1025	促腎上腺皮質荷爾蒙試驗系統	Adrenocorticotropic hormone (ACTH) test system	2
5	A.1030	丙胺酸轉胺酶試驗系統	Alanine amino transferase (ALT/SGPT) test system	1
6	A.1035	白蛋白試驗系統	Albumin test system	2
7	A.1040	醛醇縮合酵素試驗系統	Aldolase test system	1
8	A.1045	醛類脂醇試驗系統	Aldosterone test system	2
9	A.1050	鹼性磷酸酶或同功酶試驗系統	Alkaline phosphatase or isoenzymes test system	2
10	A.1055	新生兒胺基酸、游離肉鹼及醯基肉鹼篩檢用串聯質譜儀系統	Newborn screening test system for amino acids, free carnitine, and acylcarnitines using tandem mass spectrometry.	2

代碼	名稱	鑑別	等級
F.3640	骨內植體(Endosseous implant)	骨內植體(endosseous implant)－是由如鈦金屬製成的器材，以手術方式放置於上或下頜牙弓的骨骼內以提供對修復器材，如人工牙齒之支撐及恢復患者的咀嚼功能。	3

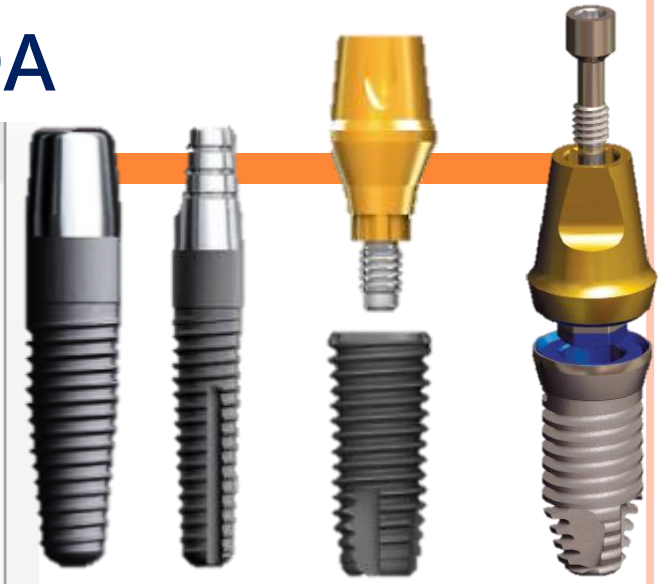
US FDA 分類醫療器材 (Taiwan TFDA)

- **Class I:** simple, low risk devices
  - General control to ensure safety and effectiveness
  - Mostly exempt from Premarket Notification [510(k)]
- **Class II:** more complex, moderate risk devices
  - General control and Special control
  - Require 510(k) → Substantial Equivalence (as safe and effective as legally marketed device, SE)
- **Class III:** most complex, highest risk devices
  - General control
  - Premarket Approval (PMA) → Safety & Effectiveness

Dental Implant Approval by FDA

New Search | Back To Search Results

Device Classification Name	Implant, Endosseous, Root-Form
510(K) Number	K122664
Device Name	ZUGA DENTAL IMPLANT SYSTEM
Original Applicant	ZUGA MEDICAL, INC. P.o. Box 566 Chesterland, OH 44026 2141
Original Contact	Karen E Warden, Phd
Regulation Number	872.3640
Classification Product Code	DZE
Subsequent Product Code	NHA
Date Received	08/31/2012
Decision Date	[illegible]
Decision	Substantially Equivalent (SE)
Classification Advisory Committee	Dental
Review Advisory Committee	Dental
Summary	Summary
Type	Traditional
Reviewed By Third Party	No
Expedited Review	No
Combination Product	No



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New Search | Back To Search Results

Device	Implant, Endosseous, Root-Form
Regulation Description	Endosseous dental implant.
Regulation Medical Specialty	Dental
Review Panel	Dental
Product Code	DZE
Submission Type	510(k)
Regulation Number	872.3640
Device Class	2
Total Product Life Cycle (TPLC)	TPLC Product Code Report
GMP Exempt?	No

Recognized Consensus Standards

- ISO 10993-14 First edition 2001-11-15 Biological evaluation of medical devices - Part 14: Identification and quantification of degradation products from ceramics
- ISO 14801 Second edition 2007-11-15 Dentistry-Implants-Dynamic fatigue test for endosseous dental implants
- ISO 7405 Second edition 2008-12-15 Dentistry - Evaluation of biocompatibility of medical devices used in dentistry
- ASTM F2024-10 Standard Practice for X-Ray Diffraction Determination of Phase Content of Plasma-Sprayed Hydroxyapatite Coatings
- AAMI/ANSI/ISO 10993-14:2001/(R) 2011 Biological evaluation of medical devices - Part 14:

GHTF（Global Harmonization Task Force）醫療器材分類

- 1992 年由美國、歐盟、日本、加拿大與澳洲五個成員發起成立
- GHTF 全球醫療器材法規調和會

Class	Risk Level	Medical Device Examples
A	Low-Risk	Surgical retractors / tongue depressors
B	Low-moderate Risk	Hypodermic Needles / suction equipment
C	Moderate Risk	Lung ventilator / orthopedic implants
D	High Risk	Heart Valve / Implantable defibrillator

醫療器材分類分級管理模式 (GMP->QMS)

第一等級 (Class I) 低風險性	第二等級 (Class II) 中風險性	第三等級 (Class III) 高風險性	新醫療器材 (Class II/III) 高風險性
醫療器材優良製造規範(GMP) (部分品項無須實施)	醫療器材優良製造規範(GMP)	醫療器材優良製造規範(GMP)	醫療器材優良製造規範(GMP)
辦理許可證查驗登記 **僅剩67項**	辦理許可證查驗登記 +技術資料	辦理許可證查驗登記 +技術資料(較高風險者須臨床資料)	辦理許可證查驗登記 +技術資料 +臨床資料

低 ——— 風險 Risk ———→ 高

低 ——— 法規管控 Level of Regulation ———→ 高

醫療器材產品檢測項目

醫療器材分類分級管理模式

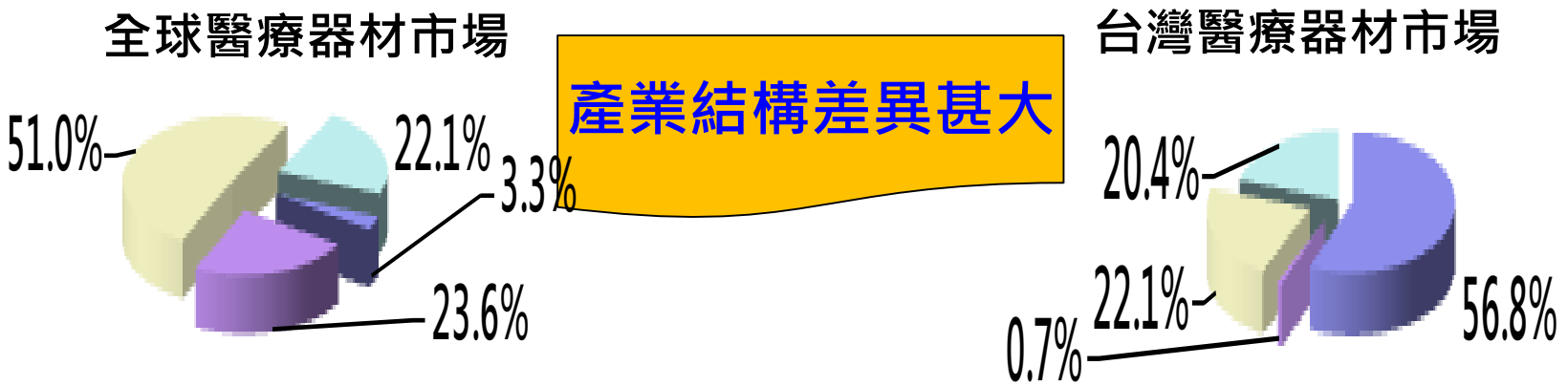
第一等級 (Class I) 低風險性	第二等級 (Class II) 中風險性	第三等級 (Class III) 高風險性
醫療器材優良製造規範(GMP) (部分品項無須實施)	醫療器材優良製造規範(GMP)	醫療器材優良製造規範(GMP)
辦理許可證查驗登記	辦理許可證查驗登記 +技術資料	辦理許可證查驗登記 +技術資料(較高風險者須臨床資料)

新醫療器材 (Class II/III) 高風險性
醫療器材優良製造規範(GMP)
辦理許可證查驗登記 +技術資料 +臨床資料

低 ——— 風險 Risk ———→ 高

低 ——— 法規管控 Level of Regulation ———→ 高

全球vs台灣醫療器材市場



居家用消費行醫材：台灣56.8% vs. 全球 3.3%

醫院用診斷監測設備：台灣0.7% vs. 全球 23.6%

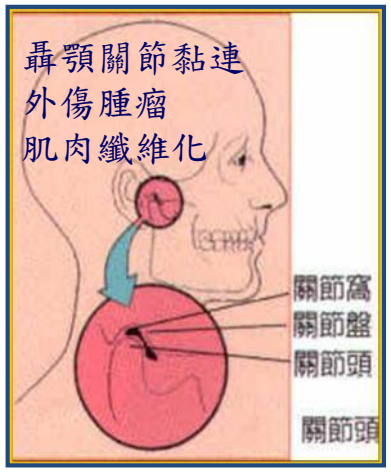
醫院醫療用產品：台灣22 % vs. 全球 51.0%

- 居家用消費型醫材：輪椅、代步車、血壓計、體溫計、血糖計等。
- 醫院用診斷監測設備：X光儀器設備、心電圖、超音波、MRI、生理監視器等。
- 醫院治療用產品：牙科、眼科與骨科儀器設備、手術器械、骨科與牙科彌補物等。
- 耗材：手套、注射器與導管、急救箱、包紮敷料等。

目前台灣醫材產業，逐漸由居家用醫材，轉換為高階醫材(較高風險)發展，企圖有效提升醫材產值與市場佔有率。

Low risk medical device development

❖口腔開合運動復健器設計開發及臨床測試



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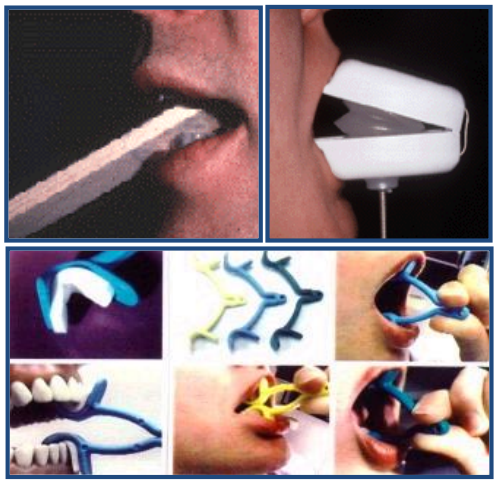
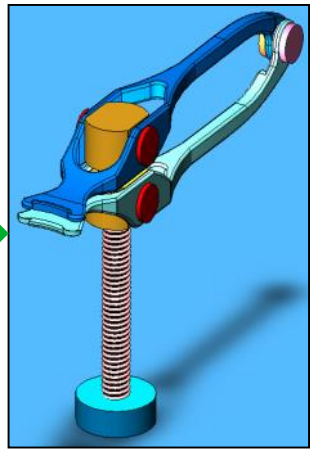
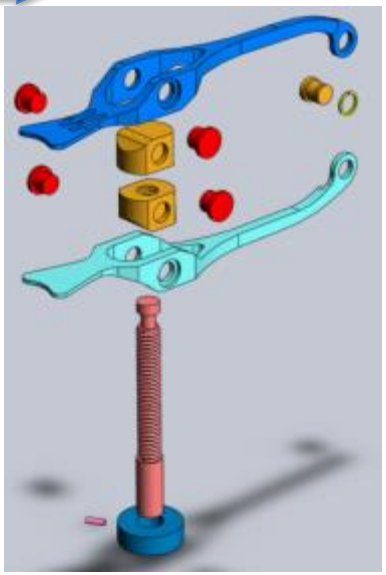


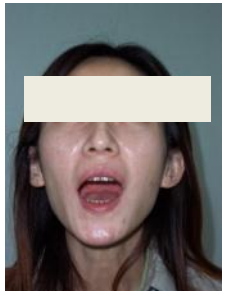
CAD

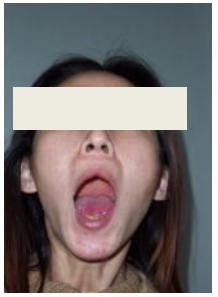


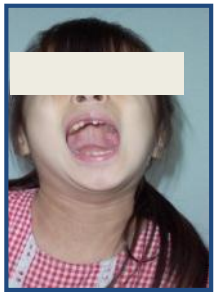


CAM

Clinical Test





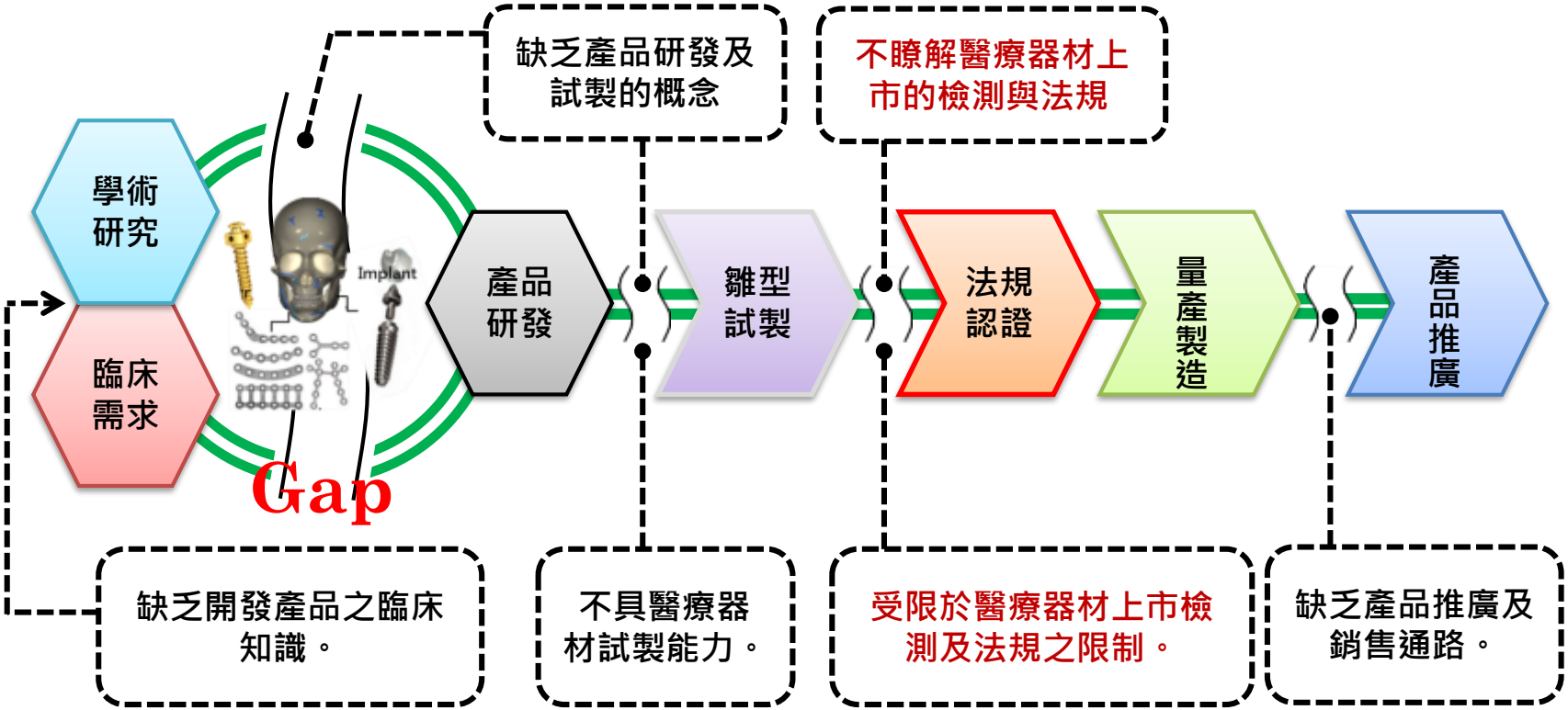


衛署衛署醫器製壹字第003944號
世亨科技股份有限公司 (02)-29038739


行政院衛生署第一等級醫療器材許可證

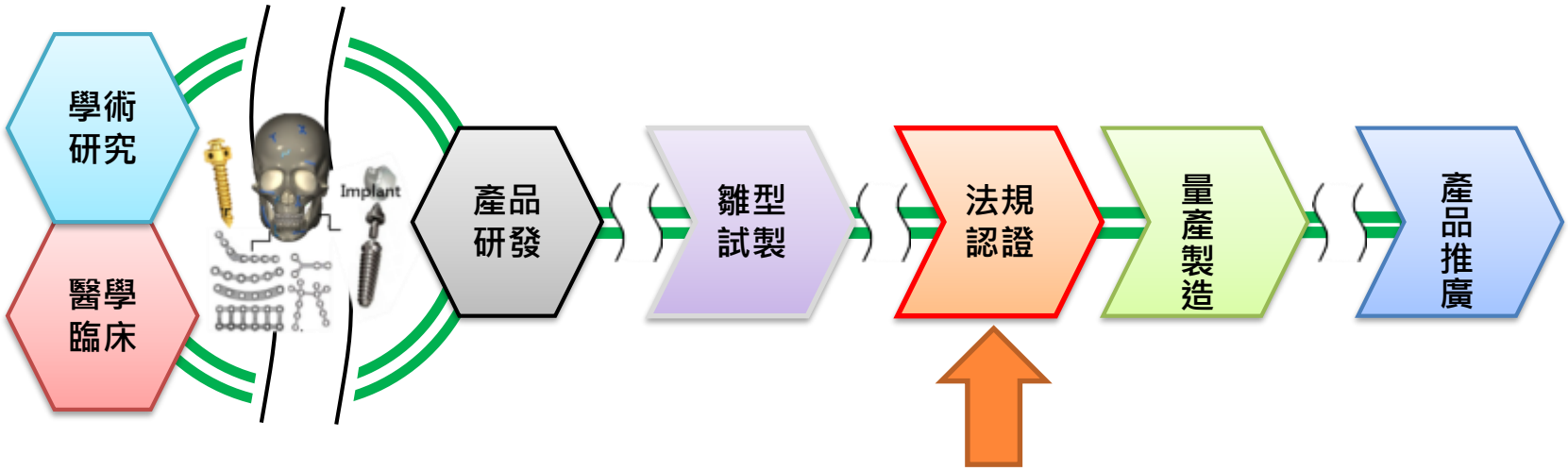
產業現況與問題-高階醫材(Class II, III)產業缺口與解決方案

臨床機構所面臨問題

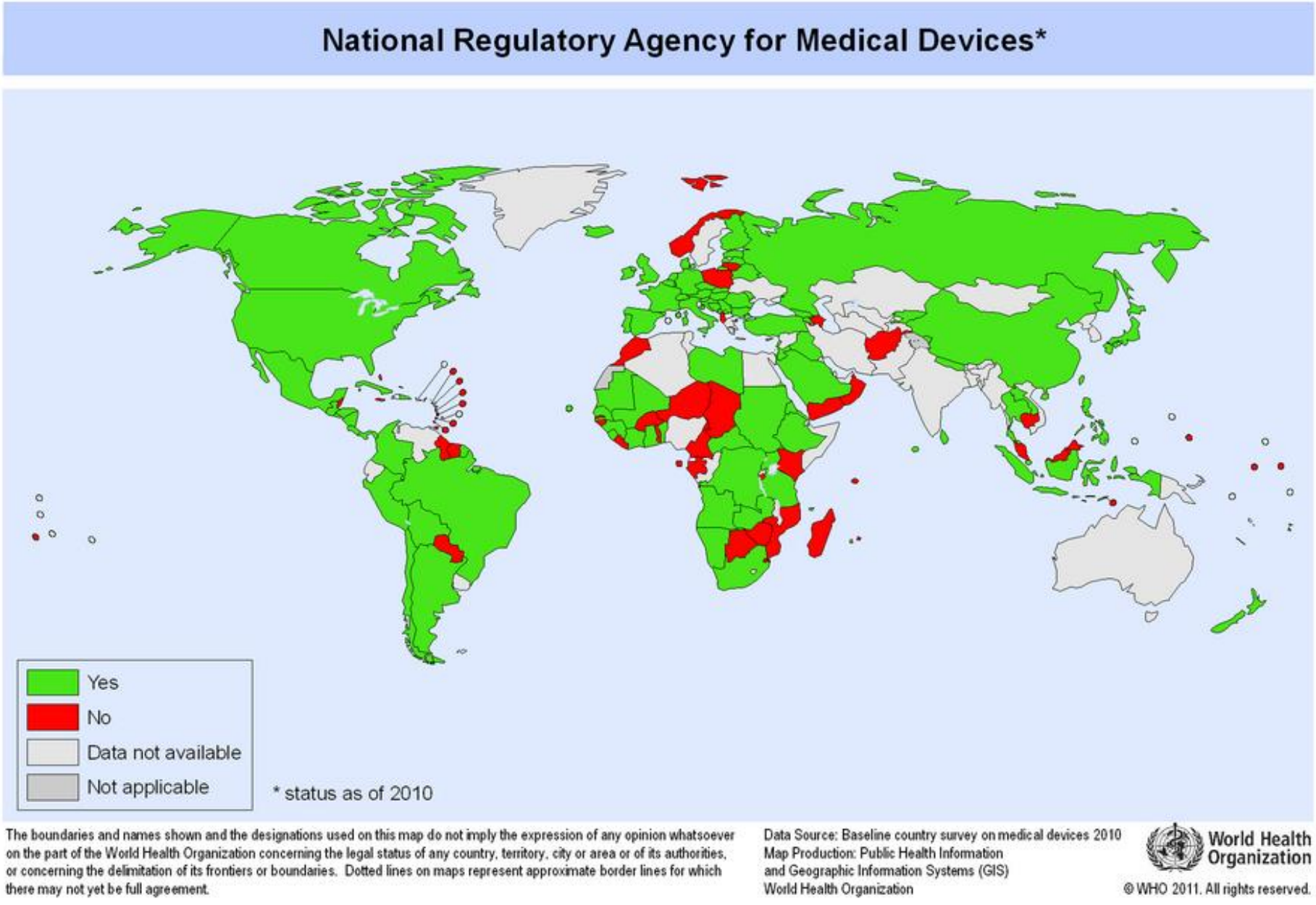


醫療器材產業所面臨問題

醫療器材上市審查原則



- 符合性審查（Conformity Assessment）
  - 品質管理系統（Quality Management System , QMS）
  - 上市後監督（Post-Market Surveillance）
  - 技術文件（Technical Documentation）
    - GLP/TAF (Professorial Lab)(專業認證實驗室)
  - 符合聲明（Declaration of Conformity）
  - 製造業者與器材登記（Registration of Manufacturers and their devices）


National Regulatory Agency for Medical Devices*
Yes
No
Data not available
Not applicable
* status as of 2010
The boundaries and names shown and the designations used on this map do not imply the expression of any opinion whatsoever on the part of the World Health Organization concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. Dotted lines on maps represent approximate border lines for which there may not yet be full agreement.
Data Source: Baseline country survey on medical devices 2010
Map Production: Public Health Information and Geographic Information Systems (GIS)
World Health Organization
World Health Organization
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資料來源：WHO

Summary of Current Medical Device Premarket Review Processes

Country	Premarket Review Documentation	Requirements	Recognized Standards
中華民國	查驗登記	醫療器材查驗登記準則 體外診斷醫療器材查驗登記審查須知	衛生署醫療器材採認標準
United States	510(k) PMA STED Pilot	Substantial Equivalence/FDA Special Controls PMA+QS Inspection Essential Principles	FDA Recognized Standards
EU+EFTA	Technical File Review	AIMD/MDD/IVDD Essential Principles Annex II: Full QS	Harmonized Standards
Australia	GHTF MD STED GHTF IVD STED	Essential Principles	TGA Recognized Standards
Canada	Technical File STED (III & IV)	Essential Principles	Health Canada Recognized Standards
Japan	醫療機器承認審查 STED (III & IV)	醫療機器基本要件(Essential Requirements)	認證基準 承認基準 醫療機器審查指南 JIS

資料來源：工研院量測中心醫療器材驗證室

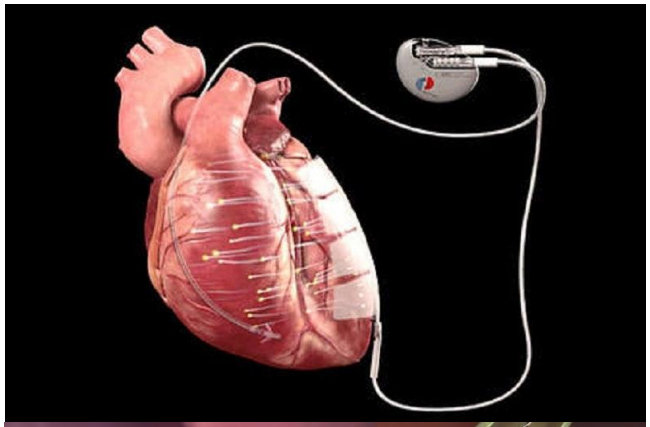
法規對醫療器材評估之要求

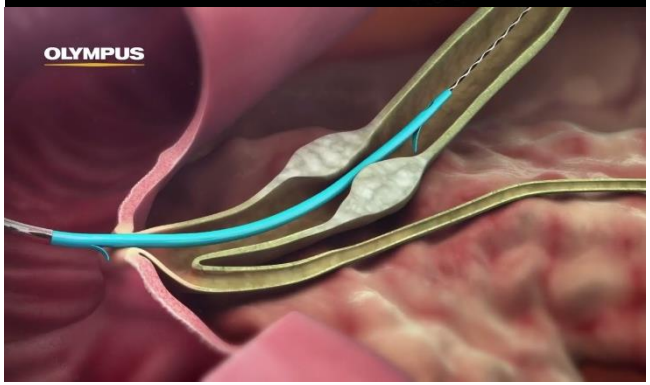
- GHTF
  - Essential Principles (EP) of Safety and Performance of Medical Devices
    - 醫療器材安全及性能的規範 (EU,JP, CA, AU, ASEAN, KSA, ROC…)
- US FDA
  - Safety and Effectiveness
    - Substantial Equivalence (U.S. Premarket Notification)
    - U.S. Class III Premarket Approval (Clinical trial)

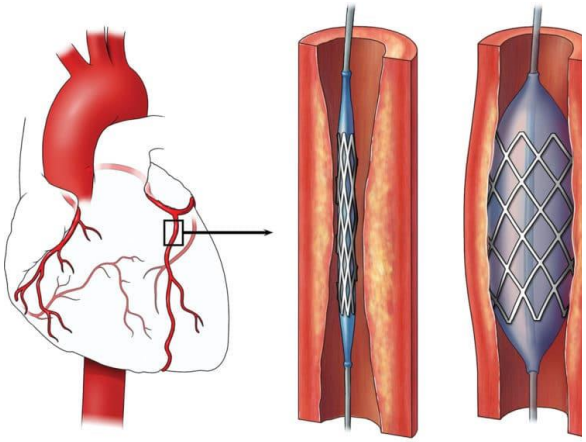
產品查證與確認 (Product verification and validation)

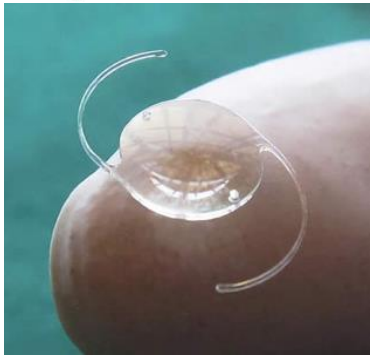
- Must develop or use standard tests at design output and deign verification and validation (Design V & V) stages to determine:
  - Biocompatibility (ISO10993)
  - Ergonomics & human factor……..
  - Software validation (ISO)
  - Sterility (EN/ISO17665)
  - Electromagnetic compatibility (EMC) (IEC60601)
  - Electromagnetic interference (EMI)
  - Electrical leakage
  - Power output
  - Material strength & durability (ASTM, ISO)
  - Physical and/or biological phantoms performance for nuclear imaging devices

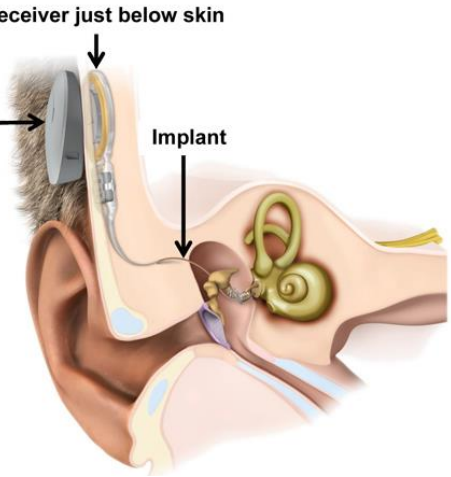
其他植入物

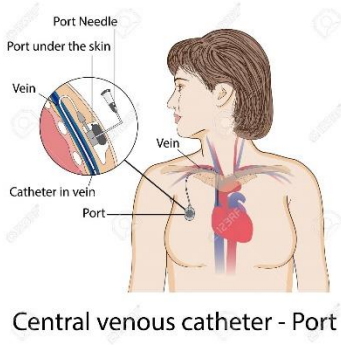












Central venous catheter - Port

https://www.medicaldevice-network.com/news/microcurrent-implant-heart-muscle-study/
https://centralgaheart.com/need-know-heart-stent/
https://www.hearinglink.org/your-hearing/implants/middle-ear-implants/

https://www.123rf.com/photo_114477640_port-totally-implantable-venous-access-device-medical-poster.html

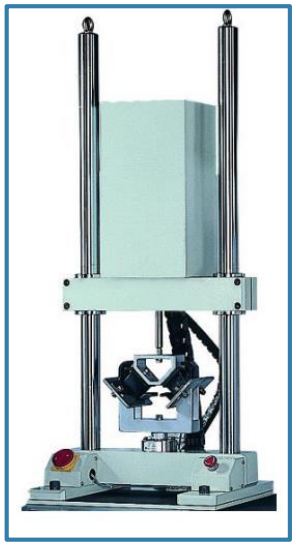
生醫工程分析實驗室能量介紹

扭轉材料靜態試驗機
(SE MODEL 2205NS, SE)

軸向材料靜態試驗機
(HT-2402EC, Hung-Ta)

機電軸向材料動態試驗機
(Instron E3000, Instron)

機電雙軸材料動態試驗機
(HT-1236FR100, Hung-Ta)



FDM 快速成型機
(Fortus 250mc, GIT)

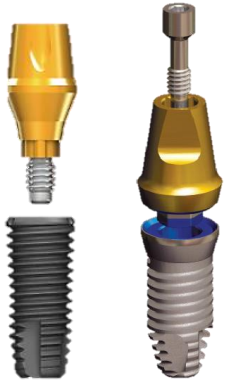
油壓雙軸材料動態試驗機
(Instron 8874, Instron)

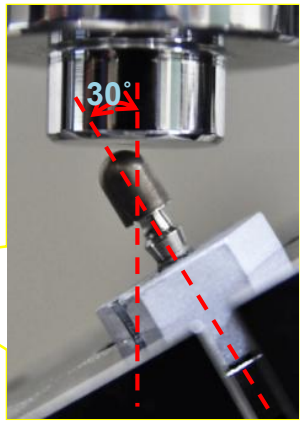
機電雙軸材料動態試驗機
(Instron E10000, Instron)

液壓軸向材料動態試驗機
(Bionix Landmark, MTS)

實驗室認證項目

人工牙根力學測試規範-ISO14801





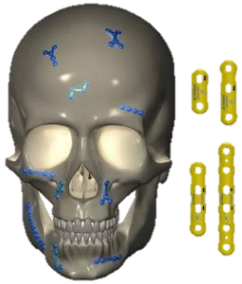
實驗架設圖

骨板力學測試規範-ASTM F382

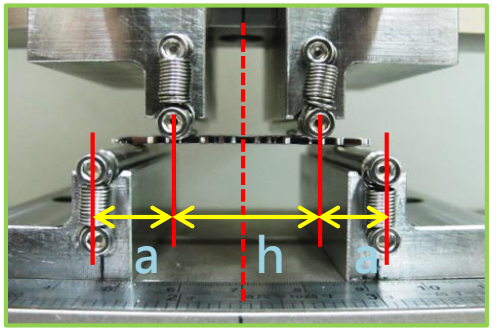
骨科大型骨板

骨科小型骨板

實驗架設圖



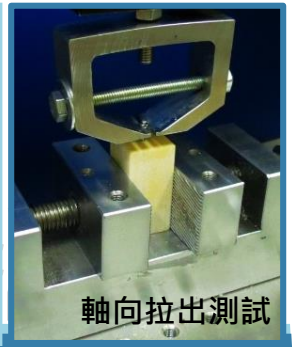
顱顏整形用骨板



骨釘力學測試規範-ASTM F543

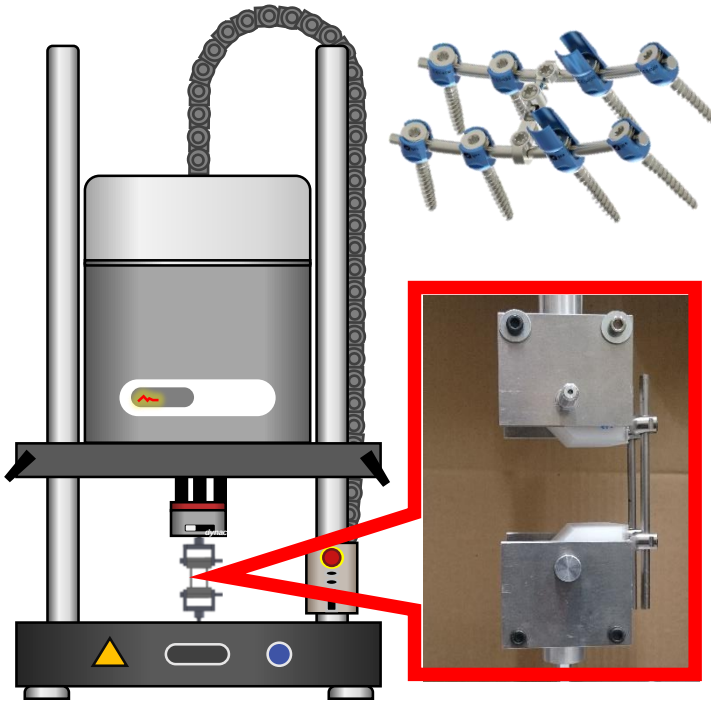
骨科創傷用骨釘

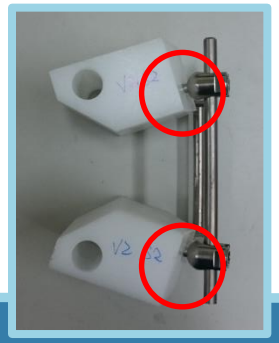
牙科矯正用迷你骨釘

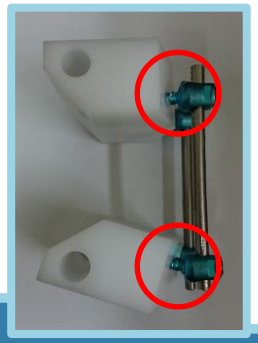


實驗室認證項目

椎弓螺釘力學測試規範-ASTM F1717







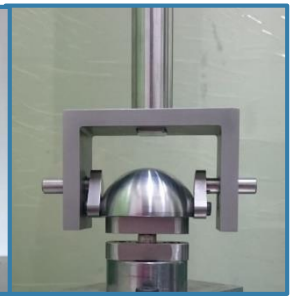
疲勞後滑移

椎籠力學規範測試-ASTM F2077

椎體椎籠

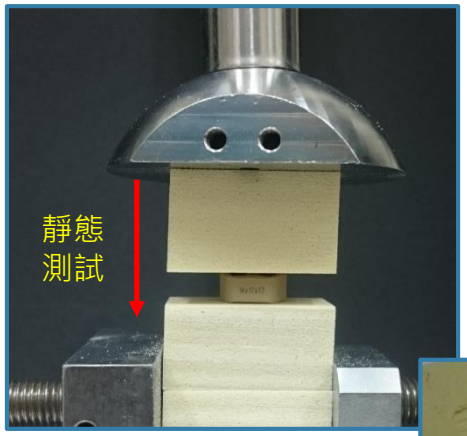
剪力測試

壓縮測試

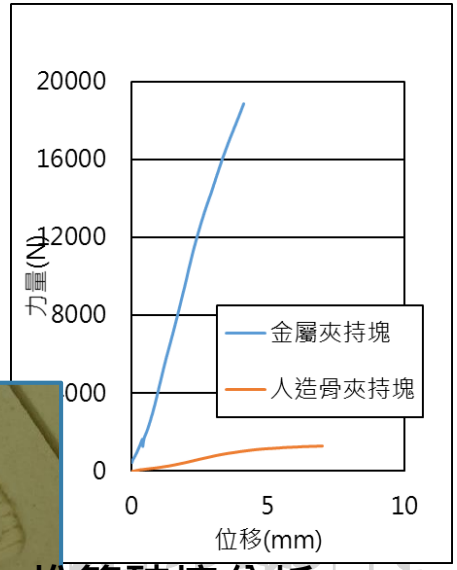


扭轉測試

椎籠沉降規範測試-ASTM F2267

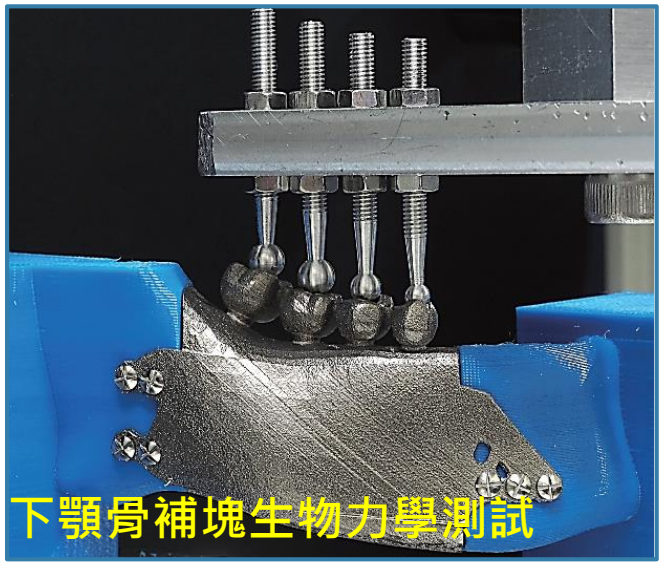


實驗架設圖

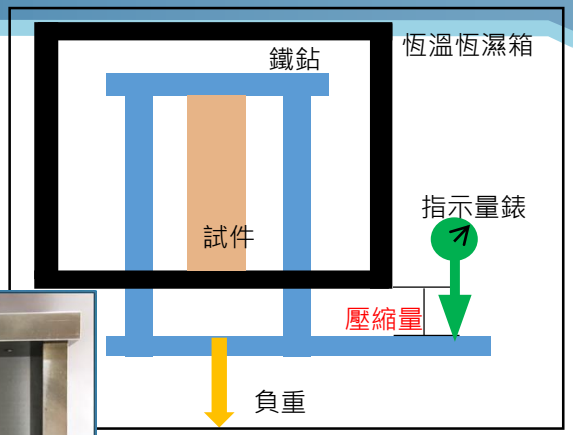


椎籠破壞分析

實驗室其他客製化功能性測試

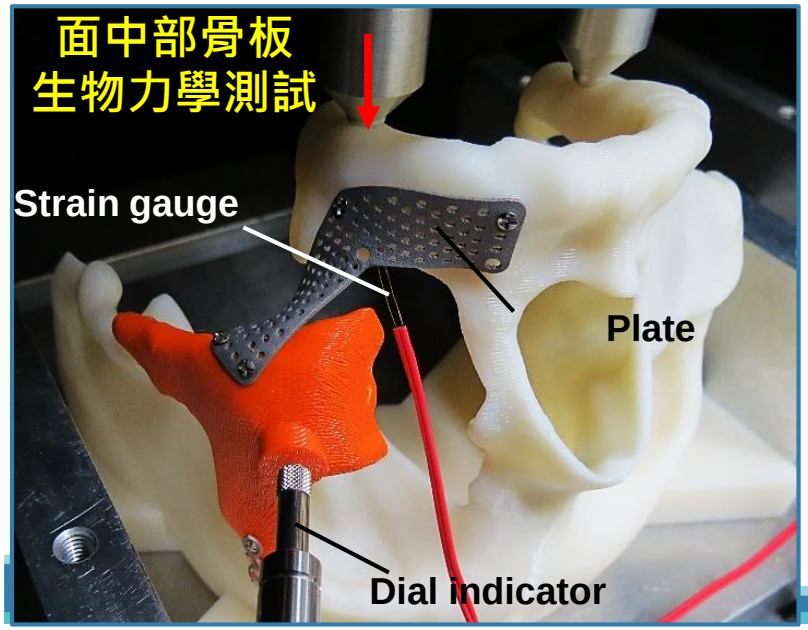


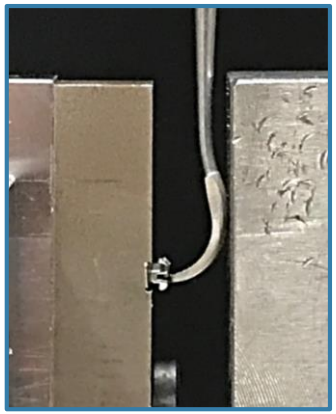
下顎骨補塊生物力學測試



骨水泥潛變測試

骨板/人造骨
生物力學測試





矯正器滑蓋測試

鈦網靜態
三點彎曲測試

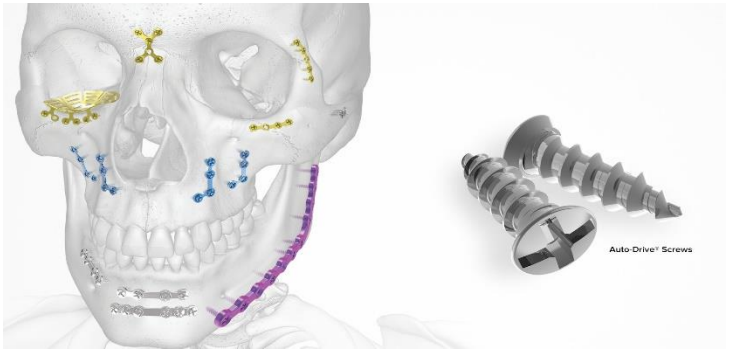
動物肩關節植入物
(Anchor)試驗

符合FDA功能性測試規範探討

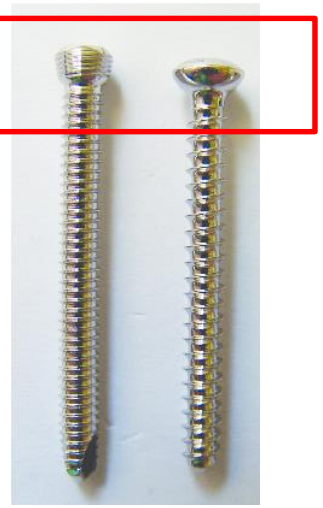
- ASTM F543(矯正釘/骨釘) (旋進旋出/拉出/扭斷)

骨釘簡介-骨釘與受力狀況

顱顏用骨釘

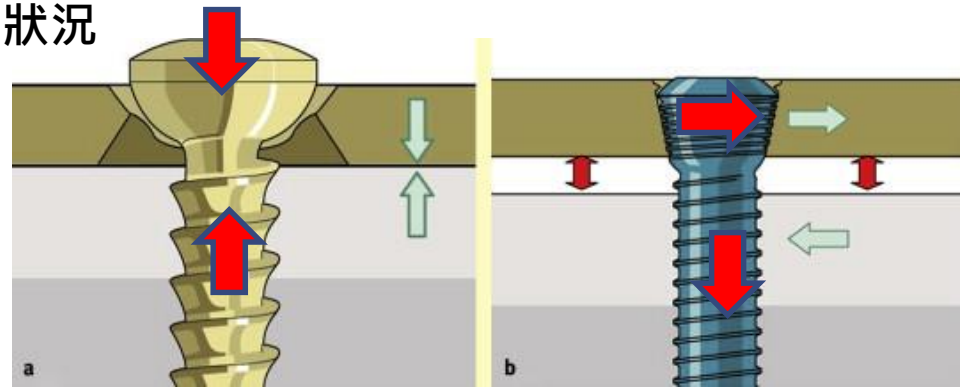


骨釘型態分類



牙科矯正釘

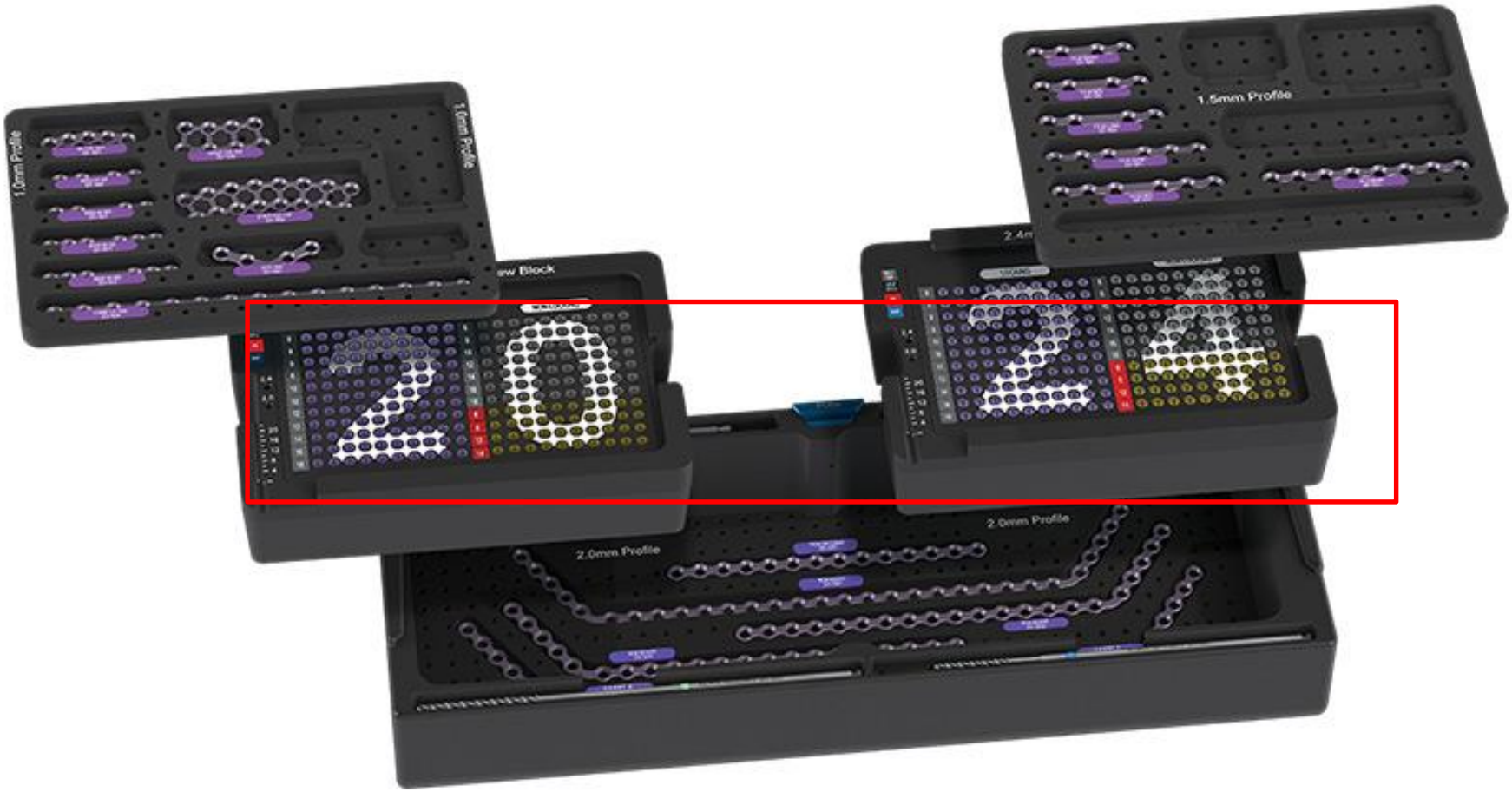
骨釘受力狀況



Compression screw

Locking screw

骨釘簡介-顱顏骨釘/骨板

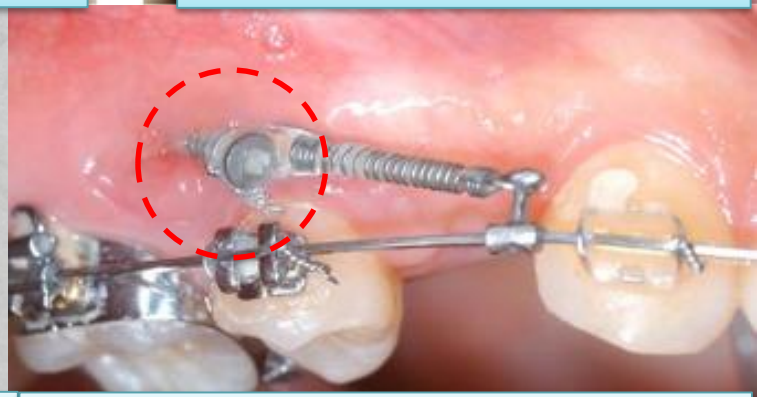


骨釘簡介-臨床失敗案例

Eliakim Mizrah,2007、Shingo Kuroda, 2014

矯正釘承受不住側向力，發生鬆脫

矯正釘被軸向拔出

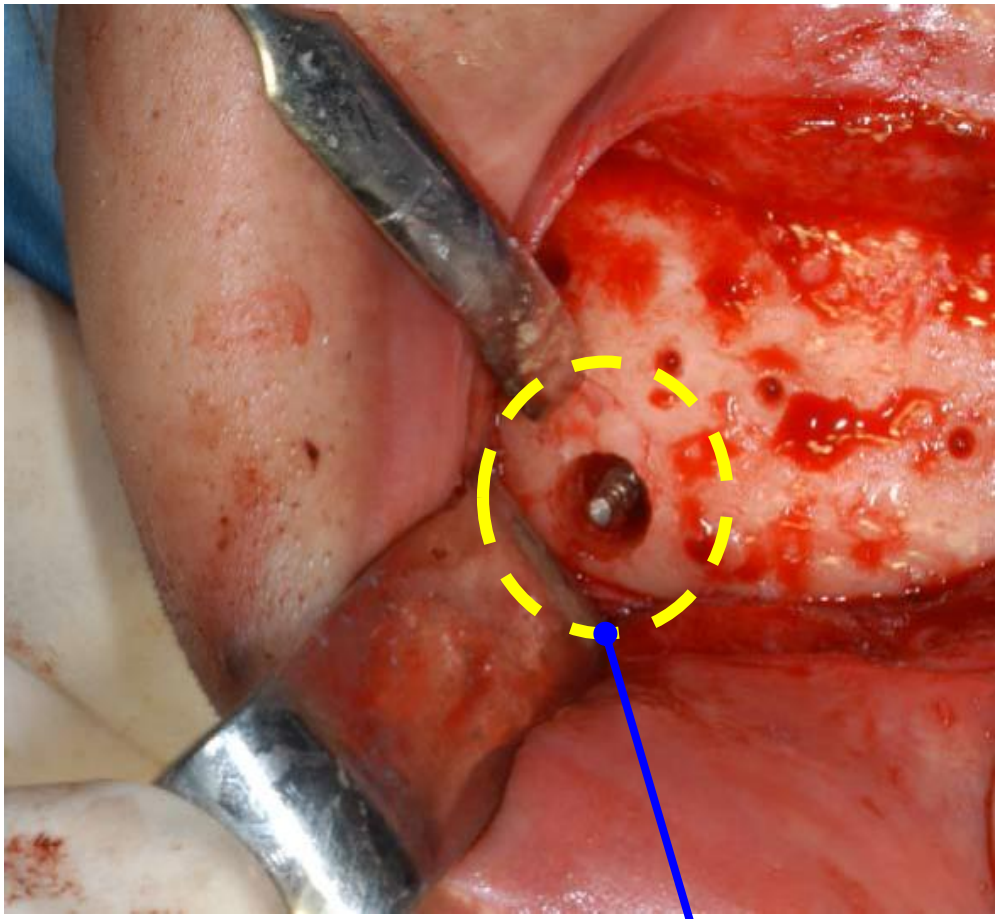


矯正釘在移除時發生斷裂

矯正釘被軸向拔出

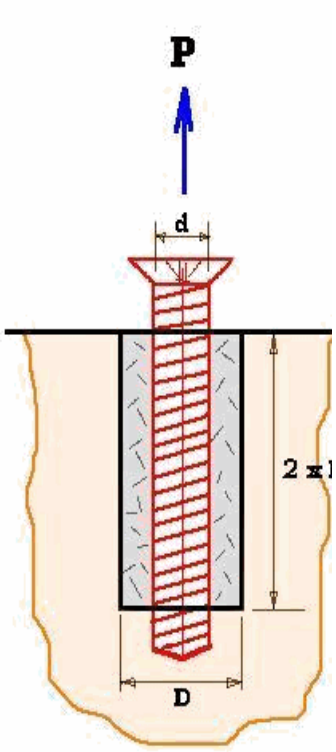
骨釘簡介-臨床失敗案例

Eliakim Mizrah,2007、Shingo Kuroda, 2014

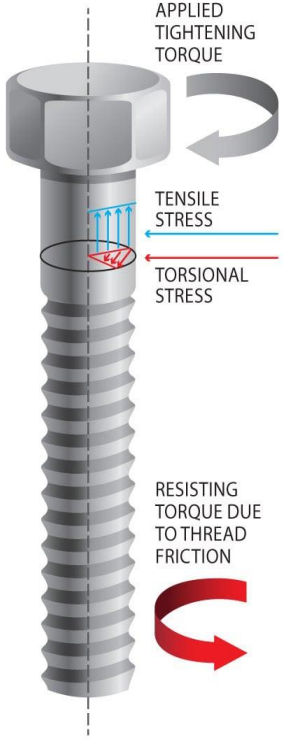


下頜骨骨釘螺頭斷裂

骨釘簡介-骨釘受力狀況



矯正釘被軸向拔出



矯正釘在移除時發生斷裂

拔出力量!!!

扭矩力量!!!

骨螺釘:台灣TFDA與美國FDA測試標準

- ASTM F543-17: Standard Specification and Test Methods for Metallic Medical Bone Screws(金屬醫用骨螺釘的標準規範和測試方法)

骨內固定器臨床前測試基準

Guidance for Pre-clinical Testing of Orthopedic Internal Fixation Devices

110.6

3.機械性質評估 (Mechanical Properties)	建議以最弱結構組成之組件(Worst case)進行測試，並提供其選擇依據。 骨板(Bone plates) (1) 靜態彎曲測試(Static bending test)。 (2) 彎曲疲勞測試(Bending fatigue test)。 骨螺釘(Bone screws) (1)扭轉測試(Torsional test)。 (2)旋入及旋出扭矩測試(Insertion and removal torque test)。 (3)軸向拉出強度測試(Axial pullout strength test)。 (4)若為自攻骨螺釘，則須加作自攻性能測試(Self-tapping performance test)。 骨固定釘(Bone staples) (1)等幅彎曲疲勞測試(Constant amplitude bending fatigue test)。 (2)拉出強度測試(Pull-out fixation strength)。	ASTM F382-17(13) ASTM F543-17(14) ASTM F564-17(15)

New Search | Back to Search Results

Device	Screw, Fixation, Bone
Regulation Medical Specialty	Orthopedic
Review Panel	Orthopedic
Product Code	HWC
Premarket Review	Orthopedic Devices (OHT6) Stereotaxic, Trauma and Restorative Devices (DHT6C)
Submission Type	510(k)
Regulation Number	888.3040
Device Class	2
Total Product Life Cycle (TPLC)	TPLC Product Code Report
GMP Exempt?	No
Summary Malfunction Reporting	Eligible
Implanted Device?	Yes
Life-Sustain/Support Device?	No

Recognized Consensus Standards

- 11-242 ASTM F1839-08 (Reapproved 2016)
  Standard Specification for Rigid Polyurethane Foam for Use as a Standard Material for Testing Orthopaedic Devices and Instruments
- 11-327 ASTM F543-17
  Standard Specification and Test Methods for Metallic Medical Bone Screws
- 11-363 ASTM F897-19
  Standard Test Method for Measuring Fretting Corrosion of Osteosynthesis Plates and Screws

骨螺釘:台灣TFDA與美國FDA測試標準

項 目	規格、需求及/或應進行測試	參 考 方 法
1.生物相容性評估 (Biocompatibility Evaluation)	材質如為常見植入醫療器材所使用之金屬材質，則可檢附符合國際標準規範之金屬材質證明代替；否則應進行下列生物相容性評估： (1)細胞毒性(Cytotoxicity) (2)致敏性(Sensitization) (3)刺激或皮內刺激性 (Irritation/Intracutaneous reactivity) (4)材質致熱原(Material mediated Pyrogen) (5)急性毒性(Acute systemic toxicity) (6)亞急性毒性(Subacute toxicity) (7)亞慢性毒性(Subchronic toxicity) (8)慢性毒性(Chronic toxicity) (9)基因毒性(Genotoxicity) (10)植入性(Implantation)	ISO 10993-1:2018[1] ISO 10993-3:2014[2] ISO 10993-5:2009[3] ISO 10993-6:2016[4] ISO 10993-10:2010[5] ISO 10993-11:2017[6] ISO 10993-12:2012[7]
	(11)致癌性(Carcinogenicity) 若產品未含新材質，下列項目得以生物安全性風險評估資料(包含學術文獻、材質安全性資料、風險評估及不需進行額外評估之理由等)替代： (1)材質致熱原(Material mediated Pyrogen) (2)慢性毒性(Chronic toxicity) (3)致癌性(Carcinogenicity)	

Recognized Consensus Standards

- 8-475 ASTM F2026-17
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- 8-495 ISO 5834-3 Second edition 2019-02
  Implants for surgery - Ultra-high-molecular-weight polyethylene - Part 3: Accelerated ageing methods
- 8-496 ISO 5834-4 Second edition 2019-02
  Implants for surgery - Ultra-high-molecular-weight polyethylene - Part 4: Oxidation index measurement method
- 8-497 ISO 5834-5 Second edition 2019-02
  Implants for surgery - Ultra-high-molecular-weight polyethylene - Part 5: Morphology assessment method
- 8-501 ISO 5834-1 Fourth edition 2019-02
  Implants for surgery - Ultra-high-molecular-weight polyethylene - Part 1: Powder form
- 8-514 ISO 5834-2 Fifth edition 2019-02
  Implants for surgery - Ultra-high-molecular-weight polyethylene - Part 2: Moulded forms
- 8-558 ASTM F3333-20
  Standard Specification for Chopped Carbon Fiber Reinforced (CFR) Polyetheretherketone (PEEK) Polymers for Surgical Implant Applications
- 8-572 ASTM F2565-21
  Standard Guide for Extensively Irradiation-Crosslinked Ultra-High Molecular Weight Polyethylene Fabricated Forms for Surgical Implant Applications
- 8-573 ASTM F2695-12(2020)
  Standard Specification for Ultra-High Molecular Weight Polyethylene Powder Blended With Alpha-Tocopherol (Vitamin E) and Fabricated Forms for Surgical Implant Applications
- 8-574 ASTM F2820-12(2021)e1
  Standard Specification for Polyetherketoneketone (PEKK) Polymers for Surgical Implant Applications
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- 11-199 ASTM F565-04 (Reapproved 2018)
  Standard Practice for Care and Handling of Orthopedic Implants and Instruments
- 11-242 ASTM F1839-08 (Reapproved 2016)
  Standard Specification for Rigid Polyurethane Foam for Use as a Standard Material for Testing Orthopaedic Devices and Instruments
- 11-327 ASTM F543-17
  Standard Specification and Test Methods for Metallic Medical Bone Screws
- 11-363 ASTM F897-19
  Standard Test Method for Measuring Fretting Corrosion of Osteosynthesis Plates and Screws
- 11-378 ASTM F2502-17
  Standard Specification and Test Methods for Absorbable Plates and Screws for Internal Fixation Implants

ASTM F543-17

Standard Specification and Test Methods for Metallic Medical Bone Screws

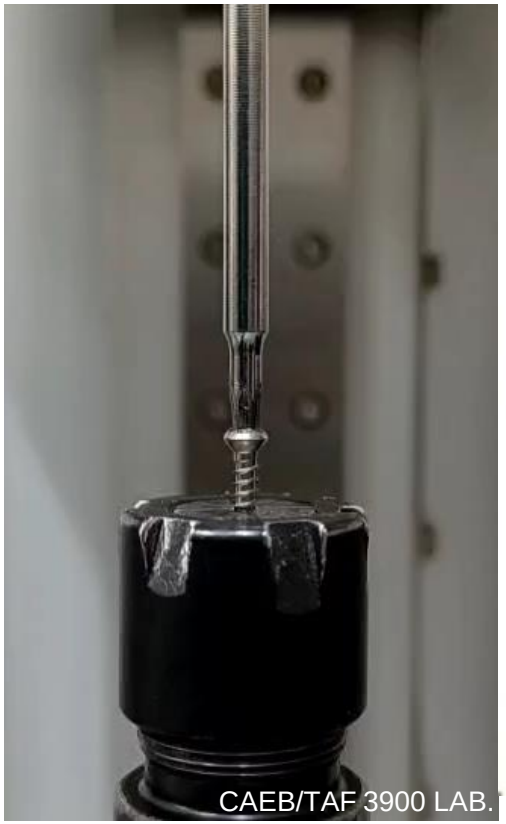
ASTM F543-17

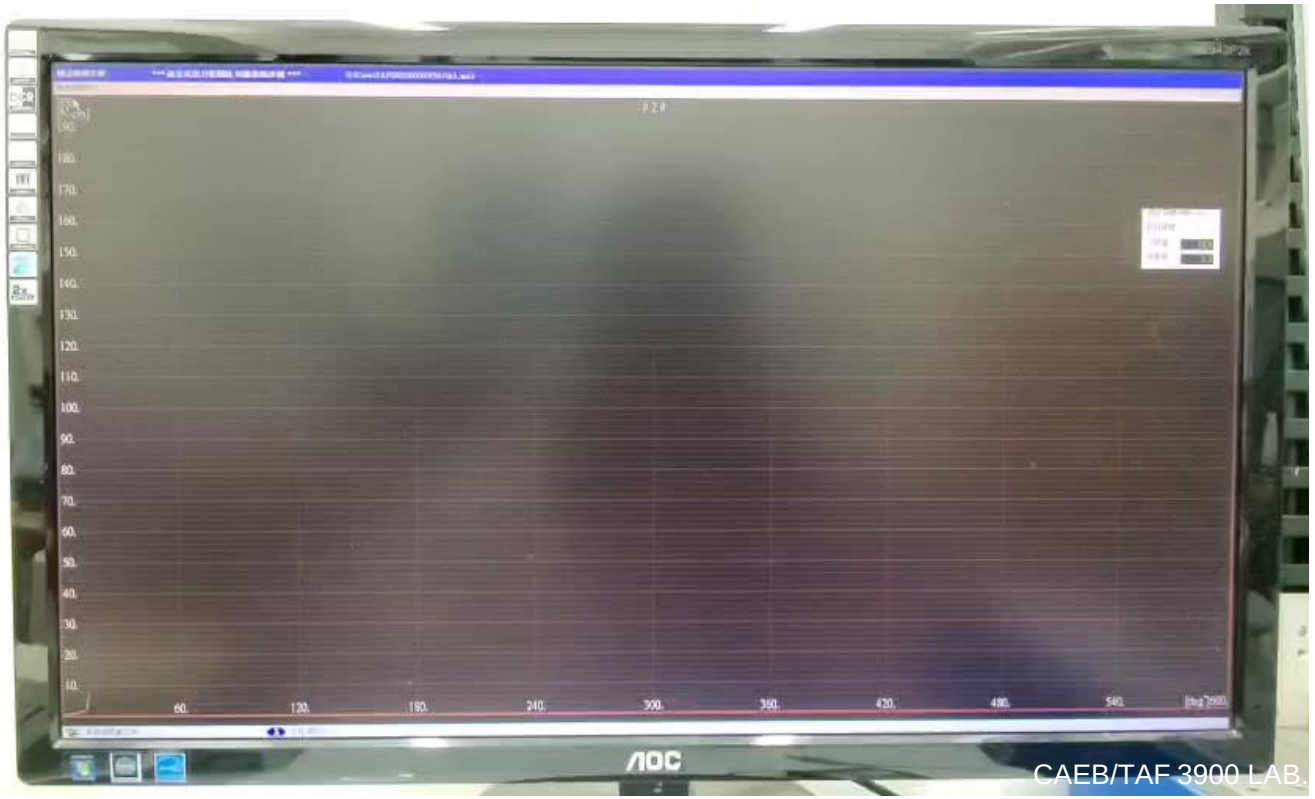
- **Testing of bone screws to ASTM F543 refers to four mechanical tests in simplified clinical use.**
- **The primary properties involved include torsional strength, insertion and removal behavior, pull-out strength and self-tapping performance of medical bone screws.**

A1	Torsional strength/ Breaking Angle
A2	Removal Torque/ Insertion Torque
A3	Axial pull-out strength of medical bone screws
A4	A Self-tapping performance test needs to be performed for self-tapping medical bone screws only

A5IA7	Specification for HA, HB, HC, HD bone screws

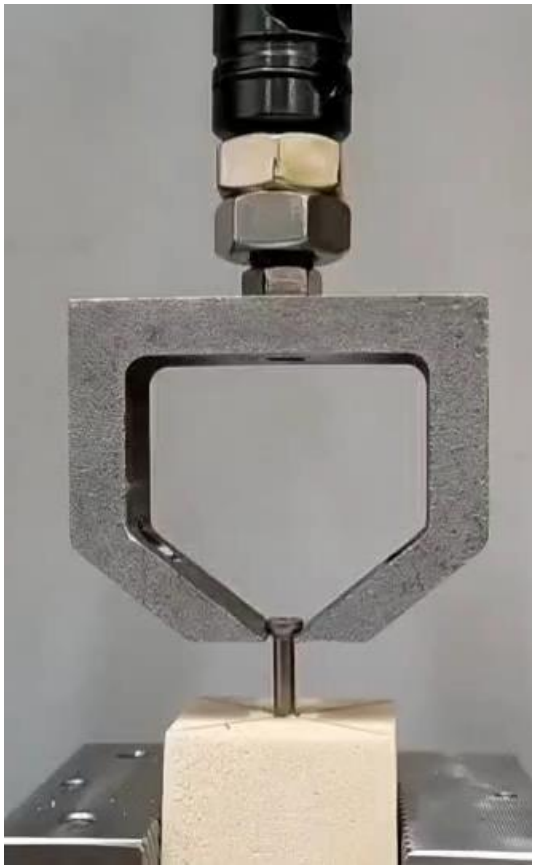
ASTM F543-17(Annexes A1)





ASTM F543-17(Annexes A2)

ASTM F543-17(Annexes A3)

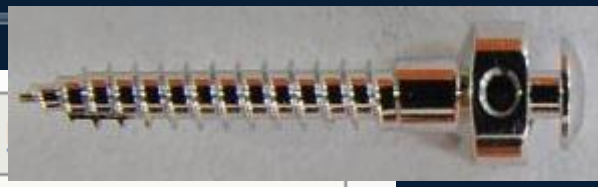


ASTM F543-17

非TAF或ISO測試實驗室，可能產生之風險與問題

常見問題	舉例	影響
機台性能不符合要求	機台可扭轉圈數/角度無法滿足法規需求(4圈=1440度)，如只能轉130度	非一次性完成，力量釋放後，再度扭轉並非真實扭斷數據
測試塊不符合規定	材質密度等偏差	數據不可信
測試塊預留空間不足	測試塊裁切太小	夾具夾持時兩側力量可能壓迫到測試樣品(骨釘)，造成數據偏大
預鑽孔大小不同	非依廠商臨床使用建議預鑽孔大小或無預鑽孔	於臨床使用上，可能因預鑽孔大小影響實際數據。可能為了讓數據提高，採取較小預鑽孔或無鑽孔。在實質性比對上應注意條件需一致
夾持時滑脫	扭轉或拔出時，夾具無法完全夾持，造成鬆脫	由力量位移圖可明顯判讀是否滑脫。造成力量不連續或樣品無法扭斷
報告未依規定呈現相關圖片、數據	如未放置機台架設照或測試完成樣品照	不符合法規要求
鎖入深度不符合規定	如大陸認知Thread runout:螺紋收尾一圈不屬於螺紋段，因此實際上多了一圈螺紋。	直接影響測試數據。無法再現性與數據可信度

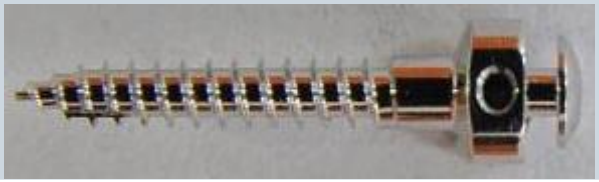
Orthodontic Mini-Screw SE Test



New Search

Device Classification Name	Implant, Endosseous, Root-Form
510(K) Number	K110425
Device Name	HC-BIOS DENTAL IMPLANT
Applicant	HUNG CHUN BIO-S CO., LTD. No.45, Minsheng Rd Danshui Town Taipei County,
Contact	Michael Lee
Regulation Number	872.3640
Classification Product Code	DZE
Date Received	02/14/2011
Decision Date	07/27/2012
Decision	Substantially Equivalent (SE)
Classification Advisory Committee	Dental
Review Advisory Committee	Dental
Summary	Summary
Type	Traditional
Reviewed By Third Party	No
Expedited Review	No
Combination Product	No

Orthodontic Mini-Screw SE Test

	XXXX	X1
Applicant	XXXX Technology Inc. (Taiwan)	XXXXXX Co. (Taiwan)
Intended use	Provide a fixed anchorage point for attachment of orthodontic appliances to facilitate the orthodontic movement of teeth	Provide a fixed anchorage point for attachment of orthodontic appliances to facilitate the orthodontic movement of teeth
Screw chemical composition	Stainless steel (SUS316LVM)	Stainless steel (SUS316LVM)
Surface finish	N/A	N/A
Diameter	1.5 mm	1.5 mm
Length	12 mm	12 mm
The size of the exposed portion of the screwdriver	N/A	N/A
Illustration	Ø1.5L12	Ø1.5L12
		

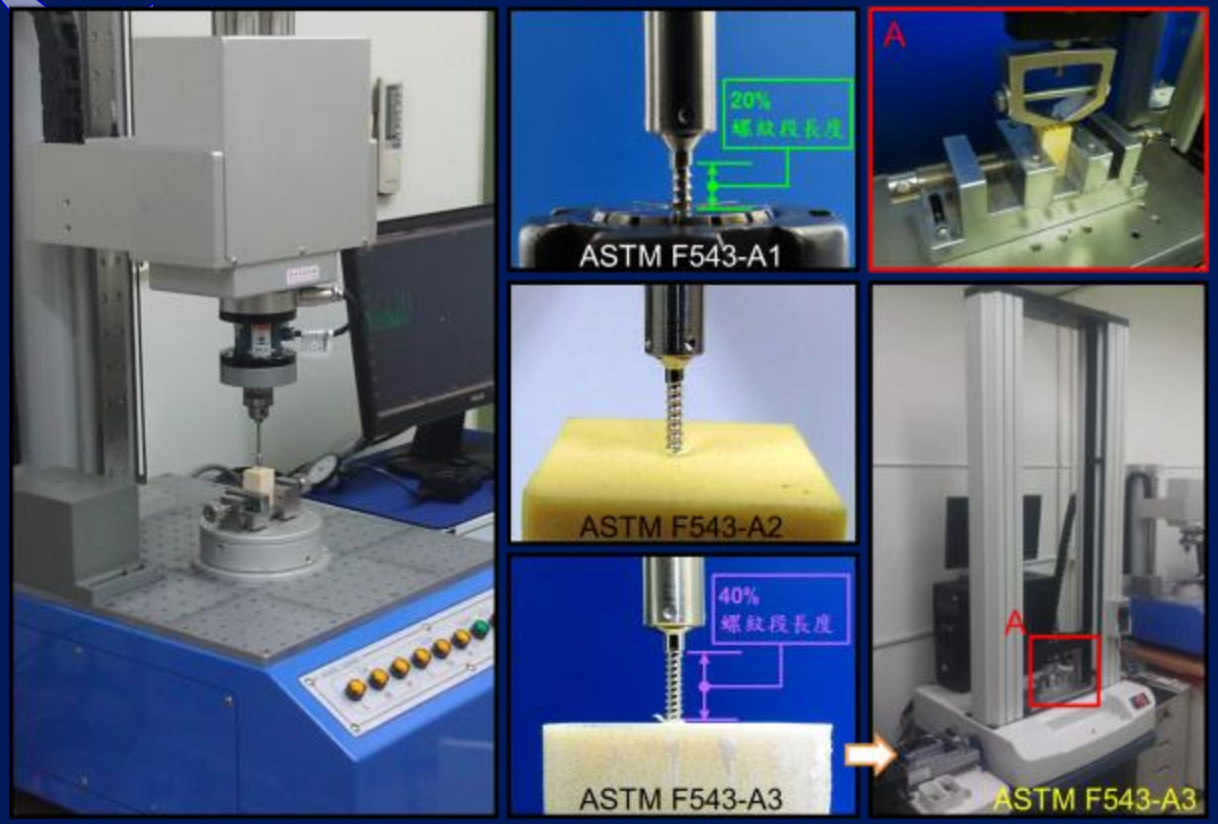
上市前測試項目

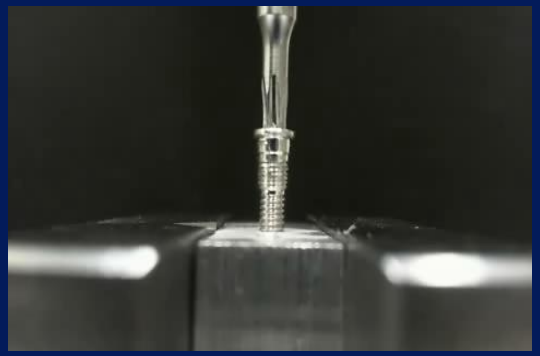
■ : FDA /TFDA要求專案

- 材料力學測試
  - -不銹鋼:ASTM F138/ ISO 5832-1
  - -鈦合金: ASTM F136 and ISO 5832-3
- 生物相容性測試 (ISO 10993)
  - -刺激/敏感/熱源

- 基本力學測試(ASTM F543)
  - 旋斷強度測試
  - 旋進/出扭力測試
  - 拔出強度測試

基本力學測試(ASTM F543)



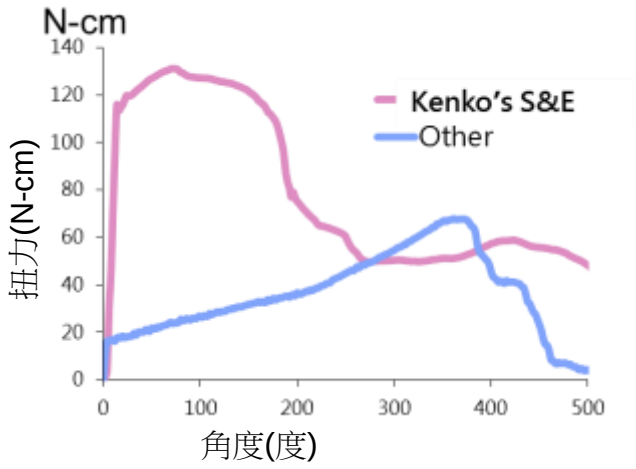


ASTM F543-A1 (旋斷强度測试)

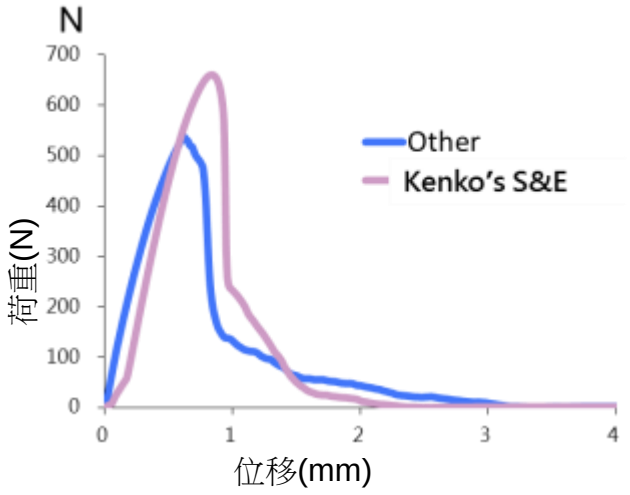
ASTM F543-A3 (拔出强度測试)

CAEB LAB

基本力學測試(ASTM F543)



ASTM F543-A1 (旋断强度测试)



ASTM F543-A3 (拔出强度测试)

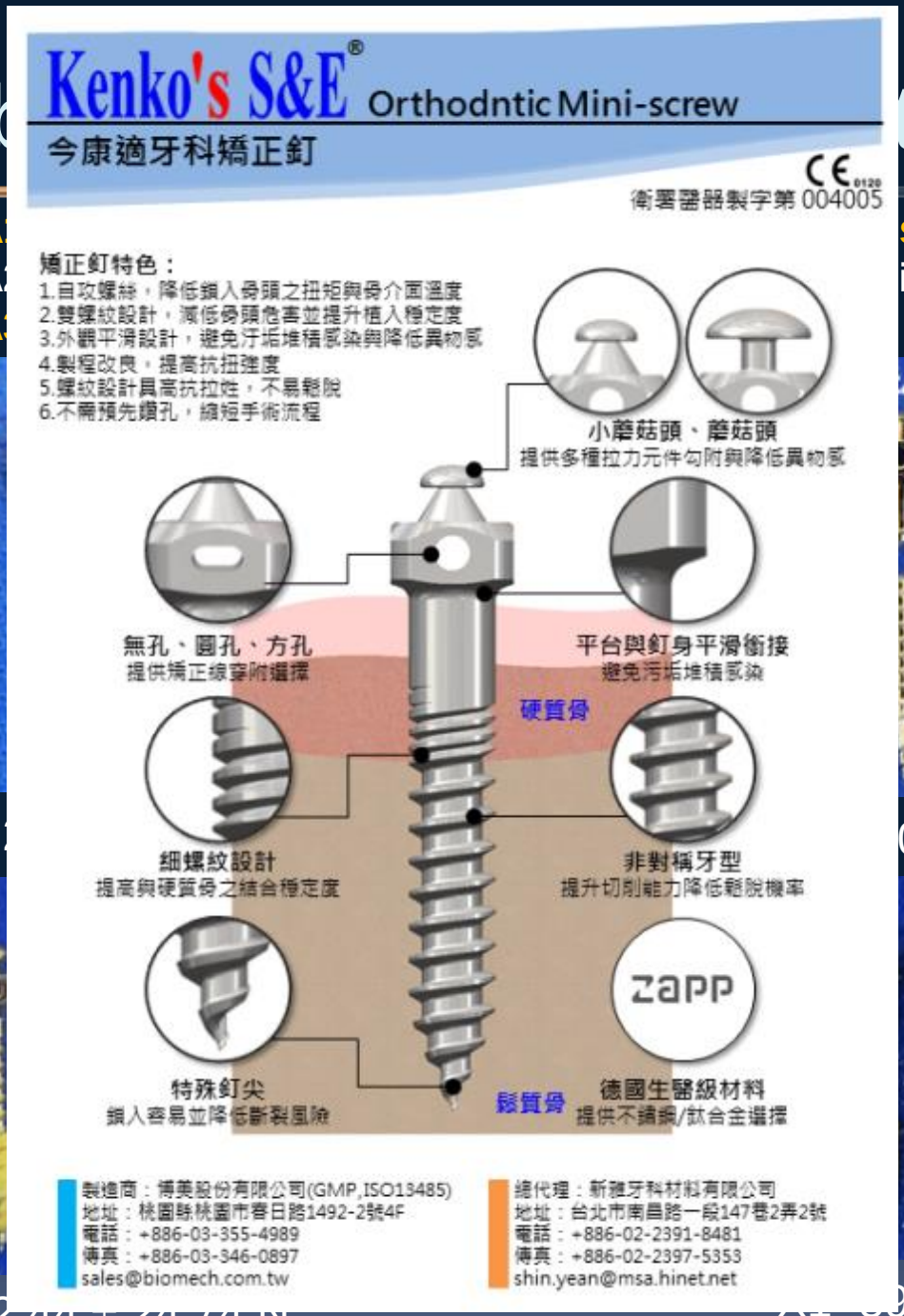
Items / Samples	Max. twisting strength (E) (N-cm)	Pull-out strength (N)
Ø2L12 (Other)	70.05±5.75	530.15±50.75
Ø2L12 (Kenko's S&E)	133.04±2.17	646.60±44.47
Ø1.5L8 (Other)	61.76±5.70	423.80±54.56
Ø1.5L8 (Kenko's S&E)	69.21±3.59	566.70±17.96

SE (Sub t) test

- ASTM F-543 A s
- ASTM F-543 A i-screws
- ASTM F-543 A

XX=44.7 0.32±0.63N-cm

XX=622.44 ± 24.74 N 92.813 ± 7.94 N

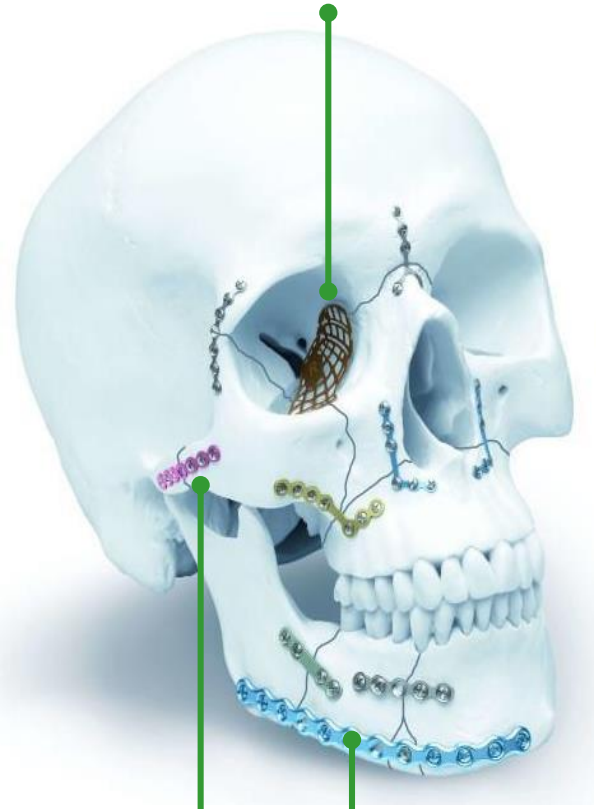


符合FDA功能性測試規範探討

- ASTM F382(顱顏用骨板)(靜動態四點彎曲測試)

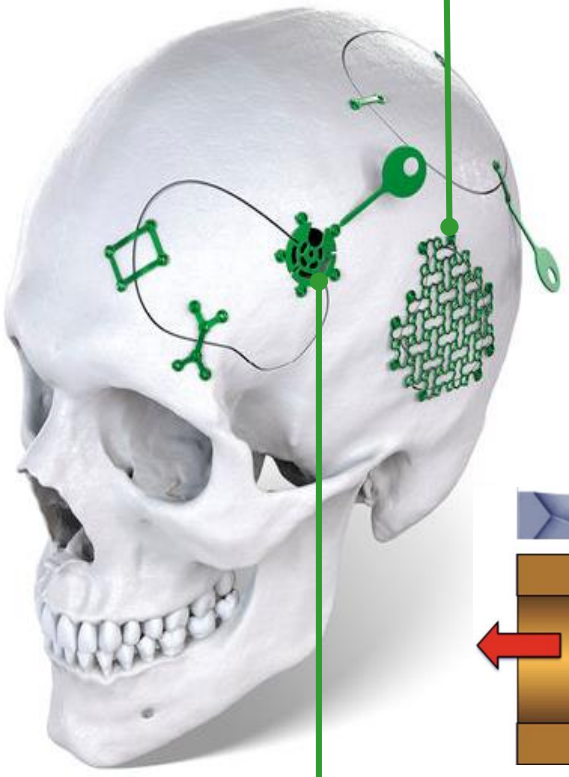
骨板簡介-骨板與受力狀況

顱顏用骨釘 眼窩骨板



顏面小骨板 下顎骨板

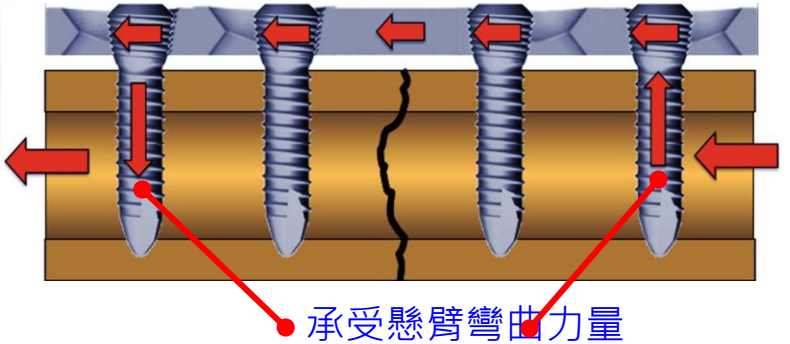
顱顏骨網片



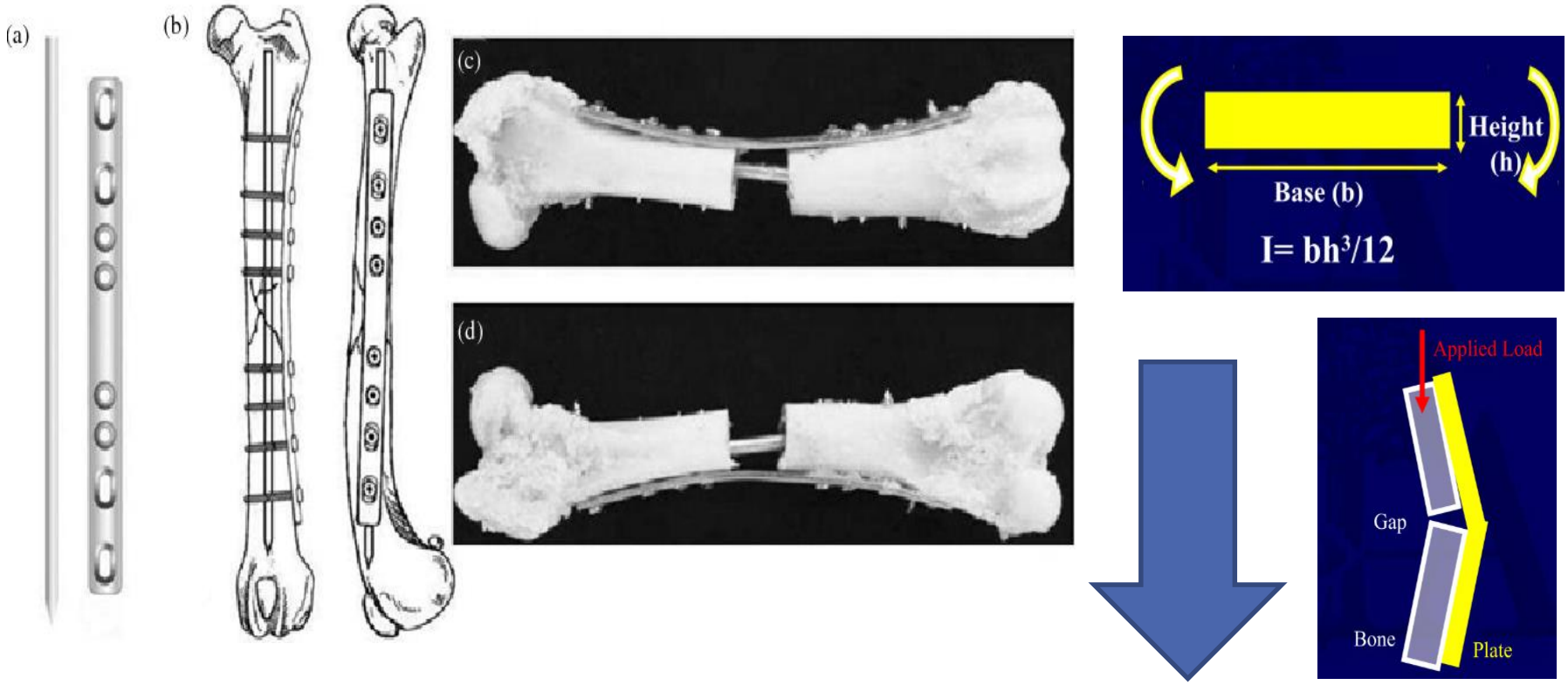
顱骨內固定系統

特製化下顎骨骨板

骨板受力狀況

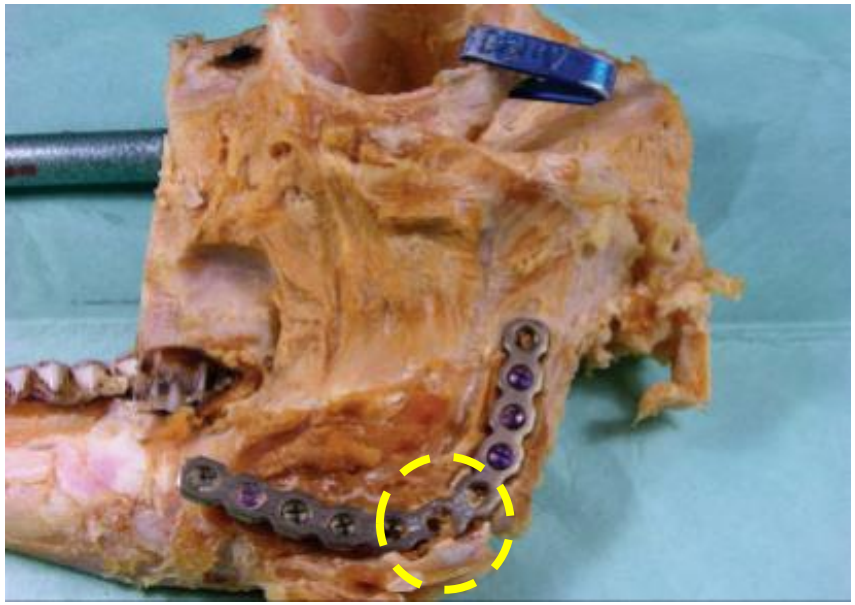


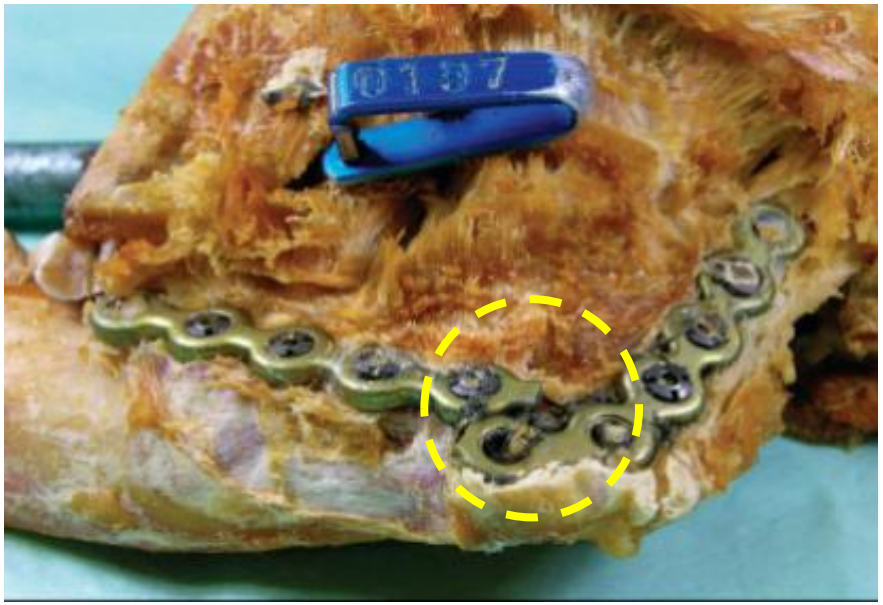
骨板簡介-骨板受力狀況



Bending moment!!!

骨板簡介-臨床失敗案例





下顎骨骨板斷裂

Martta Martola, 2007

骨板:台灣TFDA與美國FDA測試標準

- ASTM F382-17: Standard Specification and Test Method for Metallic Bone Plates (金屬骨板標準測試)

骨內固定器臨床前測試基準

Guidance for Pre-clinical Testing of Orthopedic Internal Fixation Devices

110.6

3.機械性質評估 (Mechanical Properties)	建議以最弱結構組成之組件(Worst case)進行測試，並提供其選擇依據。 骨板(Bone plates) (1) 靜態彎曲測試(Static bending test)。 (2) 彎曲疲勞測試(Bending fatigue test)。 骨螺釘(Bone screws) (1)扭轉測試(Torsional test)。 (2)旋入及旋出扭矩測試(Insertion and removal torque test)。 (3)軸向拉出強度測試(Axial pullout strength test)。 (4)若為自攻骨螺釘，則須加作自攻性能測試(Self-tapping performance test)。 骨固定釘(Bone staples) (1)等幅彎曲疲勞測試(Constant amplitude bending fatigue test)。 (2)拉出強度測試(Pull-out fixation strength)。	ASTM F382-17[13] ASTM F543-17[14] ASTM F564-17[15]

Device	Plate, Fixation, Bone
Regulation Medical Specialty	Orthopedic
Review Panel	Orthopedic
Product Code	HRS
Premarket Review	Orthopedic Devices (OHT6) Stereotaxic, Trauma and Restorative Devices (DHT6C)
Submission Type	510(k)
Regulation Number	888.3030
Device Class	2
Total Product Life Cycle (TPLC)	TPLC Product Code Report
GMP Exempt?	No
Summary Malfunction Reporting	Eligible
Implanted Device?	Yes
Life-Sustain/Support Device?	No

Recognized Consensus Standards

- 11-325 ASTM F564-17
  Standard Specification and Test Methods for Metallic Bone Staples
- 11-327 ASTM F543-17
  Standard Specification and Test Methods for Metallic Medical Bone Screws
- 11-333 ASTM F382-17
  Standard Specification and Test Method for Metallic Bone Plates
- 11-363 ASTM F897-19
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  Standard Test Method for Measuring Fretting Corrosion of Osteosynthesis Plates and Screws
- 11-378 ASTM F2502-17
  Standard Specification and Test Methods for Absorbable Plates and Screws for Internal Fixation Implants

Third Party Review Not Third Party Eligible

ASTM F382-17

Standard Specification and Test Method for Metallic Bone Plates

ASTM F382-17

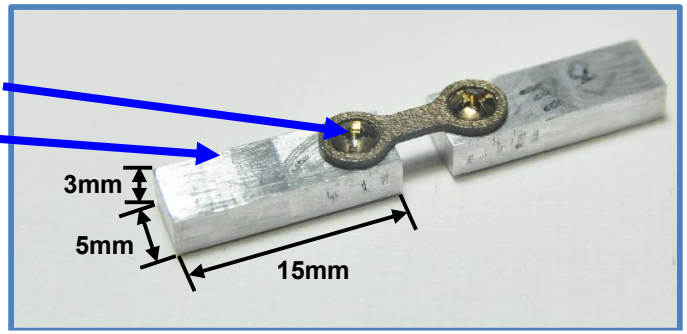
- **This specification and test method is intended to provide a comprehensive reference for bone plates used in the surgical internal fixation of the skeletal system.**
- **The device is intended to provide alignment and fixation of two or more bone sections, primarily by spanning the fracture or defect.**

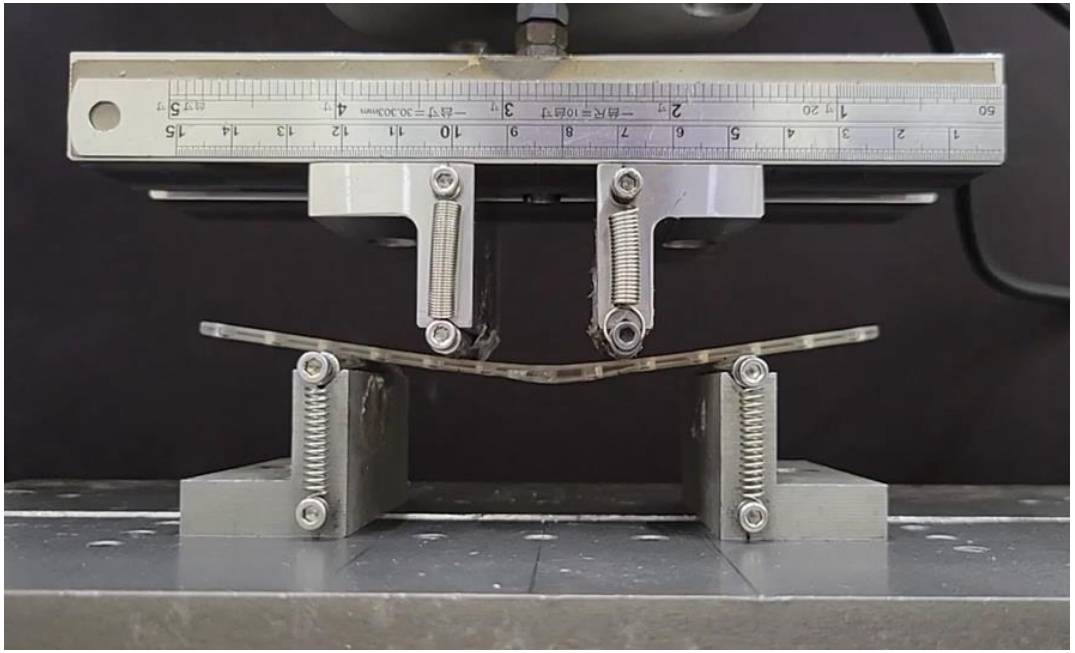
A1	Standard Test Method for Single Cycle Bend Testing of Metallic Bone Plates
A2	Standard Test Method for Determining the Bending Fatigue Properties Of Metallic Bone Plates

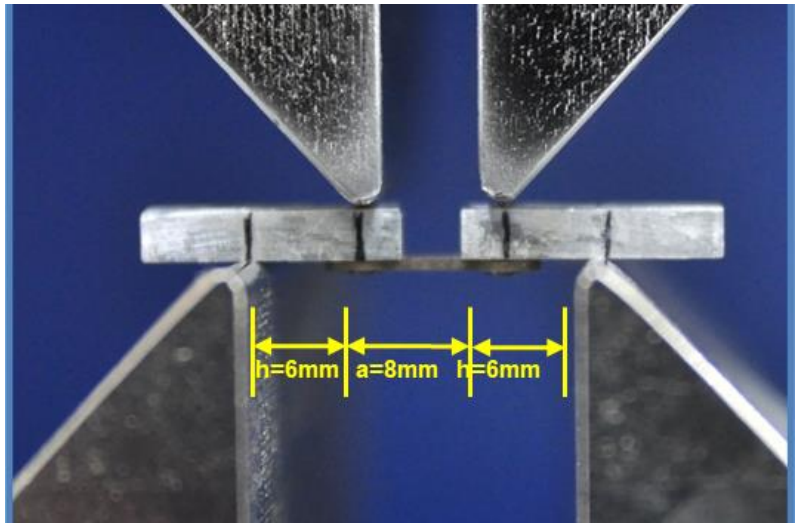
ASTM F382-17 Annex 1

鎖骨螺釘(使用原廠螺釘)

延長板(金屬材料)







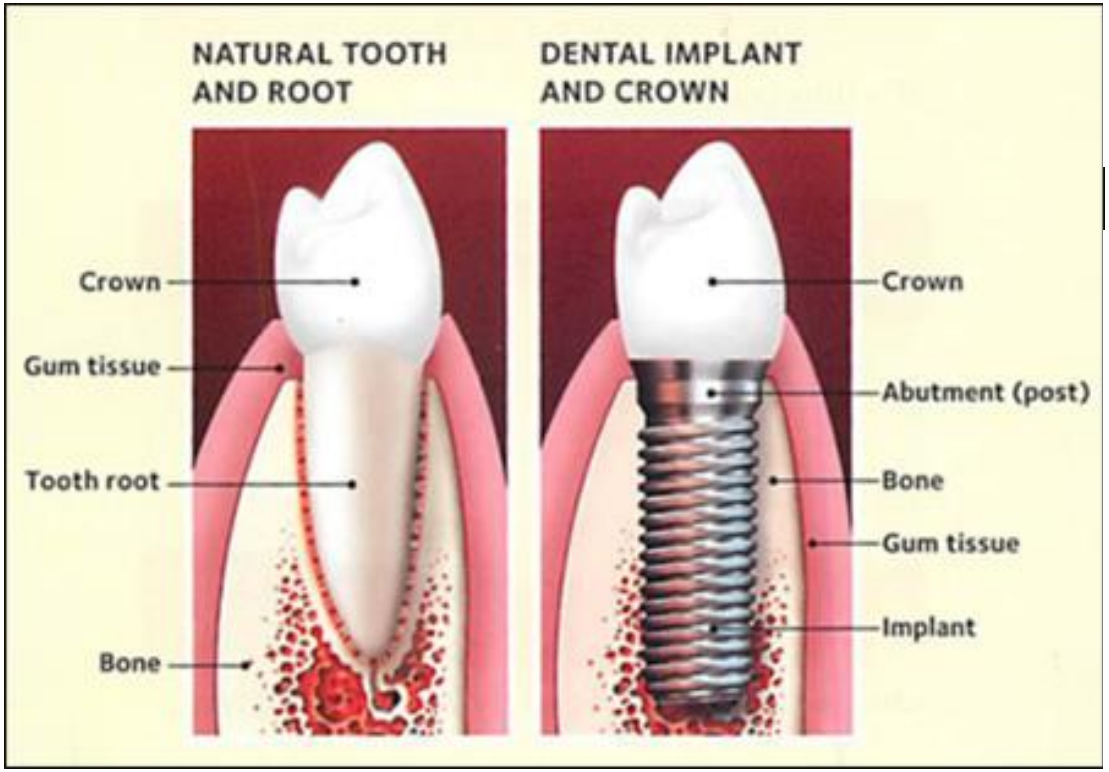
ASTM F382-17 Annex 2

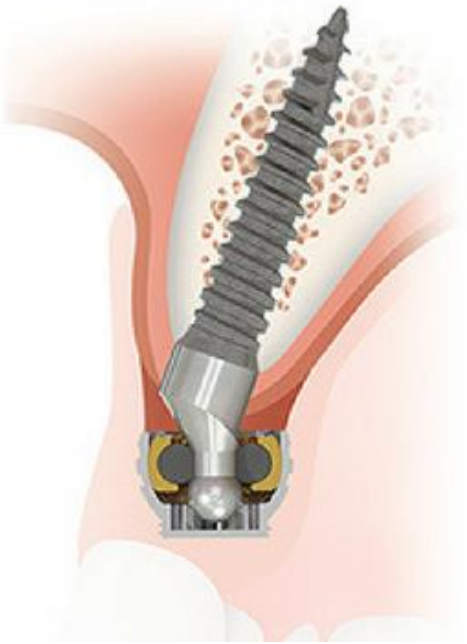
符合FDA功能性測試規範探討

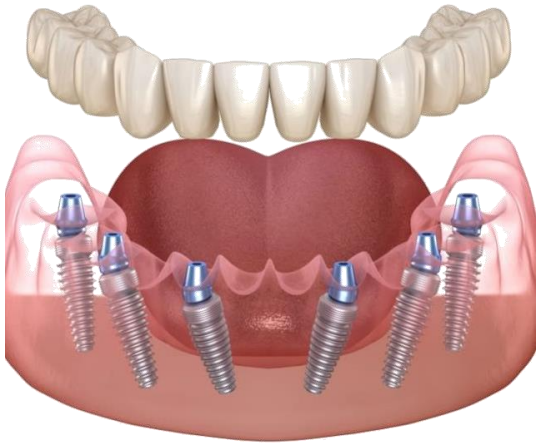
- ISO 14801(人工牙根)(靜動態壓力及剪力測試)

人工牙根簡介-分類

- 依型式分類可分為，直立式(straight)與角度式(angulated)植體

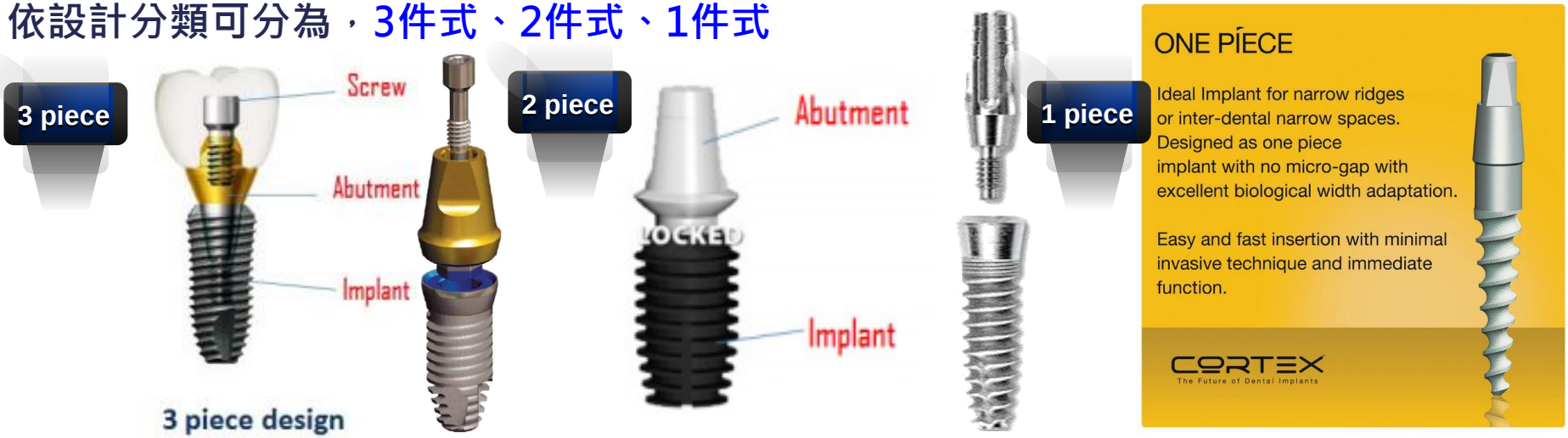


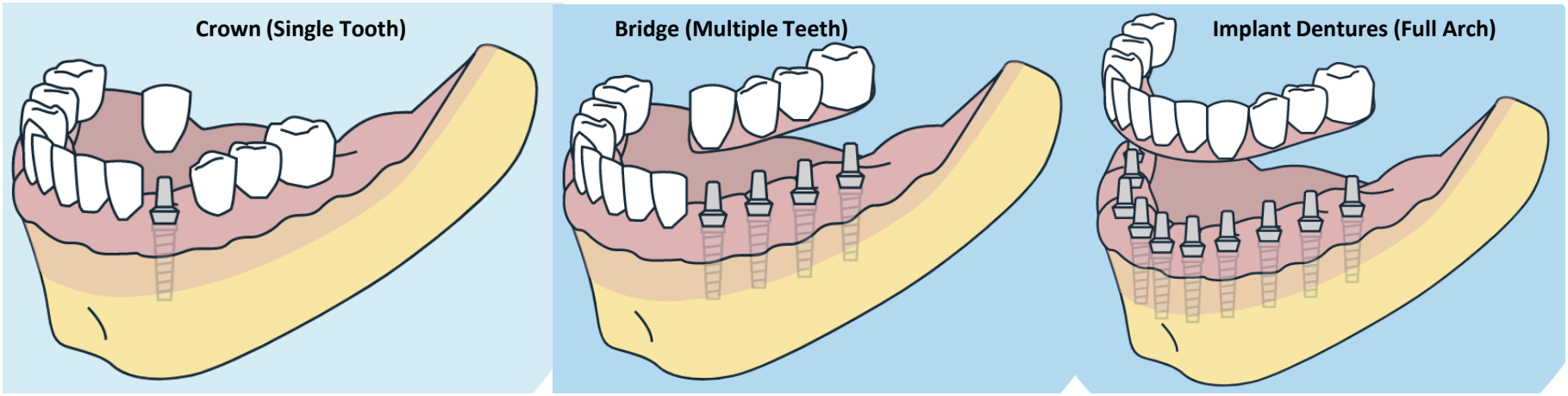




人工牙根簡介-分類

- 依設計分類可分為，3件式、2件式、1件式



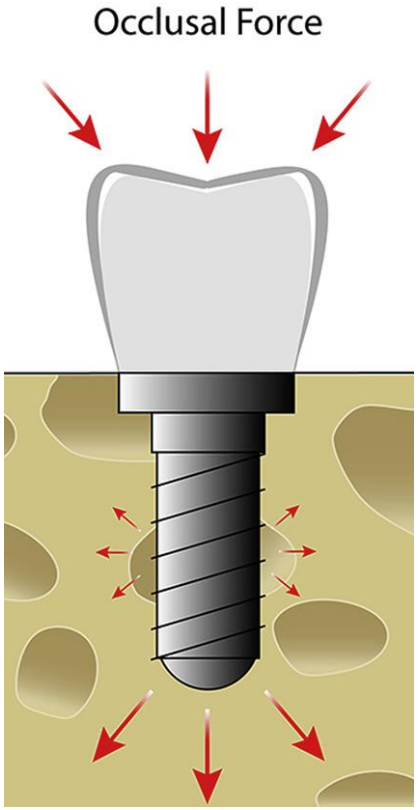


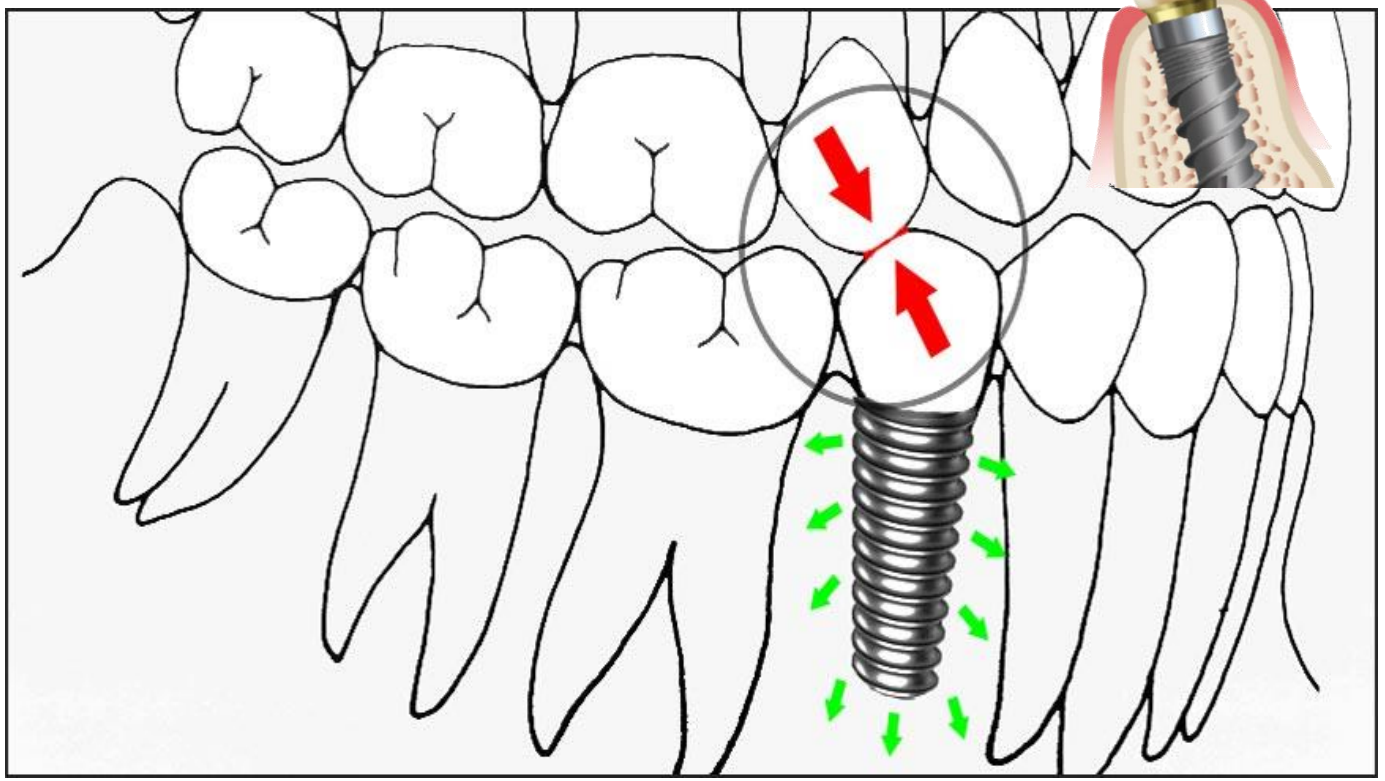
人工牙根簡介-分類

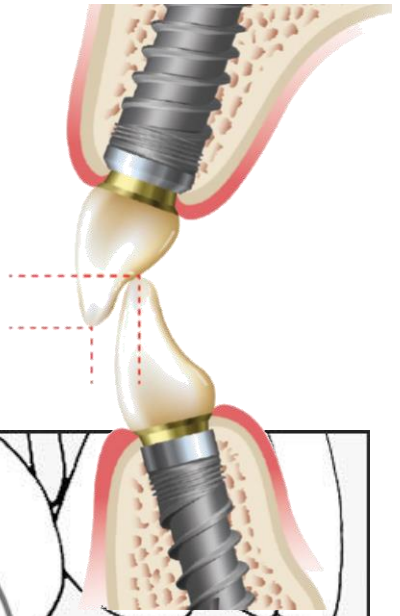
- 依材料分類可分為，**金屬、陶瓷、金屬3D列印等組合**

3D printing of Ti6Al4V dental implants

人工牙根簡介-臨床受力情況

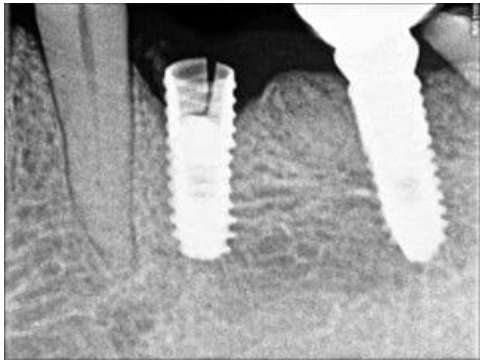


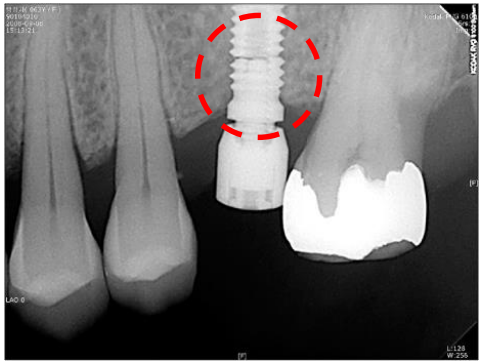


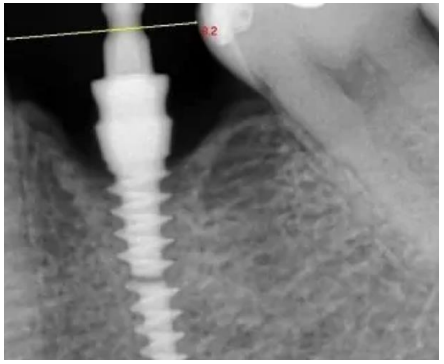


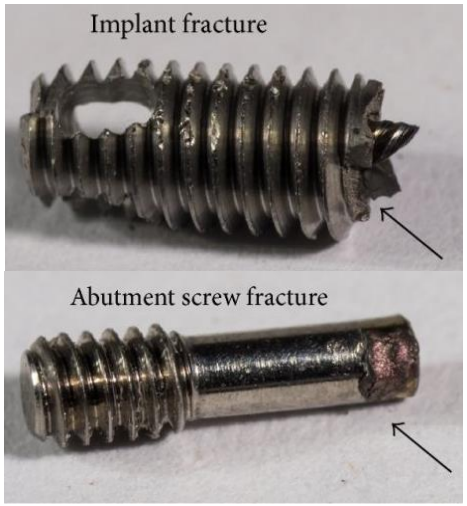
人工牙根簡介-臨床失敗案例

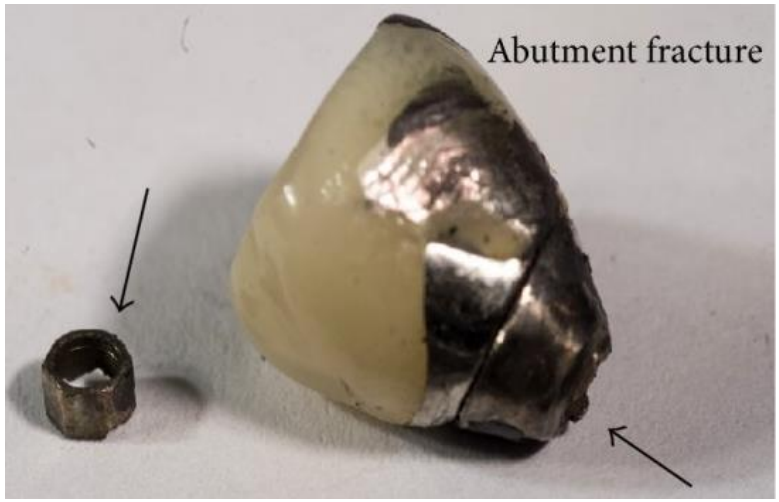
Ahmad Rohanian, 2015、Susanne S Scherrer, 2018、Keren Shemtov Yona, 2015.











人工牙根:台灣TFDA與美國FDA測試標準

骨內植體臨床前測試基準

Guidance for Pre-clinical Testing of Endosseous Implant

101.01.05 公告
106.12.13 修正

【說明】

1. **本檢測基準係提供醫療器材廠商辦理產品查驗登記時，臨床前測試應檢附資料及進行項目之建議，未包含臨床試驗等其他資料之要求，醫療器材查驗登記申請案仍應符合相關法規。廠商亦應依個案產品結構、材質及宣稱效能提出完整驗證評估（含臨床前測試及/或臨床試驗等）之資料。**

	(4)急性毒性試驗(Acute systemic toxicity)。 (5)亞急性及亞慢性毒性試驗(Subacute and subchronic toxicity)。 (6)基因毒性試驗(Genotoxicity)。 (7)植入試驗(Implantation)。 新材質者應另檢附以下測試： (1)慢性毒性試驗(Chronic toxicity)。 (2)致癌性試驗(Carcinogenicity)。	
2.滅菌確效 (Sterilization Validation)	如產品為無菌包裝供應，應進行滅菌確效(Sterilization validation)確保 SAL(Sterility assurance level)小於 10^{-6}。	依產品滅菌方式選擇適合參照之標準： ISO17665-1:2006[9] ISO11135:2014[10] ISO11137-1:2006/Amd 1:2013[11] ISO11137-2:2013[12] ISO11137-3:2017[13]
3.功能性試驗 (Performance test)	(1)全主組件組合系統中確認狀態最弱產品的評估報告。 (2)使用狀態最弱的全主組件組合系統之產品進行： a.力學試驗(Mechanical test)。 • 疲勞試驗(Fatigue test)。 • 壓力試驗(Compressive forces)。 • 剪力試驗(Shear (lateral) forces)。 b.植體與基柱之相容性(Compatibility)。 c.腐蝕試驗(Corrosion test)。 d.如有改質之產品，應進行靜力強度(Static strength)及剪力結合強度(Shear bonding strength)。	FDA Guidance(2004)[8] ISO 14801:2016[14]

Device	Abutment, Implant, Dental, Endosseous
Definition	To be used in conjunction with an endosseous dental implant fixture to aid in prosthetic rehabilitation.
Regulation Medical Specialty	Dental
Review Panel	Dental
Product Code	NHA
Premarket Review	Ophthalmic, Anesthesia, Respiratory, ENT and Dental Devices (OHT1) Division of Dental and ENT Devices (DHT1B)
Submission Type	510(k)
Regulation Number	872.3630
Device Class	2
Total Product Life Cycle (TPLC)	TPLC Product Code Report
GMP Exempt?	No
Summary Malfunction Reporting	Eligible
Implanted Device?	Yes
Life-Sustain/Support Device?	No
Recognized Consensus Standards	• 2-170 ISO 10993-14 First edition 2001-11-15 Biological evaluation of medical devices - Part 14: Identification and quantification of degradation products from ceramics • 4-259 ISO 14801 Third edition 2016-11-01 Dentistry - Implants - Dynamic loading test for endosseous dental implants • 4-270 ADA Technical Report No. 146-2018 CAD/CAM Abutments in Dentistry • 8-226 ASTM F603-12 (Reapproved 2020) Standard Specification for High-Purity Dense Aluminum Oxide for Medical Application
Third Party Review	Not Third Party Eligible

人工牙根:台灣TFDA與美國FDA測試標準

骨內植體臨床前測試基準

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項目	規格、需求及/或應進行測試	參考方法
1.生物相容性試驗(Biocompatibility test)	材質如為常見植入醫療器材所使用之金屬材質，則可檢附符合國際標準規範之金屬材質證明代替；如為其他材質則應進行下列生物相容性評估： (1)細胞毒性試驗(Cytotoxicity)。 (2)過敏試驗(Sensitization)。 (3)刺激或皮內刺激試驗(Irritaion / Intracutaneous reactivity)。	ISO 10993-1: 2009/Cor 1:2010[1] ISO 7405:2008/Amd 1:2013[2] ISO 10993-3:2014[3] ISO 10993-5:2009[4] ISO 10993-6:2016[5] ISO 10993-10:2010[6] ISO 10993-11:2017[7] FDA Guidance(2004)[8]
	(4)急性毒性試驗(Acute systemic toxicity)。 (5)亞急性及亞慢性毒性試驗(Subacute and subchronic toxicity)。 (6)基因毒性試驗(Genotoxicity)。 (7)植入試驗(Implantation)。 新材質者應另檢附以下測試： (1)慢性毒性試驗(Chronic toxicity)。 (2)致癌性試驗(Carcinogenicity)。	

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Submission Type	510(k)
Regulation Number	872.3630
Device Class	2
Total Product Life Cycle (TPLC)	TPLC Product Code Report
GMP Exempt?	No
Summary Malfunction Reporting	Eligible
Implanted Device?	Yes
Life-Sustain/Support Device?	No
Recognized Consensus Standards	• 2-170 ISO 10993-14 First edition 2001-11-15 Biological evaluation of medical devices - Part 14: Identification and quantification of degradation products from ceramics • 4-259 ISO 14801 Third edition 2016-11-01 Dentistry - Implants - Dynamic loading test for endosseous dental implants • 4-270 ADA Technical Report No. 146-2018 CAD/CAM Abutments in Dentistry • 8-226 ASTM F603-12 (Reapproved 2020) Standard Specification for High-Purity Dense Aluminum Oxide for Medical Application
Third Party Review	Not Third Party Eligible

Moderate/High Risk Medical Devices

★安全 有效★

工業用螺絲

人工牙根

NT0.X→NTX0000

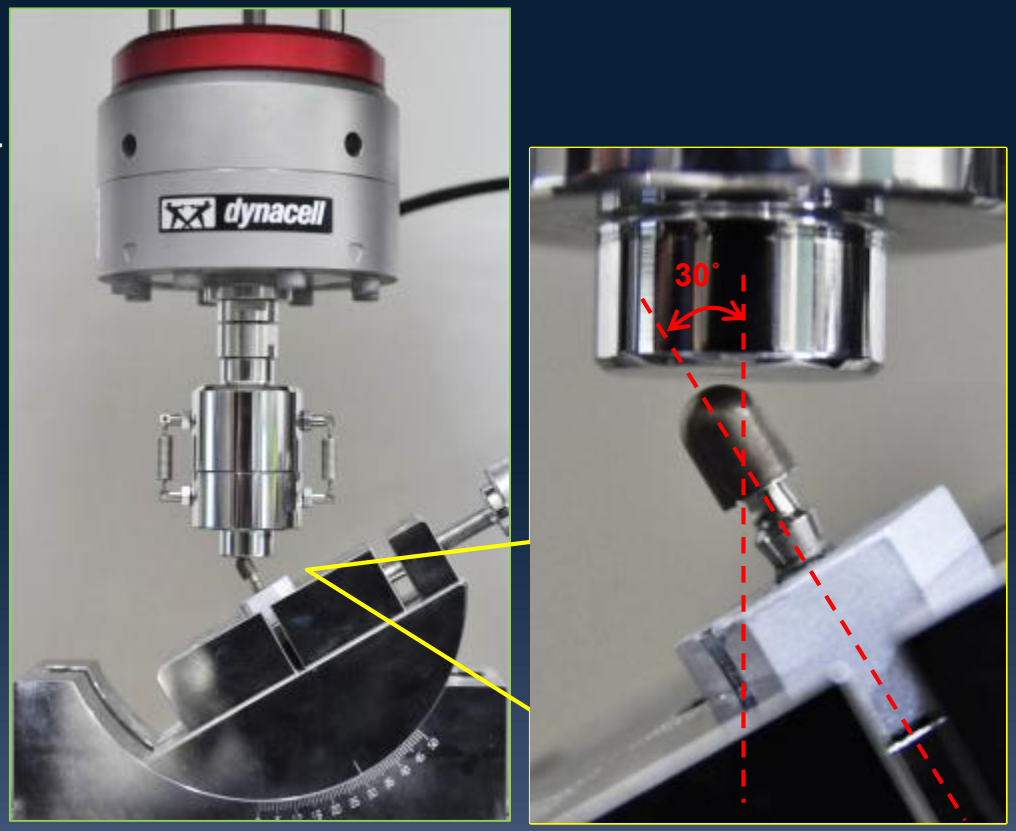
ISO 14801:2016

Dentistry - Implants - Dynamic loading test for endosseous dental implants

This standard was last reviewed and confirmed in 2022. Therefore this version remains current.

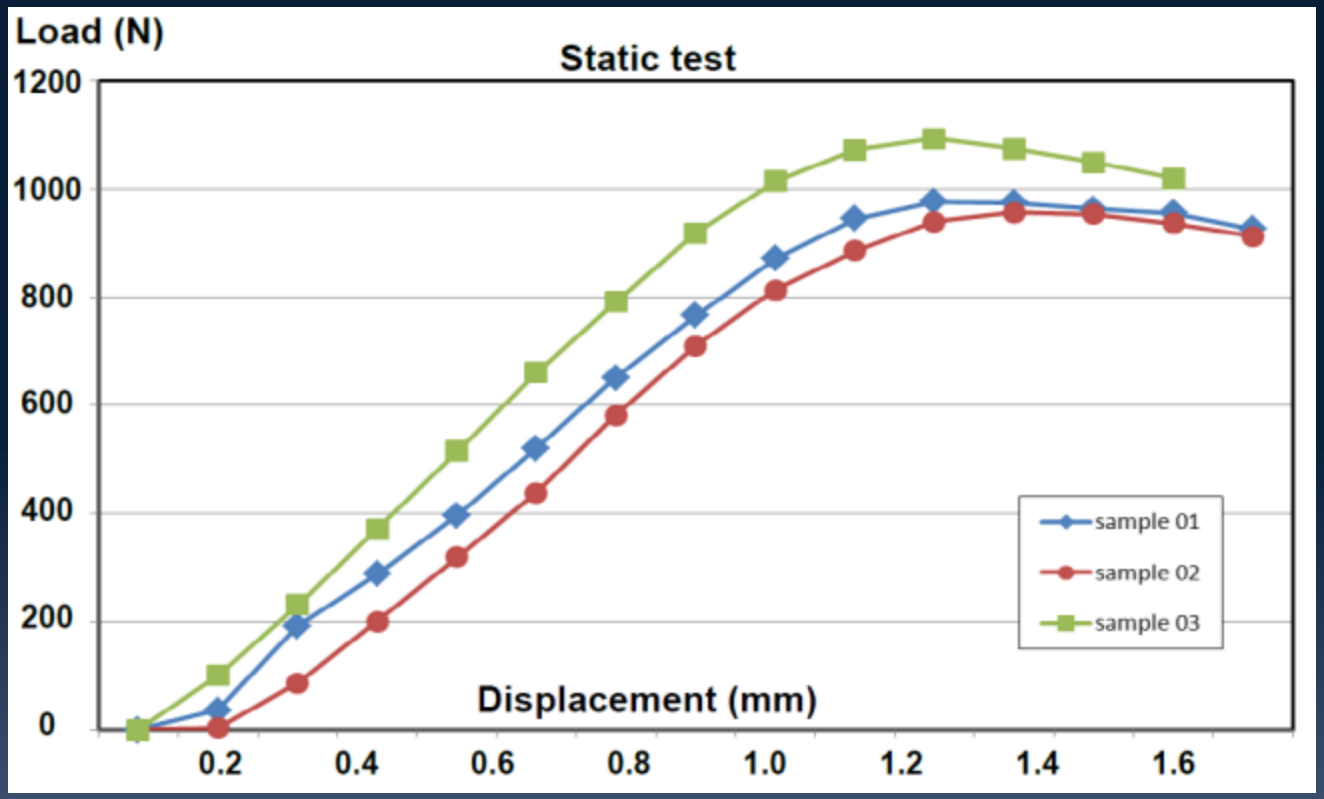
Dental Implant Fatigue Test-ISO14801

- **Purpose：Life limitation**
- **Machine：Fit ISO 7500-1及 ISO 4965 (accuracy)**
- **Setup：**
  - **Incline 30 degree**
  - **Embedding material>3GPa**
- **Static test：**
  - **Load：1 min/mm**
- **Fatigue test：**
  - **80%,70%,60%,50%,40% of Static fracture load**
  - **Sine wave**
  - **Frequency：15 HZ**
  - **Cycles：5,000,000 cycles**



Dental Implant Fatigue Test-ISO14801

- **Static testing**
  - **Failure load (N)**



Load-displacement

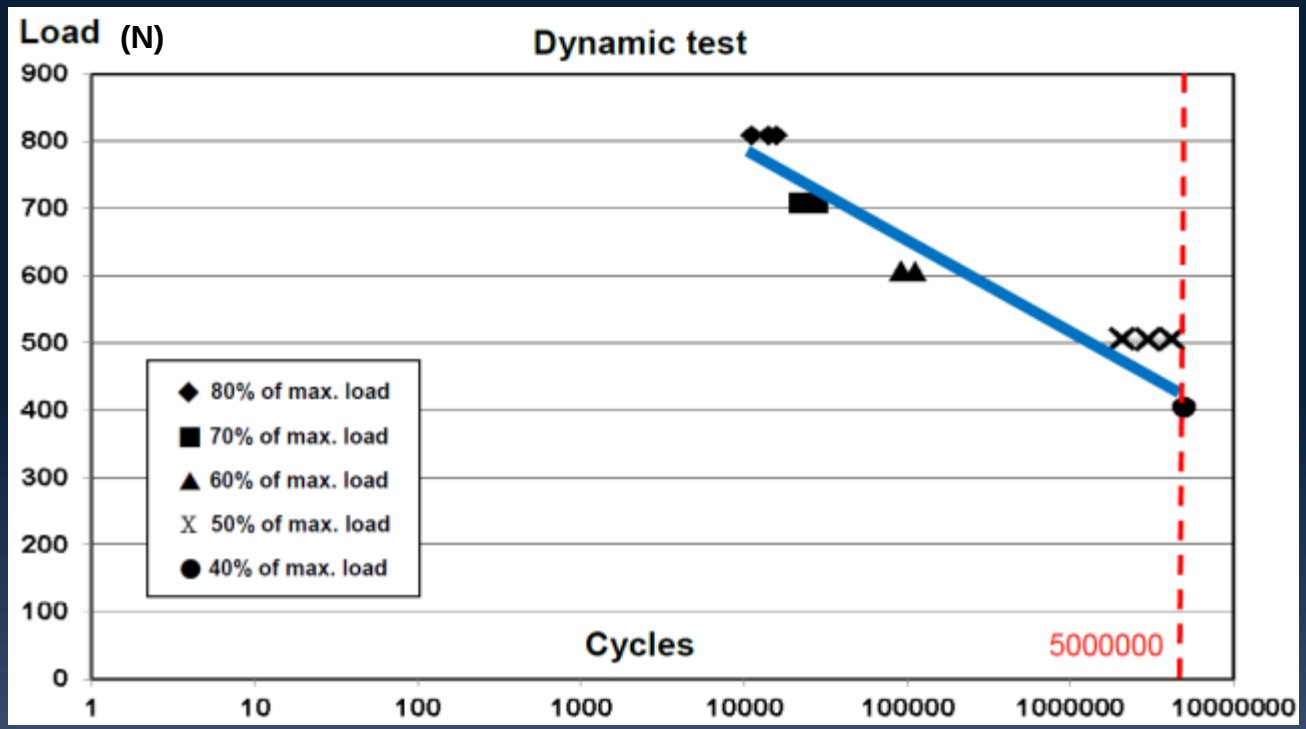
Fracture pattern

Dental Implant Fatigue Test-ISO14801

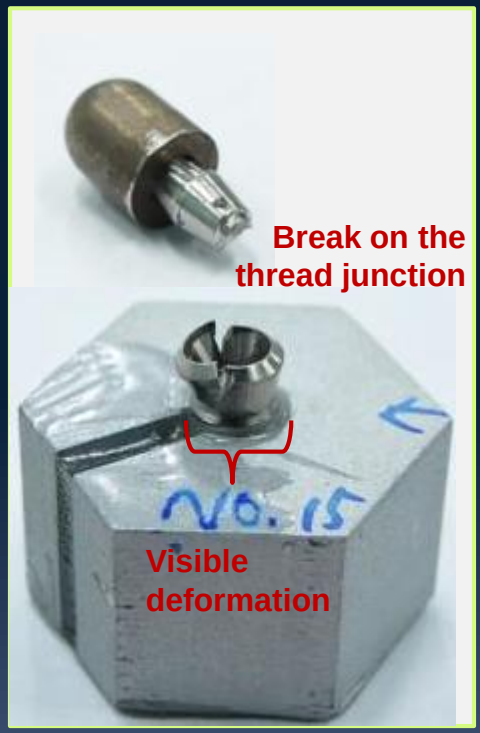
% of maximum load	Load /(Moment)	Number of cycles	Temp. / HMD.
80%	Between 80.9N to 809N/ (Between 445Nmm to 4450Nmm)	14309	21˚C / 71%
		11156	22˚C / 70%
		15765	22˚C / 70%
70%	Between 70.8N to 708N/ (Between 389Nmm to 3894Nmm)	24446	22˚C / 70%
		27809	22˚C / 70%
		22065	22˚C / 70%
60%	Between 60.7N to 607N/ (Between 334Nmm to 3339Nmm)	91839	26˚C / 61%
		112279	26˚C / 59%
		92904	28˚C / 57%
50%	Between 50.6N to 506N/ (Between 278Nmm to 2783Nmm)	2987597	28˚C / 57.5%
		4188494	27˚C / 58%
		2062882	24˚C / 60.5%
40%	Between 40.5N to 405N/ (Between 223Nmm to 2228Nmm)	5000000 (pass)	25˚C / 68%
		5000000 (pass)	21˚C / 58%
		5000000 (pass)	25˚C / 58%

Dental Implant Fatigue Test-ISO14801

- **Fatigue testing**
  - **Life-time figure**



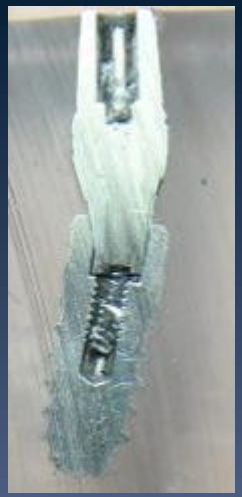
疲勞壽命曲線圖



動態負載後試件

ISO14801—static test (6 cycles)

第一版	第二版	第三版
Abutment 純鈦	Abutment 鈦合金	Abutment 鈦合金
Abutment Screw 純鈦	Abutment Screw 純鈦	Abutment Screw 鈦合金
Fixture 純鈦	Fixture 純鈦	Fixture 純鈦



第四版

1. fixture長度縮短為9mm

第五版

1.植體外徑由3.45mm增加至3.6mm。
2. 粗細螺紋交接處，增加粗螺紋之 內徑(即加工時提早收刀)。

第六版

1.增加abutment腰身厚度20條。
2. 將abutment/fixture接合向下再深入約1mm (即fixture的morse taper壁側單邊往外擴0.15mm，可將abutment向下移)。

以人工植體為例-ISO10993

表 1－ 初步評估試驗考量項目

醫療器材分類依據			生物性影響							
人體接觸性質(詳 5.2)										
類別	接觸部位	接觸時間 (詳 5.3) A－ 極短期 (≦24 小時) B－ 短期 (>24 小時至 30 天) C－ 長期 (>30 天)	細胞毒性	過敏反應	刺激或皮下反應	全身毒性 (急性)	亞慢性毒性 (亞急性毒性)	基因毒性	植入性	血液相容性
接觸體表器材	完好皮膚	A	X	X	X					
		B	X	X	X					
		C	X	X	X					
	黏膜	A	X	X	X					
		B	X	X	X	O	O		O	
		C	X	X	X	O	X	X	O	
	裂開或受傷表面	A	X	X	X	O				
		B	X	X	X	O	O		O	
		C	X	X	X	O	X	X	O	
體外連通器材	間接接觸血液路徑	A	X	X	X	X				X
		B	X	X	X	X	O			X
		C	X	X	O	X	X	X	O	X
	組織/骨/齒質*	A	X	X	X	O				
		B	X	X	X	X	X	X	X	
		C	X	X	X	X	X	X	X	
	循環血液	A	X	X	X	X		O^		X
		B	X	X	X	X	X	X	X	X
		C	X	X	X	X	X	X	X	X
植入性器材	組織/骨	A	X	X	X	O				
		B	X	X	X	X	X	X	X	
		C	X	X	X	X	X	X	X	
	血液	A	X	X	X	X	X		X	X
		B	X	X	X	X	X	X	X	X
		C	X	X	X	X	X	X	X	X

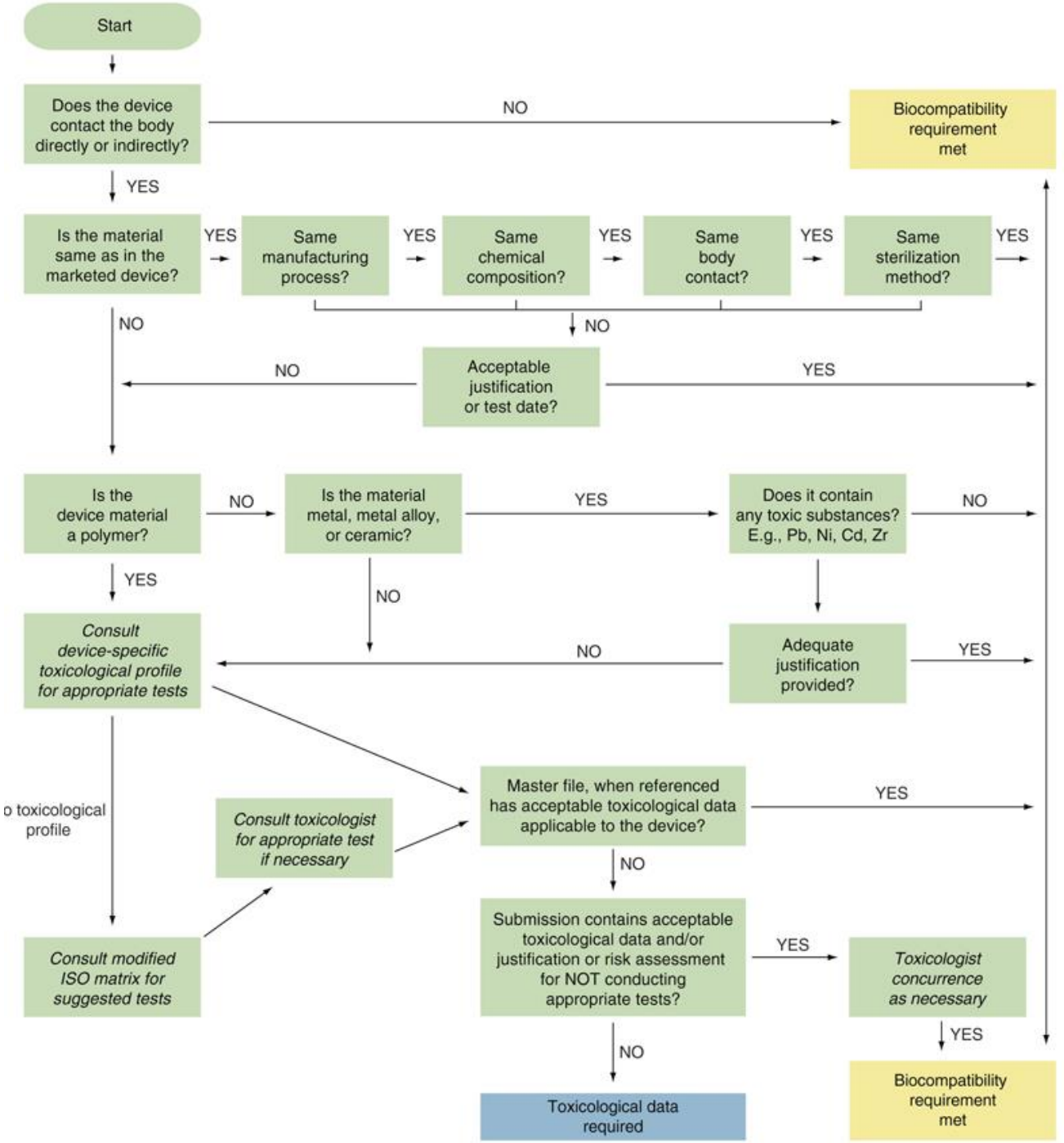
表 2– 補充評估試驗考量項目

醫療器材分類依據			生物性影響			
人體接觸性質(詳 5.2)						
類別	接觸部位	接觸時間 (詳 5.3) A– 極短期 (≦24 小時) B– 短期 (>24 小時至 30 天) C– 長期 (>30 天)	慢性毒性	致癌性	生殖/發育毒性	生物降解性
接觸體表器材	完好皮膚	A				
		B				
		C				
	黏膜	A				
		B				
		C	O			
	裂開或受傷表面	A				
		B				
		C	O			
體外連通器材	間接接觸血液路徑	A				
		B				
		C	O	O		
	組織/骨/齒質*	A				
		B				
		C	O	O		
	循環血液	A				
		B				
		C	O	O		
植入性器材	組織/骨	A				
		B				
		C	O	O		
	血液	A				
		B				
		C	O	O		

(圖片文字)

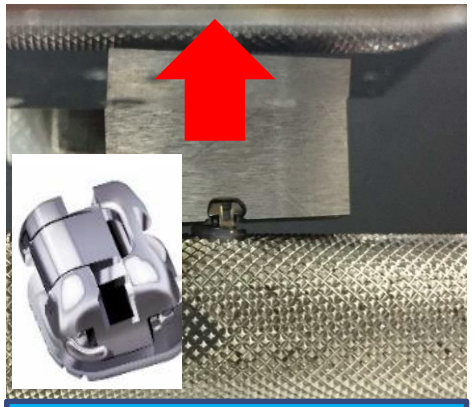
Yes = 是　　No = 否　　or = 或

開始					
器材是否有直接或間接接觸人體？					符合生物相容性要求
採用物質是否同於已上市器材？	製程相同？	化學組成相同？	人體接觸方式相同？	滅菌法相同？	
		具備可接受理由或試驗資料？			
器材物質是否為聚合物？		為金屬、合金或陶瓷物質？		是否含有任何毒性物質(如鉛、鎳、鉻、鎘)？	洽詢毒物學專家，出具物質標準證書是否足夠。
		參照修訂後 ISO 對照表以瞭解建議進行的試驗			
		必要時，洽詢毒物學專家以瞭解適用試驗			
		引述之主檔案是否含有適用器材的可接受生物相容性資料？			
		關於未進行的適用試驗，送審文件含有可接受之生物相容性資料和(或)理由，亦或是風險評估。		必要時，諮詢毒物學專家。	
		要求生物相容性資料		符合生物相容性要求	

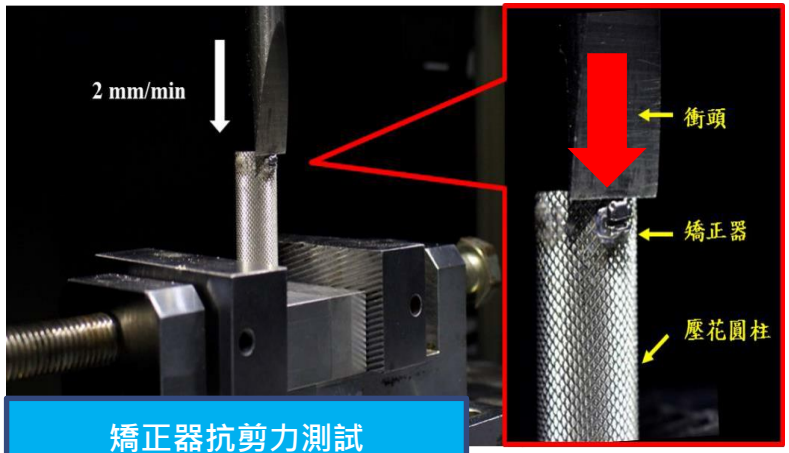

Start
Does the device contact the body directly or indirectly?
NO
Biocompatibility requirement met
YES
Is the material same as in the marketed device?
YES
Same manufacturing process?
YES
Same chemical composition?
YES
Same body contact?
YES
Same sterilization method?
YES
NO
NO
Acceptable justification or test date?
NO
YES
Is the device material a polymer?
NO
Is the material metal, metal alloy, or ceramic?
YES
Does it contain any toxic substances? E.g., Pb, Ni, Cd, Zr
NO
YES
NO
Consult device-specific toxicological profile for appropriate tests
NO
Adequate justification provided?
YES
o toxicological profile
Consult toxicologist for appropriate test if necessary
Master file, when referenced has acceptable toxicological data applicable to the device?
YES
NO
Consult modified ISO matrix for suggested tests
Submission contains acceptable toxicological data and/or justification or risk assessment for NOT conducting appropriate tests?
YES
Toxicologist concurrence as necessary
YES
NO
Biocompatibility requirement met
Toxicological data required

科學化生物力學測試
個製化醫材介紹及法規探討

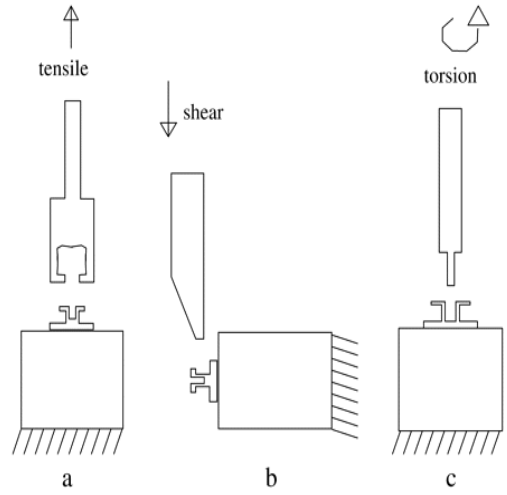
若無法規時要有生物力學測試科學方法

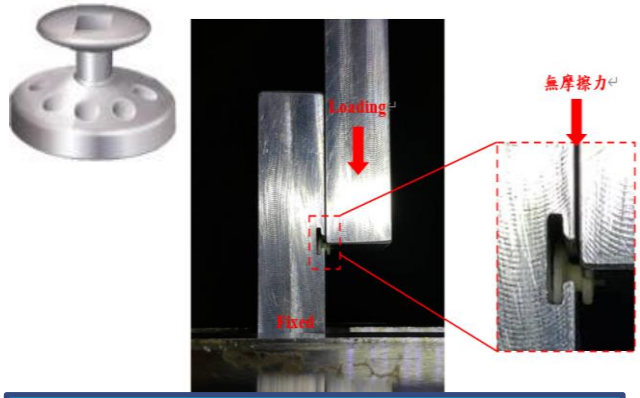


矯正器抗拉伸力測試

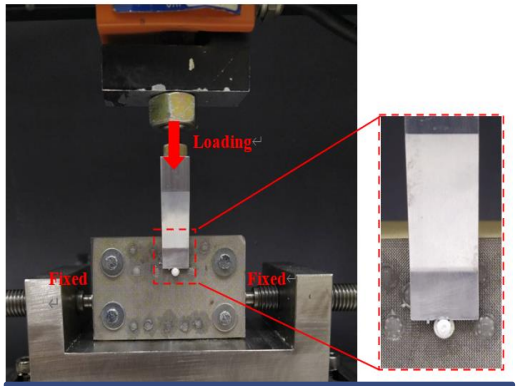


矯正器抗剪力測試

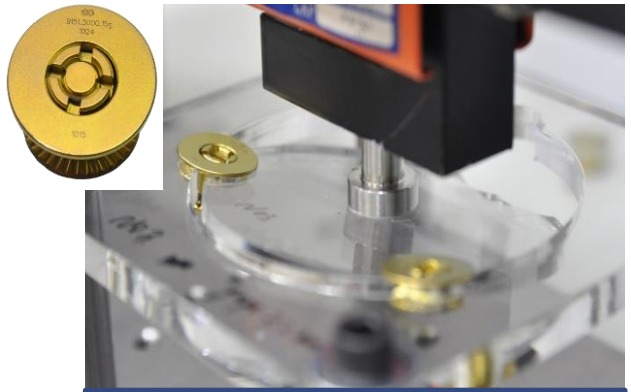




舌側扣剪力測試

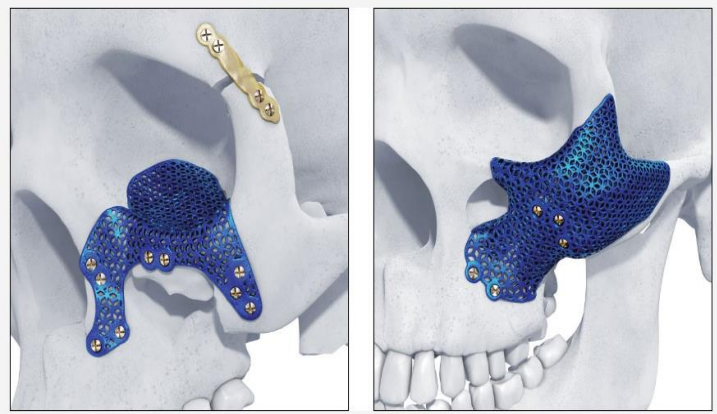


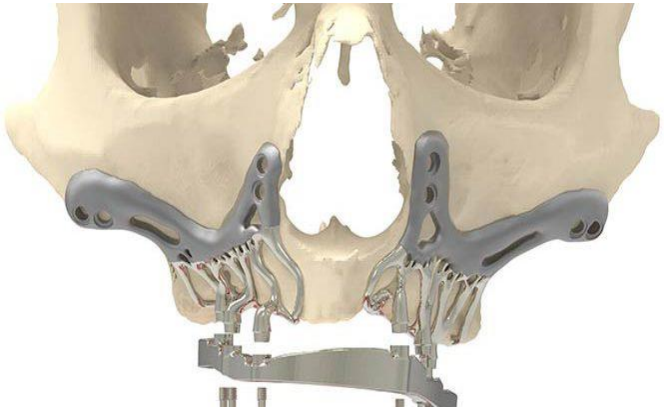
舌側扣抗剝離測試

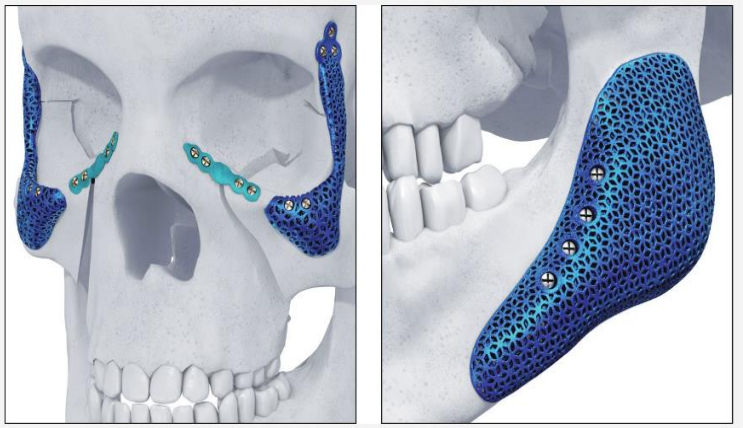


顱骨固定夾力學測試

顱顏客製化醫材介紹及法規探討







DePuy Synthes
THE ORTHOPAEDICS COMPANY OF Johnson & Johnson

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technology & health

Customy
Only Patient-Specific Solutions

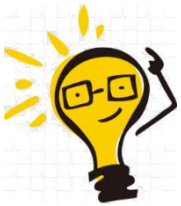
AM HUB

ODT
ORTHOPEDIC DESIGN & TECHNOLOGY

顱顏客製化醫材介紹及法規探討

- 適應症與預期用途(Indication &Intended Use)
  - 下顎骨(不包含髁頭)固定、缺損重建、復原，並於骨缺損之部位提供連續性之填補復位
  - 宣稱**同美國FDA 通過510(k)之特製化骨板**-K173039 (TruMatch CMF Titanium 3D Printed Implant)

TruMatch CMF Titanium 3D Printed Implant



考題

參考FDA通過特製化骨板之案例

Device Classification Name	Plate, Bone
510(K) Number	K173039
Device Name	TruMatch CMF Titanium 3D Printed Implant
Applicant	Materialise NV Technologielaan 15 Leuven, BE 3001
Applicant Contact	Lina Ramirez
Correspondent	Materialise NV Technologielaan 15 Leuven, BE 3001
Correspondent Contact	Lina Ramirez
Regulation Number	872.4760
Classification Product Code	JEY

device class II

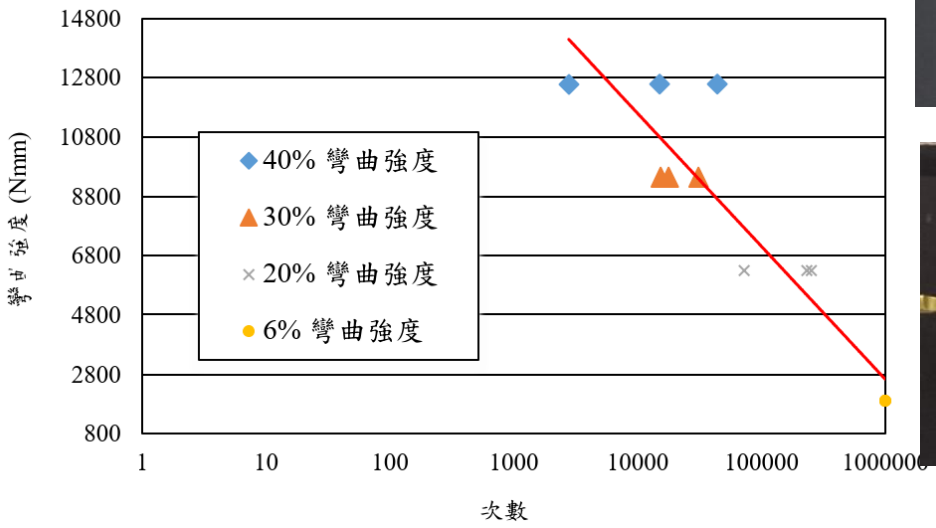
根據FDA規定
定義客製化醫材尺寸範圍值

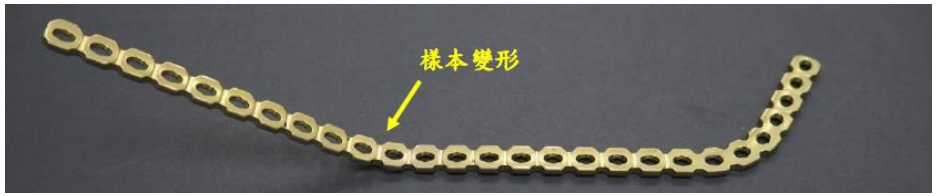
Reconstruction applications: Mandible, midface			
Brand name		TruMatch CMF Ti 3D-Printed Implant	
Material		Commercially pure titanium	
Type of design		Patient Specific	
Range of length		10-294mm	
Curvature		0º-12º/mm length	
Type of application	**Range of shapes**	**Implant thickness**	**Patient Specific associated instrument**
Midface reconstruction	Mesh-shape the patient's • One/mult • One/mult		
Mandibular reconstruction	Mesh-shape the patient's • Single/do • Straight • Curved/c • Subcond • Plated ex • One/mult • Combina		

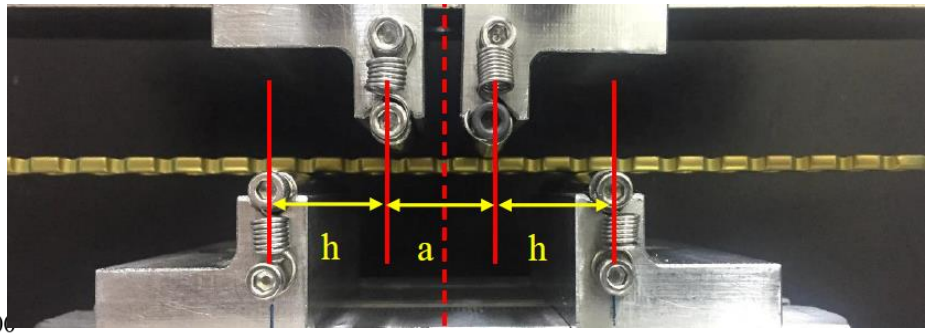
需要用worse case進行測試
但法規並沒有定義要如何尋找Worse case由長度、寬度、截面積、或慣性矩等科學方法進行定義

顱顏個製化醫材介紹及法規探討

靜態力學強度 保證荷重(Proof load) (N)		動態疲勞強度(通過一百萬次疲勞) 彎曲力矩(Bending strength)(N-mm)	
個製化產品	市售產品	個製化產品	市售產品
1798.14	274.04	1888.04	1863.47

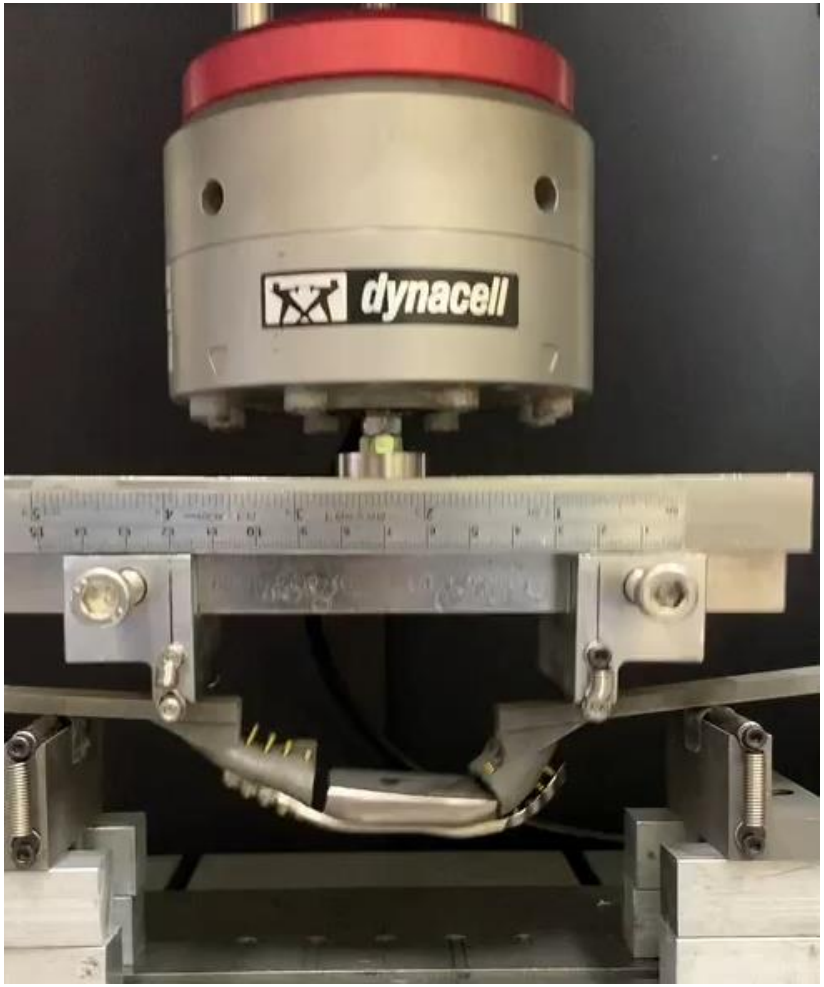






臨床前功能性及生物力學測試

1000000次, 3Hz, S-N curve



ASTM F382 Fatigue test

200N, 200000次, 3Hz

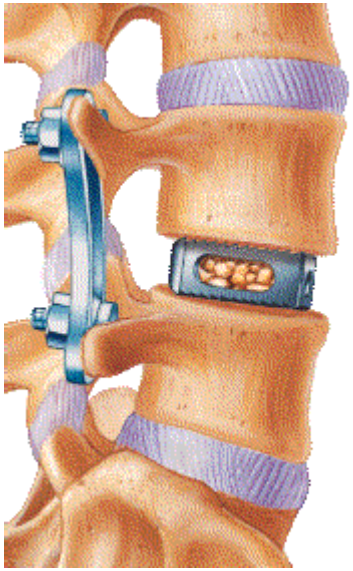
Biomechanical test

眼窩骨板開發影片介紹

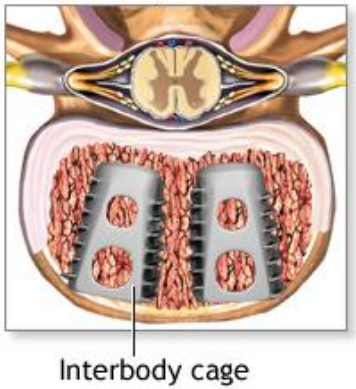
ASTM F2077-18

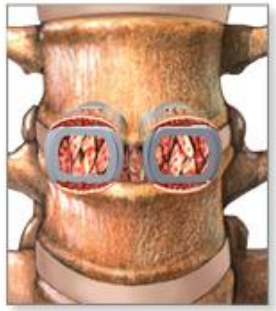
Test methods for intervertebral body fusion devices

ASTM F2077-18壓縮(靜/動態)

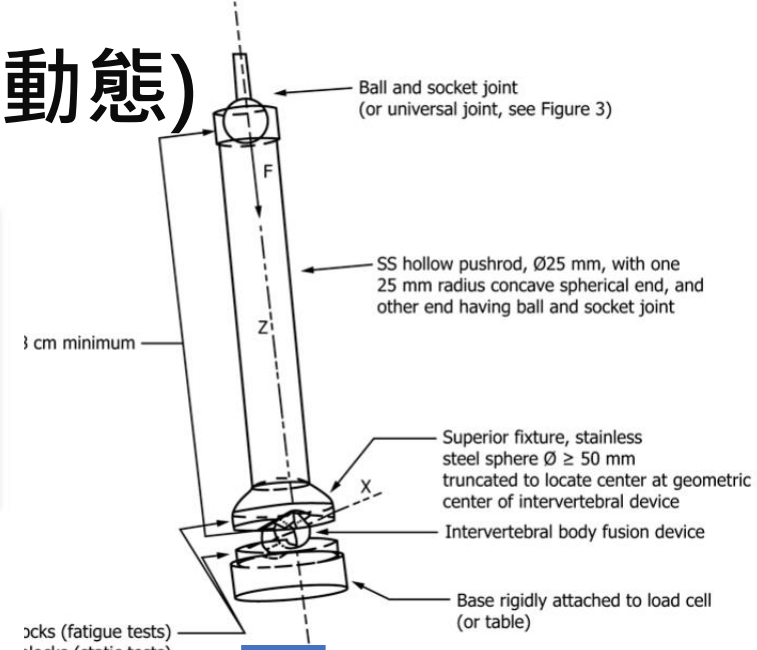


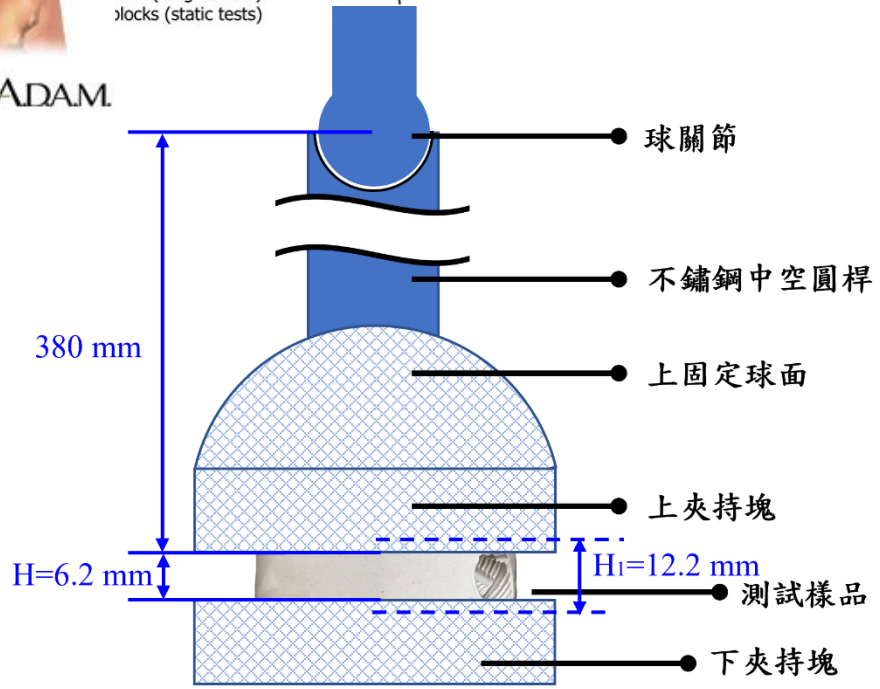
Interbody cage fusion uses a hollow threaded cylinder filled with bone graft to fuse two vertebrae



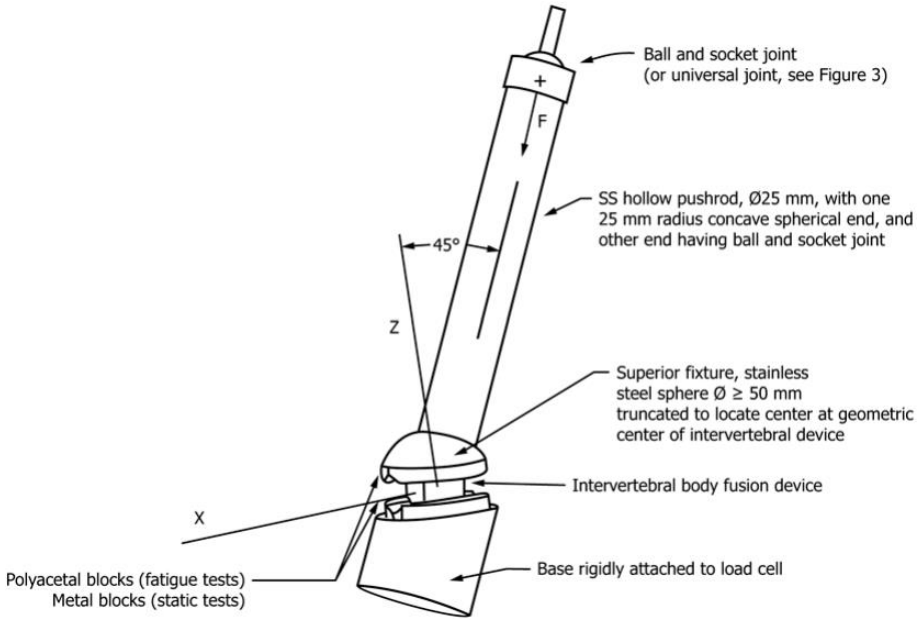


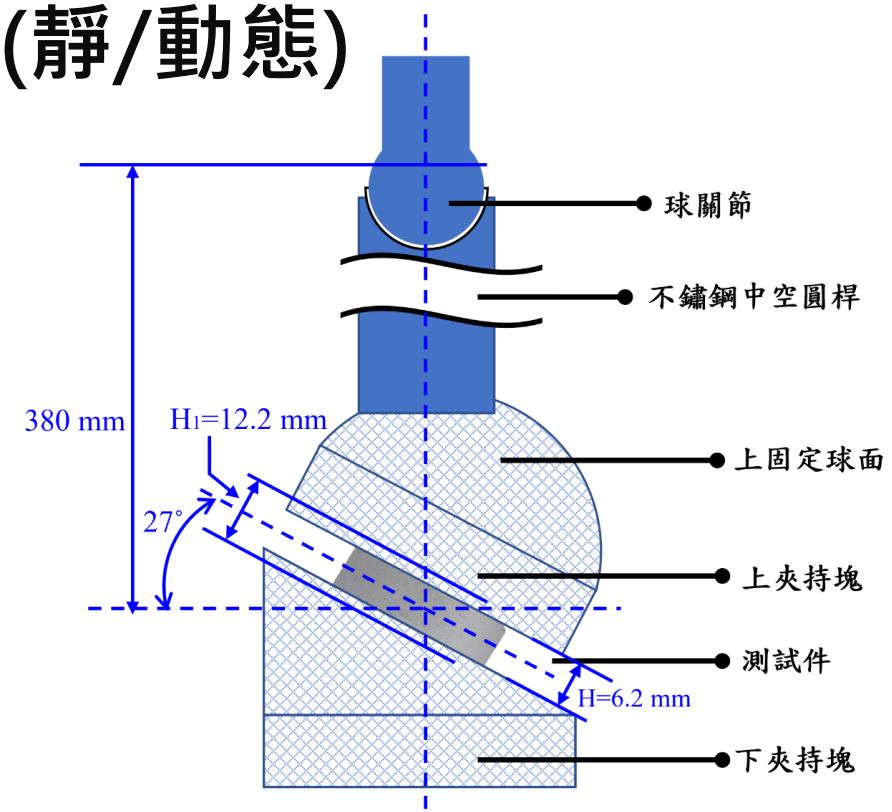
ADAM.



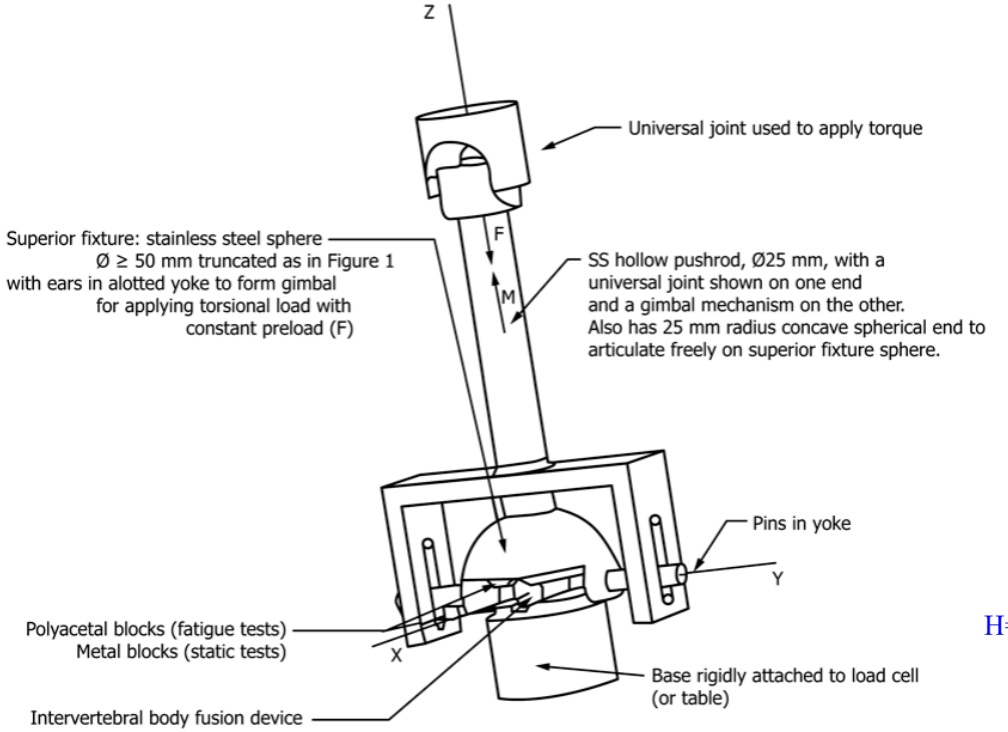


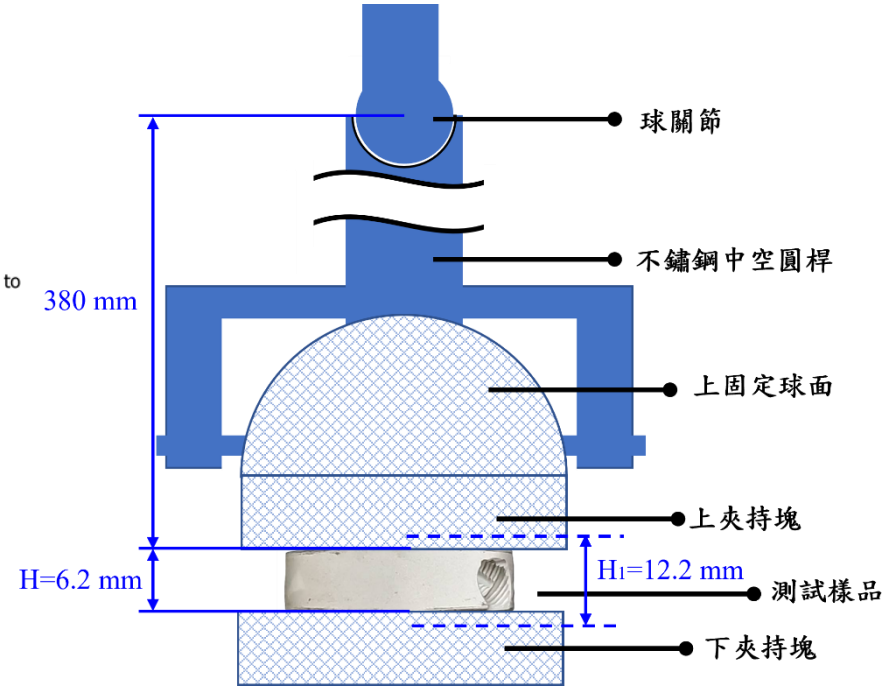
ASTM F2077-18剪力(靜/動態)





ASTM F2077-18扭轉(靜/動態)

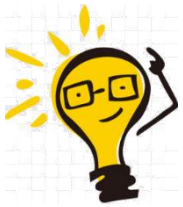




商版模擬測試討論

商版模擬測試討論

- Q1該廠商有一產品(如骨釘、骨板、人工牙根等)，不同規格，需進行測試，但組數龐大



商版模擬測試討論

Table 1. The characteristics of Tandry Locking Plate System

Model type	1.5mm Locking Plate	2.4mm Locking Juxta Distal Radius Plate	3.5mm Locking Calcaneal Plate
Chemical composition	Titanium Grade 4	Titanium Grade 4	Titanium Grade 4
Number of holes analyzed	6	5	3
Diameter of holes	Ø1.7 mm	Ø2.65 mm	Ø4.1 mm
Plate length	29.25 mm	45 mm	61 mm
Distance of two Holes	5 mm	7 mm	18 mm
Plate thickness	1.1 mm	1.8	2.0
Illustration			

商版模擬測試討論

Table 1(cont.). The characteristics of Tandry Locking Plate System

Model type	3.5mm Locking Medial Distal Humeral Plate	3.5mm Locking Distal Fibula Plate	3.5mm Locking Superior Clavicle Plate
Chemical composition	Titanium Grade 4	Ti6Al4V	Ti6Al4V
Number of holes analyzed	4	3	6
Diameter of holes	Ø4.1 mm	Ø4.1 mm	Ø4.1 mm
Plate length	110 mm	86 mm	94 mm
Distance of two Holes	13 mm	13 mm	14 mm
Plate thickness	2.43 mm	2.3 mm	3.5 mm
Illustration			

商版模擬測試討論

Table 1(cont.). The characteristics of Tandry Locking Plate System

Model type	3.5mm Locking Olecranon Plate	5.0mm Locking Medial Proximal Tibial Plate	5.0mm Locking Distal Femur Plate
Chemical composition	Titanium Grade 4	Titanium Grade 4	Ti6Al4V
Number of holes analyzed	5	14	8
Diameter of holes	Ø4.1 mm	Ø5.3 mm	Ø5.3 mm
Plate length	163 mm	322 mm	236 mm
Distance of two Holes	13 mm	18 mm	20 mm
Plate thickness	3.1 mm	3.7 mm	6.25 mm
Illustration			

商版模擬測試討論

- Q2全部進行?
- Q3若全部樣品均進行測試，金錢?時間?人力?
- Q4是否有其他方法可用?並FDA可接受?

商版模擬測試討論

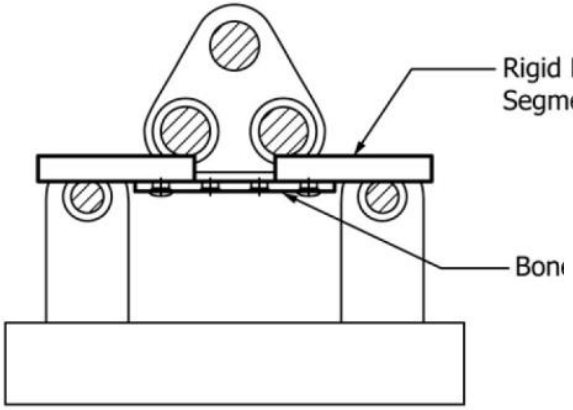
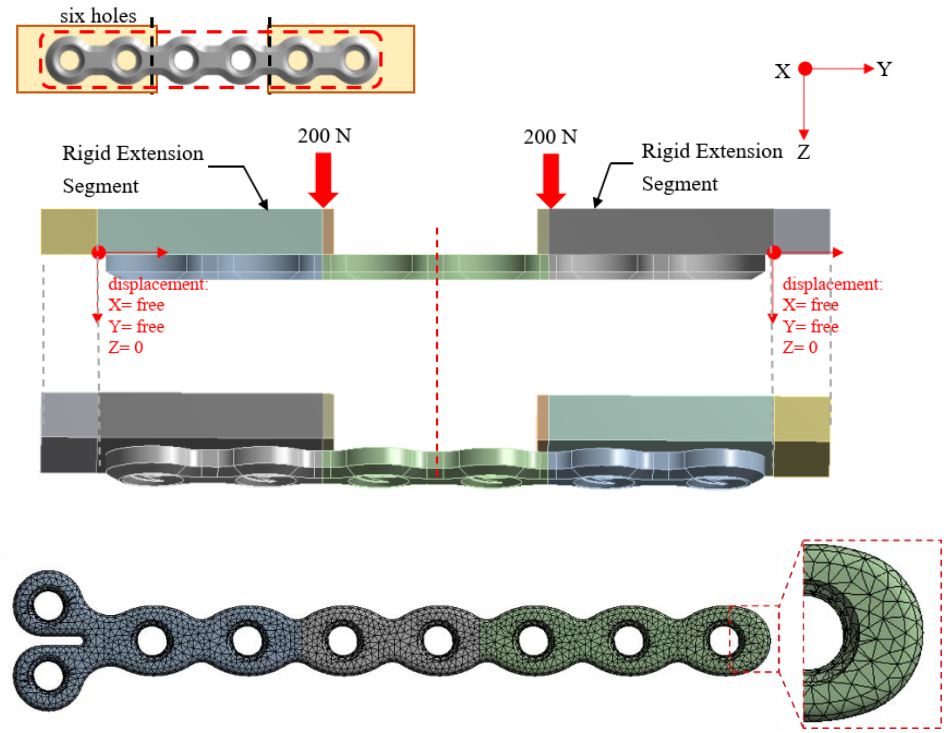
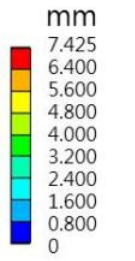


Table. 2 Material properties used in the model

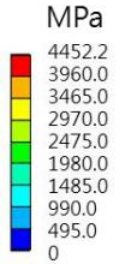
Model	Material	Young's Modulus (MPa)	Poisson Ratio	Ref.
Rigid Extension Segment	Pure Ti (Grade 4)	68200	0.30	[2]
1.5 mm Locking Plate	Ti6Al4V	105000	0.30	[3]
2.4 mm Locking Juxta Distal Radius Plate	Ti6Al4V	105000	0.30	[3]
3.5 mm Locking Calcaneal Plate	Ti6Al4V	105000	0.30	[3]
3.5 mm Locking Medial Distal Humeral Plate	Ti6Al4V	105000	0.30	[3]
3.5 mm Locking Distal Fibula Plate	Ti6Al4V	110000	0.35	[4]
3.5 mm Locking Superior Clavicle Plate	Ti6Al4V	110000	0.35	[4]
3.5 mm Locking Olecranon Plate	Titanium Grade 4	105000	0.30	[3]
5.0 mm Locking Medial Proximal Tibial Plate	Titanium Grade 4	105000	0.30	[3]
5.0 mm Locking Distal Femur Plate	Ti6Al4V	110000	0.35	[4]

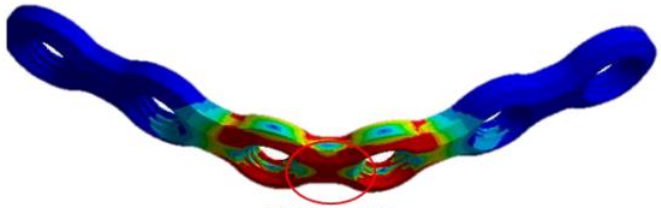
商版模擬測試討論


six holes
X
Y
Z
200 N
200 N
Rigid Extension Segment
Rigid Extension Segment
displacement:
X= free
Y= free
Z= 0
displacement:
X= free
Y= free
Z= 0


mm
7.425
6.400
5.600
4.800
4.000
3.200
2.400
1.600
0.800
0

(a)


MPa
4452.2
3960.0
3465.0
2970.0
2475.0
1980.0
1485.0
990.0
495.0
0


4452.2 MPa

(b)

商版模擬測試討論

Table 3 The result of finite element simulation analyses of 4-point bending for Tandry Locking Plate System

Model	Material	Maximum displacement (mm)	Maximum von Mises stress (MPa)		Yield strength of material (MPa)	Explanation
1.5 mm Locking Plate	Titanium Grade 4	7.425	4452.2	>	485	Maximum von Mises stress over yield strength of pure Ti (Grade 4)
2.4 mm Locking Juxta Distal Radius Plate	Titanium Grade 4	0.196	155.5	<	485	Maximum von Mises stress lower than yield strength of material (safety)
3.5 mm Locking Calcaneal Plate	Titanium Grade 4	27.078	1516.3		485	Maximum von Mises stress over yield strength of pure Ti (Grade 4)
3.5 mm Locking Medial Distal Humeral Plate	Titanium Grade 4	1.676	688.7		485	Maximum von Mises stress over yield strength of pure Ti (Grade 4)
3.5 mm Locking Distal Fibula Plate	Ti6Al4V	0.708	578.8		830	Maximum von Mises stress lower than yield strength of material (safety)
3.5 mm Locking Superior Clavicle Plate	Ti6Al4V	0.196	714.9		830	Maximum von Mises stress lower than yield strength of material (safety)
3.5 mm Locking Olecranon Plate	Titanium Grade 4	0.583	788.7		485	Maximum von Mises stress over yield strength of pure Ti (Grade 4)
5.0 mm Locking Medial Proximal Tibial Plate	Titanium Grade 4	0.196	356.7		485	Maximum von Mises stress lower than yield strength of material (safety)
5.0 mm Locking Distal Femur Plate	Ti6Al4V	0.554	86.5		830	Maximum von Mises stress lower than yield strength of material (safety)

產品開發時程圖

洗心革面

研究發展	產品設計	產品分析	非臨床測試	臨床測試	產品試量產	上市申請
主要單位	陽明大學 生產公司	陽明大學 臨床醫院	生產公司			
法規流程	市場調查 法規分析 專利分析	初步設計 製程分析	雛型試製 參數規劃	功能性安全性測試	實質性比較(臨床測試)	設備規劃 GMP申請	認證申請 查驗登記
法規要求	醫療器材製造規範ISO13485/安全性測試ISO10993/功能性測試ISO14801						
產品資料	產品規劃、設計輸出、零組件表、製程說明	測試報告	實驗報告	包裝、標示、使用說明			

Thanks for your attention

Welcome to NYCU

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國立陽明交通大學

National Yang Ming Chiao Tung University