APPENDIX A

Density and porosity

The densities of sintered samples were measured by the Archimedes method using distilled water as medium. The first, the bulk samples were dried in oven furnace at 110 °C for 4 hours, then measured dried weight as (D). Second, dried samples were boiled in distilled water for 4 hours and then continuous soaked for 12 hours. Third, bring the samples measured the weight of the water displaced as (I) and finally, take the samples of absorbed at the surface of the samples with tissue paper. Then, a measured the soaked weight in air as (S). Densities and apparent porosity were determined from the equation (7) to (10).

$$\text{Apparent density} = \left(\frac{D}{D-I}\right) \times \rho_{H2O}$$

$$\text{Bulk density} = \left(\frac{D}{S-I}\right) \times \rho_{H2O}$$

$$\text{True density} = \frac{(m2-m1)}{(X-Y)} \times \rho_{H2O}$$

$$\text{Apparent porosity} = \left(\frac{S-D}{S-I}\right) \times 100$$

For example:

Sample of Ca/P molar ratio 1.69 at 1300°C for 2 h.: D = 0.64 g, S = 0.71 g, I = 0.43 g and ρ_{H2O} = 0.997879 g/cm^3 at 21.5 °C

$$\text{Apparent density} = \left(\frac{\mathbf{0.64}}{\mathbf{0.64-0.43}}\right) \times 0.997879 \text{ g/cm}^3$$

$$= 3.04 \text{ g/cm}^3$$

$$\text{Bulk density} = \left(\frac{0.64}{0.71-0.43}\right) \times 0.997879 \text{ g/cm}^3$$

$$= 2.28 \text{ g/cm}^3$$

m_1 = weight of bottle and cover after dried (19.6992 g)

m_2 = weight of bottle, cover and solid powder (20.2543 g)

m_3 = weight of bottle, cover, distilled water and solid powder (30.1579 g)

m_4 = weight of bottle, cover and distilled water (29.7789 g)

x = weight of distilled water required to fill the bottle

= (m_4 - m_1)

y = weight of distilled water required to fill the bottle above the solid powder

= (m_3 - m_2)

(x - y) = the weight of distilled water occupying the same volume as the solid powder

$$\text{True density} = \frac{(20.2543 - 19.6992)}{((29.7789 - 19.6992) - (30.1579 - 20.2543))} \times 0.997879 \text{ g/cm}^3$$

$$= 3.145 \text{ g/cm}^3$$

$$\text{Apparent porosity} = \left(\frac{0.71 - 0.64}{0.71 - 0.43}\right) \times 100$$

$$= 25\ \%$$

APPENDIX B

Hardness

Microhardness measurements were using a Vickers hardness tester and pyramidal diamond indenter used 50 g load for 15 second. Measurement of the lengths of the diagonals of indents of hardness and measured with an optical microscope. There was selected one sample from each condition (six samples) of which to provide measured hardness. Five indentations were made for each sample and the average value was taken calculated using the equation (11) [75]

For example:

Sample of Ca/P mole ratio 1.69 at 1300°C for 2 h.

F = 490.3 mN = 50 g

$\bar{d}$ = Mean diagonal length of indentation in micrometer (μm) = 48.415 x 10^{-3} mm

$$HV = 0.1891\frac{F}{\bar{d}^2}$$

$$HV = 0.1891x \frac{0.4903}{(48.415\ x\ 10^{-3})^2} \quad N/mm^2$$

$$= \frac{0.0927}{2344x10^{-6}}$$

$$= 39.55 \quad HV$$

APPENDIX C

Flexural bending strength

Bending strength was investigated using a ball-on-ring test [76] using universal testing machine. The span length was 20 mm and the cross head speed was 0.5 mm/min. Six samples were tested and the average was appeared in all tests. The bending strength (σ) of the samples were determined from the equation (12).

$$\sigma = \frac{3F(1+\nu)}{4\pi t^2}\left[\frac{(1-\nu)}{(1+\nu)} \times \frac{2a^2 - b^2}{2R^2} + 2\ln\left(\frac{a}{b}\right) + 1\right]$$

For example: Ca/P = 1.69 at 1300 ˚C for 2 h.

The breaking load; F = 42.97 N

Poisson ratio; ν = 0.28

Radius of the support; a = 6.35 mm

Radius of the samples; R= 5.965 mm

Thickness of the sample; t = 2.37 mm

t/3; b = 0.79 mm

$$\sigma = \frac{3*42.97*1.28}{4\pi*(2.37^2)}\left[\frac{(1-0.28)}{(1+0.28)} * \frac{2*(6.35^2) - 0.79^2}{2*(5.965^2)} + 2\ln\left(\frac{6.35}{0.79}\right) + 1\right]$$

$$\sigma = \frac{165}{70.6124} * \left[(0.5625) * \left(\frac{80.645 - 0.6241}{71.1625}\right) + (4.1683 + 1)\right]$$

$$\sigma = 2.3367 * [(0.5625 * 1.1245) + 5.1683]$$

σ = 13.55 MPa

APPENDIX D

Data JCPDS file

- $Ca_5(PO_4)_3(OH)$: Hydroxyapatite, Syn/Calcium Phosphate hydroxide, Lattice: Hexagonal, Radiation = 1.540598 A°, Quality: Indexed. Reference: de Wolff, P., Technisch Physische Dienst, Delft, The Netherlands. Danasg, volume 0, page 879, 1964.

- $Ca_3(PO_4)_2$: Whitlockite, syn/Calcium Phosphate, Lattice: Rhombohedral, Radiation = 1.540598 A°, Quality: Indexed. Reference: de Wolff, P., Technisch Physische Dienst, Delft, The Netherlands. Danasg, volume 0, page 684, 1951.

- CaO: Lime, syn/Calcium Oxide, calcia burnt lime, quicklime, Lattice: Face-centered cubic, Radiation = 1.540598 A°, Quality: High. Reference: McMurdie, H., Morris, M., Evans. E., Paretzkin, B., Wong-Ng, W. and Hubbard, C, Podie2, volume 1, page 266, 1986.

$Ca_5(PO_4)_3(OH)$

JCPDS no. 9-432	
2θ	Intensity
10.813	12
16.848	6
18.79	4
21.811	10
22.909	10
25.356	2
25.886	40
28.124	12
28.969	18
31.783	100

$Ca_3(PO_4)_2$

JCPDS no. 9-169	
2θ	Intensity
10.856	12
13.63	16
14.238	6
17.001	20
18.462	2
20.211	8
21.394	4
21.877	16
22.206	4
25.797	25

CaO

JCPDS no.37-1497	
2θ	Intensity
32.209	36
37.358	100
53.854	54
64.158	16
67.365	16
79.664	6
88.517	6
91.473	16
103.331	12
112.645	6

32.187	60
32.905	60
34.053	25
35.475	6
39.206	8
39.824	20
40.444	2
42.033	10
42.31	4
43.816	8
44.374	2
45.306	6
46.711	30
48.099	16
48.619	6
49.472	40
50.494	20
51.282	12
52.096	16
53.154	20
54.434	4
55.869	10
57.141	8
58.076	4
59.933	6
60.456	6
61.657	10
63.017	12
63.447	4
64.081	13

26.196	4
26.505	10
27.414	8
27.769	55
28.68	2
29.66	16
31.022	100
32.456	20
33.017	10
33.49	8
34.368	65
35.001	6
35.113	8
35.588	12
35.905	6
37.336	10
37.859	6
39.801	10
40.054	4
40.214	2
41.087	14
41.686	12
42.981	4
43.56	8
43.746	4
43.885	6
44.537	10
44.769	6
44.909	4
45.306	8

129.887	6
142.619	10
147.811	16

65.024	9
66.384	4
69.712	3
71.641	5
72.28	4
73.997	7
75.026	3
75.598	9
76.144	1
77.188	11
78.24	9

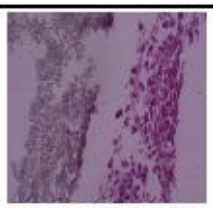
46.031	2
46.64	4
46.969	20
47.958	16
48.406	14
49.78	12
50.304	6
50.733	6
51.258	6
51.473	8
52.624	4
52.937	25
53.515	8
54.41	8
55.114	4
56.137	6
56.602	6
57.436	6
57.559	4
59.51	12
60.381	4

APPENDIX E

SURGICAL PATHOLOGY REPORT

SURGICAL PATHOLOGY REPORT

Operation Date: 3R-003 Age: 0 HN: 0 ANI3414605
Hospital: ภาควิชาฟิสิกส์และวัสดุศาสตร์ Doctor: Hospital Lab No: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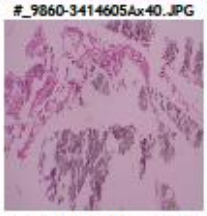
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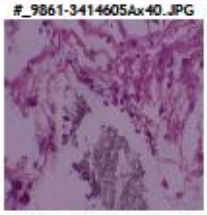
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MICROSCOPIC DESCRIPTION:

The sections present fragments of ceramic body with walling off fibroadipose tissue showing mild foreign body reaction and some changes as followed

1. foreign body reaction = 1+

2. cellular infiltration into the ceramic body = absent

3. dystrophic calcification in the ceramic body = absent

4. displacement of ceramic components in to surrounding host tissue = present

NOTE: Foreign by reaction grading

grade I (1+)= mild mixed cellular inflammatory infiltration and presence of fibroblasts

grade II (2+) = presence of minimal epithelioid cells with or without small size of monocytoid foreign body giant cells

grade III (3+) = presence of some epithelioid or large size multinucleated foreign body giant cells.

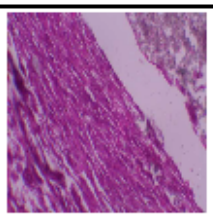
38999 Other

Received: 17-10-2014 **Reported:** 18-10-2014 10:35:45
Pathologist: Dr. Kamthorn Thamprasert **Consultant:**
Online-Approved by Kamthorn Thamprasert MD FRCPath

คลินิกพยาธิวิทยาเชียงใหม่ เวชกรรมเฉพาะทาง 3/37 ถ.สายลำพูน ต.พระสิงห์ อ.เมือง จ.เชียงใหม่ 50200 Tel.053-814476 Fax.053-904368 095-6899339

SURGICAL PATHOLOGY REPORT

Operation Date: 3R-007 Age: 0 HN: 0 ANI3414606
Hospital: ภาควิชาฟิสิกส์และวัสดุทางการแพทย์ Doctor: Hospital Lab No: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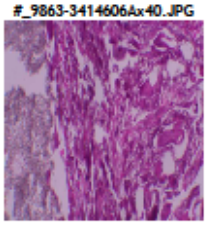
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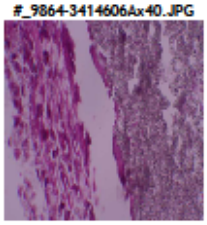
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MICROSCOPIC DESCRIPTION:

The sections present fragments of ceramic body with walling off fibroadipose tissue showing moderate foreign body reaction and some changes as followed

1. foreign body reaction = 2+

2. cellular infiltration into the ceramic body = absent

3. dystrophic calcification in the ceramic body = absent

4. displacement of ceramic components in to surrounding host tissue = present

NOTE: Foreign boby reaction grading

grade I (1+)= mild mixed cellular inflammatory infiltration and presence of fibroblasts

grade II (2+) = presence of minimal epithelioid cells with or without small size of monocytoid foreign body giant cells

grade III (3+) = presence of some epithelioid or large size multinucleated foreign body giant cells.

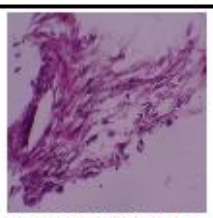
38999 Other

Received: 17-10-2014 **Reported:** 25-10-2014 13:47:04
Pathologist: Dr. Kamthorn Thamprasert **Consultant:**
Online-Approved by Kamthorn Thamprasert MD FRCPath

คลินิกพยาธิวิทยาเชียงใหม่ เวชกรรมเฉพาะทาง 3/37 ถ.สามล้าน ต.พระสิงห์ อ.เมือง จ.เชียงใหม่ 50200 Tel.053-814476 Fax.053-904368 095-6899339

SURGICAL PATHOLOGY REPORT

Operation Date: 3R-014 Age: 0 HN: 0 ANI3414607
Hospital: ภาควิชาฟิสิกส์และวัสดุศาสตร์ Doctor: Hospital Lab No:



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MICROSCOPIC DESCRIPTION:

The sections present fragments of ceramic body with walling off fibroadipose tissue showing moderate foreign body reaction and some changes as followed

1. foreign body reaction = 2+

2. cellular infiltration into the ceramic body = absent

3. dystrophic calcification in the ceramic body = absent

4. displacement of ceramic components in to surrounding host tissue = absent

NOTE: Foreign boby reaction grading

grade I (1+)= mild mixed cellular inflammatory infiltration and presence of fibroblasts

grade II (2+) = presence of minimal epithelioid cells with or without small size of monocytoid foreign body giant cells

grade III (3+) = presence of some epithelioid or large size multinucleated foreign body giant cells.

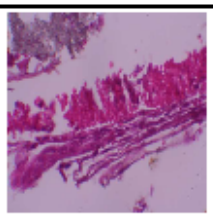
38999 Other

Received: 17-10-2014 **Reported:** 25-10-2014 13:47:09
Pathologist: Dr. Kamthorn Thamprasert **Consultant:**
Online-Approved by Kamthorn Thamprasert MD FRCPath

คลินิกพยาธิวิทยาเชียงใหม่ เวชกรรมเฉพาะทาง 3/37 ถ.สามล้าน ต.พระสิงห์ อ.เมือง จ.เชียงใหม่ 50200 Tel.053-814476 Fax.053-904368 095-6899339

SURGICAL PATHOLOGY REPORT

Operation Date: 3R-021 Age: 0 HN: 0 ANI3414608
Hospital: ภาควิชาฟิสิกส์และวัสดุศาสตร์ Doctor: Hospital Lab No:



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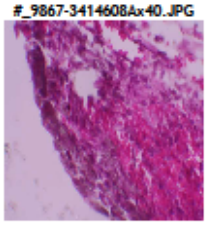

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MICROSCOPIC DESCRIPTION:

The sections present fragments of ceramic body with walling off fibroadipose tissue showing mild/moderate/severe foreign body reaction and some changes as followed

1. foreign body reaction = 2+

2. cellular infiltration into the ceramic body = absent

3. dystrophic calcification in the ceramic body = absent

4. displacement of ceramic components in to surrounding host tissue = present

NOTE: Foreign boby reaction grading

grade I (1+)= mild mixed cellular inflammatory infiltration and presence of fibroblasts

grade II (2+) = presence of minimal epithelioid cells with or without small size of monocytoid foreign body giant cells

grade III (3+) = presence of some epithelioid or large size multinucleated foreign body giant cells.

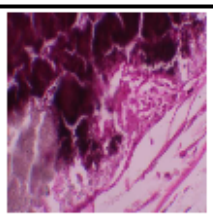
38999 Other

Received: 17-10-2014 **Reported:** 25-10-2014 13:47:13
Pathologist: Dr. Kamthorn Thamprasert **Consultant:**
Online-Approved by Kamthorn Thamprasert MD FRCPath

คลินิกพยาธิวิทยาเชียงใหม่ เวชกรรมเฉพาะทาง 3/37 ถ.สามล้าน ต.พระสิงห์ อ.เมือง จ.เชียงใหม่ 50200 Tel.053-814476 Fax.053-904368 095-6899339

SURGICAL PATHOLOGY REPORT

Operation Date: 3R-030 Age: 0 HN: 0 ANI3414609
Hospital: ภาควิชาฟิสิกส์และวัสดุศาสตร์ Doctor: Hospital Lab No: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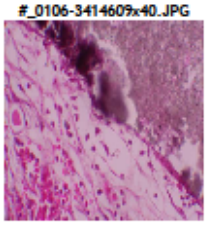
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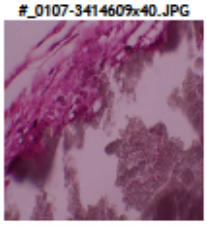
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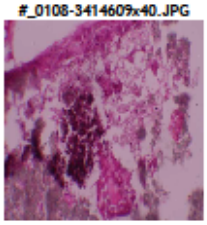
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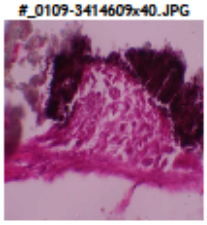
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MICROSCOPIC DESCRIPTION:

The sections present fragments of ceramic body with walling off fibroadipose tissue showing mild/moderate/severe foreign body reaction and some changes as followed

1. foreign body reaction = 1+

2. cellular infiltration into the ceramic body = absent

3. dystrophic calcification in the ceramic body = present

4. displacement of ceramic components in to surrounding host tissue = present

NOTE: Foreign boby reaction grading

grade I (1+)= mild mixed cellular inflammatory infiltration and presence of fibroblasts

grade II (2+) = presence of minimal epithelioid cells with or without small size of monocytoid foreign body giant cells

grade III (3+) = presence of some epithelioid or large size multinucleated foreign body giant cells.

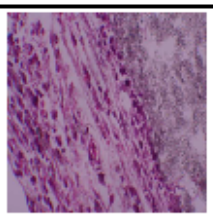
38999 Other

Received: 17-10-2014 **Reported:** 25-10-2014 13:47:19
Pathologist: Dr. Kamthorn Thamprasert **Consultant:**
Online-Approved by Kamthorn Thamprasert MD FRCPath

คลินิกพยาธิวิทยาเชียงใหม่ เขตการแพทย์ 3/37 ถ.สามล้าน ต.พระสิงห์ อ.เมือง จ.เชียงใหม่ 50200 Tel.053-814476 Fax.053-904368 095-6899339

SURGICAL PATHOLOGY REPORT

Operation Date: 3R-045 Age: 0 HN: 0 ANI3414610
Hospital: ภาควิชาฟิสิกส์และวัสดุศาสตร์ Doctor: Hospital Lab No: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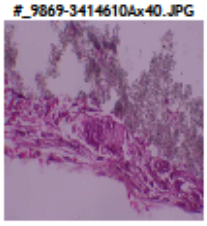
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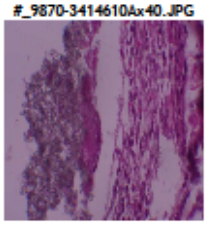
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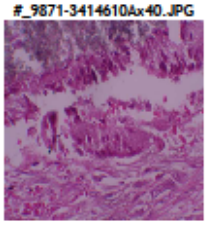
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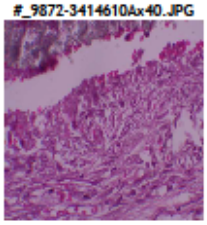
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MICROSCOPIC DESCRIPTION:

The sections present fragments of ceramic body with walling off fibroadipose tissue showing moderate foreign body reaction and some changes as followed

1. foreign body reaction = 2+

2. cellular infiltration into the ceramic body = present

3. dystrophic calcification in the ceramic body = present

4. displacement of ceramic components in to surrounding host tissue = present

NOTE: Foreign boby reaction grading

grade I (1+)= mild mixed cellular inflammatory infiltration and presence of fibroblasts

grade II (2+) = presence of minimal epithelioid cells with or without small size of monocytoid foreign body giant cells

grade III (3+) = presence of some epithelioid or large size multinucleated foreign body giant cells.

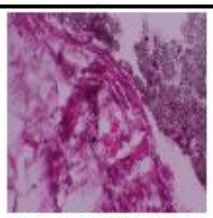
38999 Other

Received: 17-10-2014 **Reported:** 25-10-2014 13:47:23
Pathologist: Dr. Kamthorn Thamprasert **Consultant:**
Online-Approved by Kamthorn Thamprasert MD FRCPath

คลินิกพยาธิวิทยาเชียงใหม่ เวชกรรมเฉพาะทาง 3/37 ถ.สามล้าน ต.พระสิงห์ อ.เมือง จ.เชียงใหม่ 50200 Tel.053-814476 Fax.053-904368 095-6899339

SURGICAL PATHOLOGY REPORT

Operation Date: 3R-090 Age: 0 HN: 0 ANI3414611
Hospital: ภาควิชาฟิสิกส์และวัสดุศาสตร์ Doctor: Hospital Lab No:



#_9875-3414611Ax40..JPG

MICROSCOPIC DESCRIPTION:

The sections present fragments of ceramic body with walling off fibroadipose tissue showing mild/moderate/severe foreign body reaction and some changes as followed

1. foreign body reaction = 1+

2. cellular infiltration into the ceramic body = absent

3. dystrophic calcification in the ceramic body = present

4. displacement of ceramic components in to surrounding host tissue = absent

NOTE: Foreign boby reaction grading

grade I (1+)= mild mixed cellular inflammatory infiltration and presence of fibroblasts

grade II (2+) = presence of minimal epithelioid cells with or without small size of monocytoid foreign body giant cells

grade III (3+) = presence of some epithelioid or large size multinucleated foreign body giant cells.

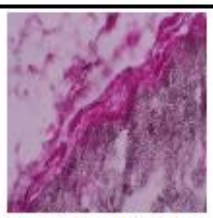
38999 Other

Received: 17-10-2014 **Reported:** 18-10-2014 10:37:36
Pathologist: Dr. Kamthorn Thamprasert **Consultant:**
Online-Approved by Kamthorn Thamprasert MD FRCPath

คลินิกพยาธิวิทยาเชียงใหม่ เวชกรรมเฉพาะทาง 3/37 ถ.สามล้าน ต.พระสิงห์ อ.เมือง จ.เชียงใหม่ 50200 Tel.053-814476 Fax.053-904368 095-6899339

SURGICAL PATHOLOGY REPORT

Operation Date: 3R-180 Age: 0 HN: 0 ANI3414612
Hospital: ภาควิชาฟิสิกส์และวัสดุศาสตร์ Doctor: Hospital Lab No: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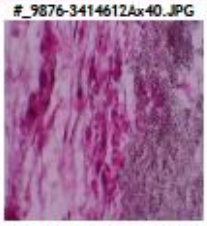
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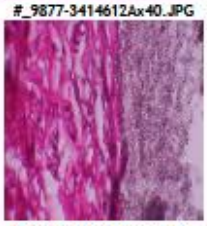
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MICROSCOPIC DESCRIPTION:

The sections present fragments of ceramic body with walling off fibroadipose tissue showing mild foreign body reaction and some changes as followed

1. foreign body reaction = 1+

2. cellular infiltration into the ceramic body = absent

3. dystrophic calcification in the ceramic body = present

4. displacement of ceramic components in to surrounding host tissue = absent

NOTE: Foreign boby reaction grading

grade I (1+)= mild mixed cellular inflammatory infiltration and presence of fibroblasts

grade II (2+) = presence of minimal epithelioid cells with or without small size of monocytoid foreign body giant cells

grade III (3+) = presence of some epithelioid or large size multinucleated foreign body giant cells.

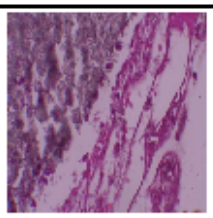
38999 Other

Received: 17-10-2014 **Reported:** 25-10-2014 13:47:29
Pathologist: Dr. Kamthorn Thamprasert **Consultant:**
Online-Approved by Kamthorn Thamprasert MD FRCPath

คลินิกพยาธิวิทยาเชียงใหม่ เวชกรรมเฉพาะทาง 3/37 ถ.สามล้าน ต.พระสิงห์ อ.เมือง จ.เชียงใหม่ 50200 Tel.053-814476 Fax.053-904368 095-6899339

SURGICAL PATHOLOGY REPORT

Operation Date: 5R-003 Age: 0 HN: 0 ANI3415944
Hospital: ภาควิชาฟิสิกส์และวัสดุทางการแพทย์ Doctor: Hospital Lab No:



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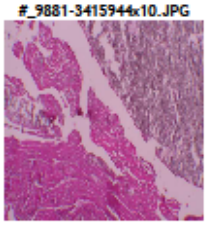

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MICROSCOPIC DESCRIPTION:

The sections present fragments of ceramic body with walling off fibroadipose tissue showing mild/moderate/severe foreign body reaction and some changes as followed

1. foreign body reaction = 1+

2. cellular infiltration into the ceramic body = absent

3. dystrophic calcification in the ceramic body = present

4. displacement of ceramic components in to surrounding host tissue = present

NOTE: Foreign boby reaction grading

grade I (1+)= mild mixed cellular inflammatory infiltration and presence of fibroblasts

grade II (2+) = presence of minimal epithelioid cells with or without small size of monocytoid foreign body giant cells

grade III (3+) = presence of some epithelioid or large size multinucleated foreign body giant cells.

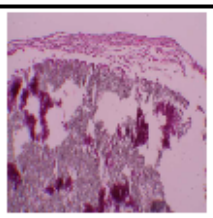
38999 Other

Received: 12-11-2014 **Reported:** 12-11-2014 14:14:19
Pathologist: Dr. Kamthorn Thamprasert **Consultant:**
Online-Approved by Kamthorn Thamprasert MD FRCPath

คลินิกพยาธิวิทยาเชียงใหม่ เวชกรรมเฉพาะทาง 3/37 ถ.สามล้าน ต.พระสิงห์ อ.เมือง จ.เชียงใหม่ 50200 Tel.053-814476 Fax.053-904368 095-6899339

SURGICAL PATHOLOGY REPORT

Operation Date: 5R-007 Age: 0 HN: 0 ANI3415945
Hospital: ภาควิชาฟิสิกส์และวัสดุศาสตร์ Doctor: Hospital Lab No: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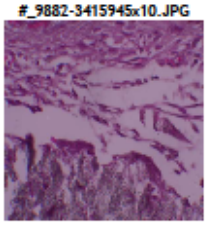
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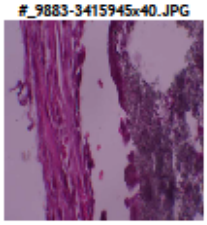
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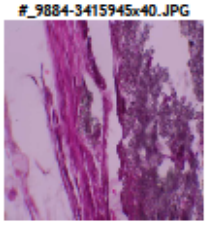
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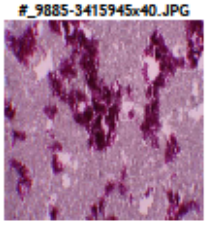
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MICROSCOPIC DESCRIPTION:

The sections present fragments of ceramic body with walling off fibroadipose tissue showing mild/moderate/severe foreign body reaction and some changes as followed

1. foreign body reaction = 1+

2. cellular infiltration into the ceramic body = present

3. dystrophic calcification in the ceramic body = present

4. displacement of ceramic components in to surrounding host tissue = present

NOTE: Foreign boby reaction grading

grade I (1+)= mild mixed cellular inflammatory infiltration and presence of fibroblasts

grade II (2+) = presence of minimal epithelioid cells with or without small size of monocytoid foreign body giant cells

grade III (3+) = presence of some epithelioid or large size multinucleated foreign body giant cells.

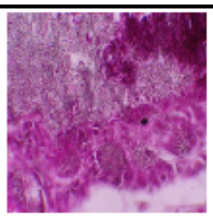
38999 Other

Received: 12-11-2014 **Reported:** 12-11-2014 14:14:42
Pathologist: Dr. Kamthorn Thamprasert **Consultant:**
Online-Approved by Kamthorn Thamprasert MD FRCPath

คลินิกพยาธิวิทยาเชียงใหม่ เขตการแพทย์ 3/37 ถ.สามล้าน ต.พระสิงห์ อ.เมือง จ.เชียงใหม่ 50200 Tel.053-814476 Fax.053-904368 095-6899339

SURGICAL PATHOLOGY REPORT

Operation Date: 5R-014 Age: 0 HN: 0 ANI3415946
Hospital: ภาควิชาฟิสิกส์และวัสดุศาสตร์ Doctor: Hospital Lab No: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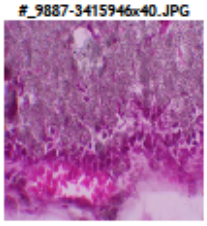
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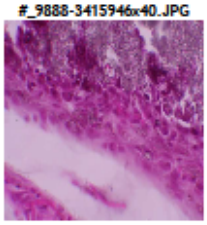
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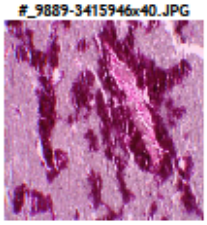
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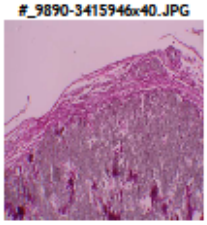
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MICROSCOPIC DESCRIPTION:

The sections present fragments of ceramic body with walling off fibroadipose tissue showing mild/moderate/severe foreign body reaction and some changes as followed

1. foreign body reaction = 2+

2. cellular infiltration into the ceramic body =present

3. dystrophic calcification in the ceramic body = present

4. displacement of ceramic components in to surrounding host tissue = present

NOTE: Foreign boby reaction grading

grade I (1+)= mild mixed cellular inflammatory infiltration and presence of fibroblasts

grade II (2+) = presence of minimal epithelioid cells with or without small size of monocytoid foreign body giant cells

grade III (3+) = presence of some epithelioid or large size multinucleated foreign body giant cells.

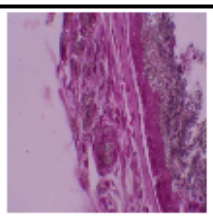
38999 Other

Received: 12-11-2014 **Reported:** 12-11-2014 14:14:51
Pathologist: Dr. Kamthorn Thamprasert **Consultant:**
Online-Approved by Kamthorn Thamprasert MD FRCPath

คลินิกพยาธิวิทยาเชียงใหม่ เขตการแพทย์ 3/37 ถ.สามล้าน ต.พระสิงห์ อ.เมือง จ.เชียงใหม่ 50200 Tel.053-814476 Fax.053-904368 095-6899339

SURGICAL PATHOLOGY REPORT

Operation Date: 5R-021 Age: 0 HN: 0 ANI3415947
Hospital: ภาควิชาฟิสิกส์และวัสดุศาสตร์ Doctor: Hospital Lab No: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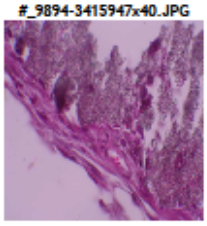
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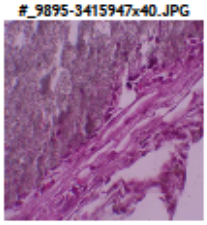
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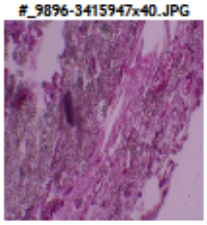
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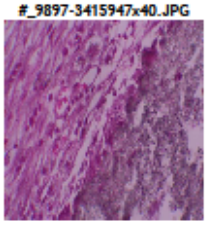
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MICROSCOPIC DESCRIPTION:

The sections present fragments of ceramic body with walling off fibroadipose tissue showing mild/moderate/severe foreign body reaction and some changes as followed

1. foreign body reaction = 2+

2. cellular infiltration into the ceramic body =present

3. dystrophic calcification in the ceramic body = present

4. displacement of ceramic components in to surrounding host tissue = present

NOTE: Foreign boby reaction grading

grade I (1+)= mild mixed cellular inflammatory infiltration and presence of fibroblasts

grade II (2+) = presence of minimal epithelioid cells with or without small size of monocytoid foreign body giant cells

grade III (3+) = presence of some epithelioid or large size multinucleated foreign body giant cells.

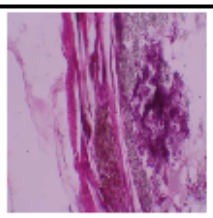
38999 Other

Received: 12-11-2014 **Reported:** 12-11-2014 14:15:09
Pathologist: Dr. Kamthorn Thamprasert **Consultant:**
Online-Approved by Kamthorn Thamprasert MD FRCPath

คลินิกพยาธิวิทยาเชียงใหม่ เขตการแพทย์ 3/37 ถ.สามล้าน ต.พระสิงห์ อ.เมือง จ.เชียงใหม่ 50200 Tel.053-814476 Fax.053-904368 095-6899339

SURGICAL PATHOLOGY REPORT

Operation Date: 5R-030 Age: 0 HN: 0 ANI3415948
Hospital: ภาควิชาฟิสิกส์และวัสดุทางการแพทย์ Doctor: Hospital Lab No: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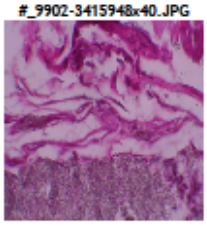
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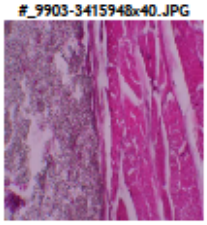
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MICROSCOPIC DESCRIPTION:

The sections present fragments of ceramic body with walling off fibroadipose tissue showing mild/moderate/severe foreign body reaction and some changes as followed

1. foreign body reaction = 2+

2. cellular infiltration into the ceramic body = present

3. dystrophic calcification in the ceramic body = present

4. displacement of ceramic components in to surrounding host tissue = present

NOTE: Foreign boby reaction grading

grade I (1+)= mild mixed cellular inflammatory infiltration and presence of fibroblasts

grade II (2+) = presence of minimal epithelioid cells with or without small size of monocytoid foreign body giant cells

grade III (3+) = presence of some epithelioid or large size multinucleated foreign body giant cells.

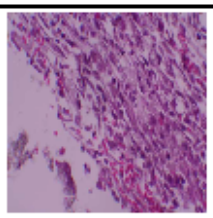
38999 Other

Received: 12-11-2014 **Reported:** 12-11-2014 14:15:17
Pathologist: Dr. Kamthorn Thamprasert **Consultant:**
Online-Approved by Kamthorn Thamprasert MD FRCPath

คลินิกพยาธิวิทยาเชียงใหม่ เวชกรรมเฉพาะทาง 3/37 ถ.สามล้าน ต.พระสิงห์ อ.เมือง จ.เชียงใหม่ 50200 Tel.053-814476 Fax.053-904368 095-6899339

SURGICAL PATHOLOGY REPORT

Operation Date: 5R-045 Age: 0 HN: 0 ANI3415949
Hospital: ภาควิชาฟิสิกส์และวัสดุศาสตร์ Doctor: Hospital Lab No: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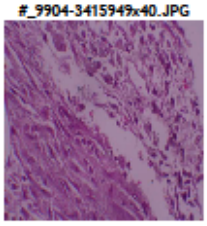
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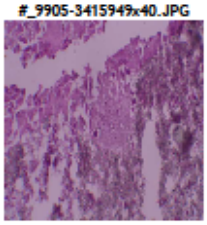
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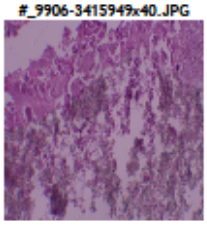
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MICROSCOPIC DESCRIPTION:

The sections present fragments of ceramic body with walling off fibroadipose tissue showing mild/moderate/severe foreign body reaction and some changes as followed

1. foreign body reaction = 3+

2. cellular infiltration into the ceramic body = present

3. dystrophic calcification in the ceramic body = present

4. displacement of ceramic components in to surrounding host tissue = present

NOTE: Foreign boby reaction grading

grade I (1+)= mild mixed cellular inflammatory infiltration and presence of fibroblasts

grade II (2+) = presence of minimal epithelioid cells with or without small size of monocytoid foreign body giant cells

grade III (3+) = presence of some epithelioid or large size multinucleated foreign body giant cells.

38999 Other

Received: 12-11-2014 **Reported:** 12-11-2014 14:15:27
Pathologist: Dr. Kamthorn Thamprasert **Consultant:**
Online-Approved by Kamthorn Thamprasert MD FRCPath

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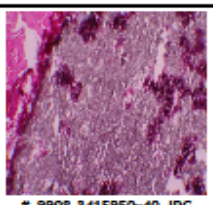
SURGICAL PATHOLOGY REPORT

Operation Date: 5R-090 Age: 0 HN: 0 ANI3415950
Hospital: ภาควิชาฟิสิกส์และวัสดุศาสตร์ Doctor: Hospital Lab No: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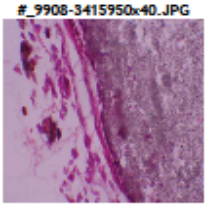
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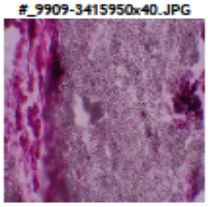
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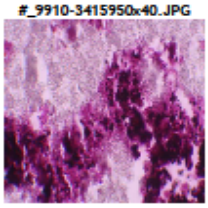
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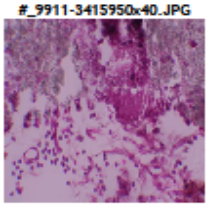
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MICROSCOPIC DESCRIPTION:

The sections present fragments of ceramic body with walling off fibroadipose tissue showing mild/moderate/severe foreign body reaction and some changes as followed

1. foreign body reaction = 3+

2. cellular infiltration into the ceramic body =present

3. dystrophic calcification in the ceramic body = present

4. displacement of ceramic components in to surrounding host tissue = present

NOTE: Foreign boby reaction grading

grade I (1+)= mild mixed cellular inflammatory infiltration and presence of fibroblasts

grade II (2+) = presence of minimal epithelioid cells with or without small size of monocytoid foreign body giant cells

grade III (3+) = presence of some epithelioid or large size multinucleated foreign body giant cells.

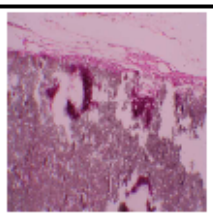
38999 Other

Received: 12-11-2014 **Reported:** 12-11-2014 14:15:36
Pathologist: Dr. Kamthorn Thamprasert **Consultant:**
Online-Approved by Kamthorn Thamprasert MD FRCPath

คลินิกพยาธิวิทยาเชียงใหม่ เวชกรรมเฉพาะทาง 3/37 ถ.สามล้าน ต.พระสิงห์ อ.เมือง จ.เชียงใหม่ 50200 Tel.053-814476 Fax.053-904368 095-6899339

SURGICAL PATHOLOGY REPORT

Operation Date: 5R-180 Age: 0 HN: 0 ANI3415951
Hospital: ภาควิชาฟิสิกส์และวัสดุทางการแพทย์ Doctor: Hospital Lab No: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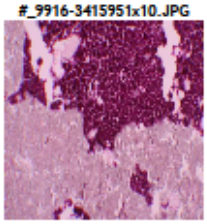
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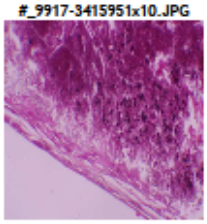
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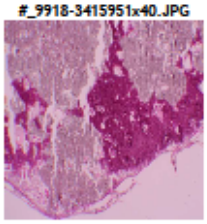
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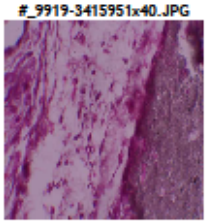
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MICROSCOPIC DESCRIPTION:

The sections present fragments of ceramic body with walling off fibroadipose tissue showing mild/moderate/severe foreign body reaction and some changes as followed

1. foreign body reaction = 2+

2. cellular infiltration into the ceramic body = present

3. dystrophic calcification in the ceramic body = present

4. displacement of ceramic components in to surrounding host tissue = present

NOTE: Foreign boby reaction grading

grade I (1+)= mild mixed cellular inflammatory infiltration and presence of fibroblasts

grade II (2+) = presence of minimal epithelioid cells with or without small size of monocytoid foreign body giant cells

grade III (3+) = presence of some epithelioid or large size multinucleated foreign body giant cells.

38999 Other

Received: 12-11-2014 **Reported:** 12-11-2014 14:15:44
Pathologist: Dr. Kamthorn Thamprasert **Consultant:**
Online-Approved by Kamthorn Thamprasert MD FRCPath

คลินิกพยาธิวิทยาเชียงใหม่ เวชกรรมเฉพาะทาง 3/37 ถ.สันต้น ต.พระสิงห์ อ.เมือง จ.เชียงใหม่ 50200 Tel.053-814476 Fax.053-904368 095-6899339

APPENDIX F

Certificate of Approval For Use of Animals

Certificate of Approval
For Use of Animals
Faculty of Medicine, Chiang Mai University

Protocol Number: **08/2549**
Title of project: **Processing and Characterization of Cow Bone for Human Bone Graft Substitute**
Principal investigator: **Associate Professor Sittiporn Punyanitya, M.D**
Affiliation: **Department of Surgery**

The Faculty of Medicine, Chiang Mai University, supported by the results of Animal Ethics committee review in the meeting **4/2549** dated **26 June 2006** that the use of animals in the project conforms with international and national guidelines for ethical conduct on the care and use of animals,

Hereby approves the research proposal to be conducted under its proposed scheme. The approval is effective from **26 June 2006**

Nimit Morakote
Nimit Morakote, Ph.D
Associate Professor
Chair
Date 30 June 2006

Supot Wudhikarn
Supot Wudhikarn, M.D.
Professor
Dean
Date 3 July 2006

Curriculum Vitae

Name Mr. Rungsarit Koonawoot

Date of Birth August, 14, 1974

Place of Birth Chiang Mai Province, Thailand

Education

1990: Junior High school, Prince Royal College, Chiang Mai, Thailand

1993: Senior school, Prince Royal College, Chiang Mai, Thailand

1997: Bachelor of Science (Materials science), Faculty of Science, Chiang Mai University, Chiang Mai, Thailand

2010: Master of Science (Industrial Chemistry), Faculty of Science, Chiang Mai University, Chiang Mai, Thailand

Publication

1. **R. koonawoot**, S. Thiansem, S. Punyanitya and A. Raksujarit.. "Physical and mechanical properties of films made from rice starch and bovine bone powder composite" North . Reg . J . Sci . Tech, Vol. 3, N0. 1, January – April (2010). (Master degree)

2. **R. Koonawoot,** S. Thiamsem**,** S. Punyanitya**,** A. Raksujarit, S. Laosatirawong**,** "Structure and Mechanical Properties of Rice Starch and Bovine Bone Powder Composite Films" Chiang Mai Med J, 49(4):139-144**,** (2010). (Master degree)

3. **R. Koonawoot** "Fabrication of Gelatin/Carbon Nanocomposite for Human Tissue Adhesive". Advanced Materials Research, (2010). (Master degree)

4. S. Punyanitya, **R. Koonawoot**, S. Thiansem, S. Laosatirawong and A. Raksujarit. "Absorbable Suture Mede From Rice Starch" Advanced Materials Research, 123-125, 291-294 (2010). (Master degree)

5. S. Punyanitya, **R. Koonawoot**, and A. Raksujarit. "Biodegradable rice starch/hydroxyapatite nanocomposite scaffolds for bone repairing applications".

Proceeding of The Second International Symposium on Surface and Interface of Biomaterials (ISSIB-II) (2010), p. 105. (Master degree)

6. **R. Koonawoot**, S. Thiansem, S. Punyanitya, A. Raksujarit, S. Laosatirawong, W. Pompimon. "Synthesis of Hydroxyapatite Powder from Mollusc shell". Advanced Materials Research. Vols. 311-313, pp. 1621-1624 (2011). (Ph.D.)

7. **R. Koonawoot,** C. Saelee, S. Thiansem, S. Punyanitya. "Influence of composition and isothermal sintering on the properties of hydroxyapatite bioceramic bodies". Advanced Materials Research. Vol. 979, pp. 3471-350 (2014). (Ph.D.)